Evaluating the Impacts of Urban Freight Traffic on the Network and Environment

An Application of Microscopic Simulations and Environmental Impact Assessment on a Shopping Mall

Master's Thesis in Infrastructure and Environmental Engineering

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Gothenburg, Sweden 2022
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Cover: An illustration of microscopic simulation model in PTV-Vissim.

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Abstract

Urban freight transportation (UFT) is an aspect of infrastructure and urban planning that often gets neglected despite the impact it has on traffic operations and the environment. In this study, the effect that UFT has on a network is inspected. The purpose of this master's thesis is to examine the impact that UFT has on the network performance around the shopping mall Kungsmässan, located in Kungsbacka, using the traffic simulation software PTV VISSIM. The study also aims to investigate the environmental impact that the traffic has, namely the air quality, by inspecting the NO_x and PM_{10} emissions. For this, EnViVer Pro is used. These investigations are conducted for the year 2021 to see the current network performance and 2030, mainly to compare the emission values with the environmental goals of 2030 and 2045 set by the Swedish Government and the EU. A literature study is provided to present information for further understanding of the thesis, such as emission details, models used in the study and explanations of some relevant PTV VISSIM tools.

Data provided by Aranäs AB, Norconsult AB, the Swedish Administration of Transportation, and Ramboll, is analysed, calibrated, validated and used as input values in PTV VISSIM. To determine the impact that UFT has on the study area, two scenarios for the year 2021 are used: one where all vehicles are accounted for and another consisting of only light vehicles. Two additional scenarios of the same type are used for the prognosis, where the input data has been altered. Based on the results from the simulations, the environmental impact assessment (EIA) is produced in EnViVer Pro. The results showed that UFT significantly effects the traffic flow but that the impact will decrease over time. This is likely due to a decrease in the share of UFT in the future. Furthermore, the EIA shows that the NO_x emissions exceed the hourly exposure, according to the limitations set by the Swedish government. PM_{10} do not exceed the national regulation's daily limit value. However, in the most critical points of the network, where vehicles decelerate, accelerate and form queues, the concentration of the pollutant is close to the limit value. In conclusion, the study shows that the UFT has a substantial impact on the network performance and air quality, both now and in the future. Thereby, the results indicate on the importance of establishing a sustainable urban logistics plan in order to achieve the national and international objectives for the years 2030 and 2045.

Keywords: Microscopic traffic simulation, HGV, UFT, EIA, Air pollutants, NO_x, PM_{10}, PTV VISSIM

Utvärdering av godstransporters påverkan på trafiknätverket och miljön
En tillämpning av mikroskopiska simuleringar och miljökonsekvensbedömning på ett köpcentrum
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Sammanfattning

Godstransporter är en aspekt av infrastruktur och stadsplanering som ofta försummas trots dess påverkan på trafiken och miljön. I denna studie inspekteras effekten som godstransporter har på ett nätverk. Syftet med detta examensarbete är att undersöka vilken inverkan godstransporter har på nätverkets prestanda kring köpcentret Kungsmässan, beläget i Kungsbacka, med hjälp av trafiksimuleringsmjukvaran PTV VISSIM. Studien syftar också till att undersöka vilken miljöpåverkan trafiken har, i synnerhet luftkvaliteten, genom att undersöka NO_x- och PM_{10}-utsläppen. För detta används EnViVer Pro. Dessa undersökningar görs för år 2021 för att se nuvarande nätprestanda och 2030, främst för att jämföra utsläppsvärdena med miljömålen 2030 och 2045 som satts upp av den svenska regeringen och EU. En litteraturstudie tillhandahålls för att presentera information för ytterligare förståelse av avhandlingen, såsom emissionsdetaljer, modeller som används i studien och förklaringar av några relevanta PTV VISSIM-verktyg.

Data som tillhandahålls av Aranäs AB, Norconsult AB, Trafikverket och Ramböll analyseras, kalibreras, valideras och används som ingångsvärden i PTV VISSIM. För att fastställa vilken påverkan godstransporter har på studieområdet används två scenarier för år 2021: ett där alla fordon redovisas och ett annat som endast består av lätta fordon. Ytterligare två scenarier av samma typ används för prognosen, där indata har ändrats. Baserat på resultaten från simuleringarna tas miljökonsekvensbedömningen fram i EnViVer Pro. Resultaten visade att godstransporter påverkar trafikflödet signifikant men att påverkan kommer att minska över tiden. Detta beror sannolikt på en minskning av andelen godstransporter i framtiden. Vidare visar miljökonsekvensbedömningen att NO_x-utsläppen överstiger timexponeringen, enligt de begränsningar som den svenska regeringen har satt. PM_{10} överskrider inte den nationella förordningens dagliga gränsvärde. Däremot ligger koncentrationen av föroreningen nära gränsvärdet i de mest kritiska punkterna i nätet, där fordon bromsar, accelererar och bildar köer. Sammanfattningsvis visar studien att godstransporter har en betydande inverkan på nätverkets prestanda och luftkvalitet, både nu och i framtiden. Därmed pekar resultaten på vikten av att upprätta en hållbar stadslogistikplan för att nå de nationella och internationella målen för åren 2030 och 2045.

Nyckelord: Mikroskopisk trafiksimulering, Tunga fordon, Godstransporter, Miljökonsekvensbedömningen, Luftföroreningar, NO_x, PM_{10}, PTV VISSIM

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Sukaina Didi, Ida Sokhi, Gothenburg, June 2022

List of Acronyms

A compilation of all acronyms used in this master's thesis study are provided in the following list:

CI	Compression Ignition
CNG	Compressed Natural Gas
EIA	Environmental Impact Assessment
GHG	Green House Gas
HGV	Heavy Goods Vehicle
LNG	Liquified Natural Gas
MKN	Miljökvalitetsnormer
NOx	Nitric Oxide
OAT	Once At a Time
PM	Particulate Matter
SCR	Selective Catalytic Reduction
SI	Spark Ignition
UFT	Urban Freight Traffic

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1 Introduction

Urbanisation has characterised the 20th and 21st centuries, where industries in cities have attracted people from rural areas whilst both the economy and the population has grown across the globe (Encyclopedia Britannica, n.d.). In 1950, around one third of the world's population lived in urban areas. Today, that number is closer to 50% and in 2050 it is predicted to have increased to two thirds of the population (UN, 2019). While urbanisation and globalisation has had various prosperous affects such as higher GDP, there are factors that become increasingly challenging along with the development of the phenomenon. City planning, traffic engineering and urban logistics are examples of such. With extensive demographical changes comes challenges within mobility and logistics, such as congestion, higher emissions and a higher demand of goods and services.

Today, approximately 72% of the population of the countries in the EU-28 live in urban areas (European Investment Bank, 2019) and by 2050, this number is predicted to increase to about 84% (European Commission, n.d). Within the EU, road freight transport alone increased by 1.3% between the years 2017 and 2018 (EU, 2019). Thereby, for cities and communities to develop sustainably, it is important to plan for sustainable transportation and urban logistics. However, that is something rarely prioritised when planning in public sectors (Sánchez-Díaz, I., Holguín-Veras, J., & Jaller, M., 2015). Without careful planning and consideration of freight transports, issues such as congestion, emissions, and noise can become huge costs for the society.

In Sweden, the rate of urbanisation has varied since the 1960's, as can be seen in Figure 1.1 (the World Bank Data, n.d.). During the past 40 years, suburban municipalities, towns, and cities have grown by 70%, 20% and 11% respectively (Government Offices of Sweden, 2016). The increasing growth in the suburbs has led to expansion of housing and infrastructure in the hinterland surrounding the cities and has thereby caused urban sprawl. However, in the recent years investments and efforts have been made to densify urban areas. It will help to reduce the negative effects sprawling has on the society economically, socially, and environmentally. Moreover, it also improves utilisation of already existing land-use and infrastructure, and it enables a more sustainable future. Furthermore, migration surplus has been the main reason for the rapid population growth in recent years. That has contributed to the need of rapid urbanisation and densification in urban areas in the country.

Today, numerous urban areas surpass environmental goals set by the UN, the EU and national organisations and authorities, which drives countries to act on the issue (Holman et al., 2015). Several countries have therefore implemented policies and laws regarding urban mobility and road traffic as an effort to make transportation more sustainable. In Sweden in 2020, transportation constituted 31% of greenhouse gas (GHG) emissions and freight transportation made up roughly 30% of the transportation sector (Naturvårdsverket, n.d.). Further, in urban tracking, traveling in congested traffic is the main negative environmental impact (Holguín-Veras et al., 2018). Consequently, it is crucial to reduce the GHG emissions within the transportation sector to diminish climate change. Within land-use planning and civil engineering, this challenge along with urbanisation is highly relevant.

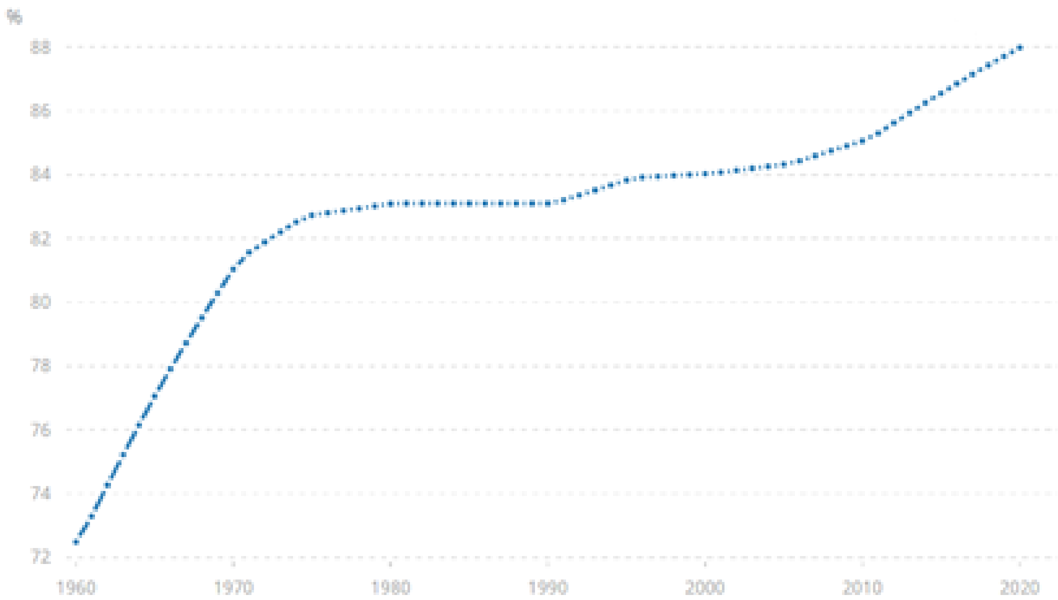


Figure 1.1: The graph visualises the percentage of urban population in Sweden through-out the years (the World Bank Data, n.d.).

1.1 Urban Freight Traffic

The continued growth in urbanisation, along with the development of new technologies (e.g., e-commerce) is expected to have a significant impact on the demand of urban freight (Zhang, 2021). This in turn, is assumed to have an impact on the network performance in urban cities as well as on the environment.

The European Road Transport Research Advisory Council (ETRAC) and Alliance of Logistics Innovation through Collaboration in Europe (alice) is currently conducting research to produce a roadmap on urban freight and logistics and how to sustainably improve and progress it (ETRAC, 2015). For instance, several guiding objectives have been established for 2030 (e.g., Regulation EU 2019/1242), one of which is decarbonisation, which involves sustainable progress in infrastructure as well as transportation and urban freight. A key factor for this objective is energy efficiency, both in the aspect of the development of vehicle fuels and charging infrastructure and consolidation of goods delivery. Such development would not only gradually reduce carbon emissions, but it would also increase the efficiency of urban freight in general.

Improving the local environment is also an objective that ETRAC and alice deems as important to improve until 2030 (ETRAC, 2015). There are two emission values that are mainly focused on for this objective: NO_x and PM. Emission reduction within vehicles and making the system of road freight operation in urban areas more efficient, are two tangible ways of lowering these emission rates. Stricter requirements on euro classes are also estimated to make a notable change for the better in this regard. It is expected that a vehicle fleet consisting of Euro 6 vehicles solely will emit 80% and 90% less NO_x and PM respectively, compared to a fleet that has an average Euro 4 vehicles. Moreover, further development in electric vehicles and other technological breakthroughs in road freight transportation could further improve the local environment.

A different local emission that urban freight causes is noise. HGV operation and loading and unloading of goods can cause disturbance for citizens and can affect their health. One solution to this is night delivery, although it is best suited for larger cities.

Further efficiency in urban delivery system and logistics operation will improve all aspects mentioned. City planning along with regulations are therefore key factors in this regard.

1.1.1 Swedish Instruments for All Transport

There is currently an ongoing emission reduction policy in Sweden to decrease the negative environmental impact that the transportation sector accounts for. As mentioned in Chapter 1, the transportation sector accounts for one third of the GHG emissions. Consequently, the Swedish government has introduced several comprehensive policies in year 2018 to achieve certain environmental goals by the year 2020 – 2045 (Naturvårdsverket, n.d.). The long-term objective for Sweden is to have zero net emissions of GHG emissions into the atmosphere by year 2045, to subsequently achieve negative emissions. The Swedish government has also decided that GHG emissions from domestic transport, excluding domestic flights, is aimed to reduce by at least 70% by the year 2030 compared to 2010. There are also policies for emission reduction from activities not included in the European Union Emissions Trading Schema (EU ETS) for year 2020, 2030 and 2040. Figure 1.2 presents Sweden's emission targets. It is also worth to emphasize that researchers (Montzka et al, 2011: EPA, 2022 et cetera) have found that non-CO_2 greenhouse gases such as NO_x and PM have a substantial contribution to the increase of GHG-emissions and climate change. Thus, implying the importance of reducing GHG-emissions as well as pollutants categorised as non-CO_2 greenhouse gases to achieve the set objectives.

Moreover, the political parties of Sweden have all agreed on including consumption-based emissions on Sweden's climate objectives (Motion 2020/21:2061). I.e., in addition to including emissions that are produced in Swedish territory, the climate objectives will also include emissions of Swedish consumption that are produced abroad (e.g., transport, food, clothing etc.). Thus, further indicating on the importance of reducing the produced emissions.

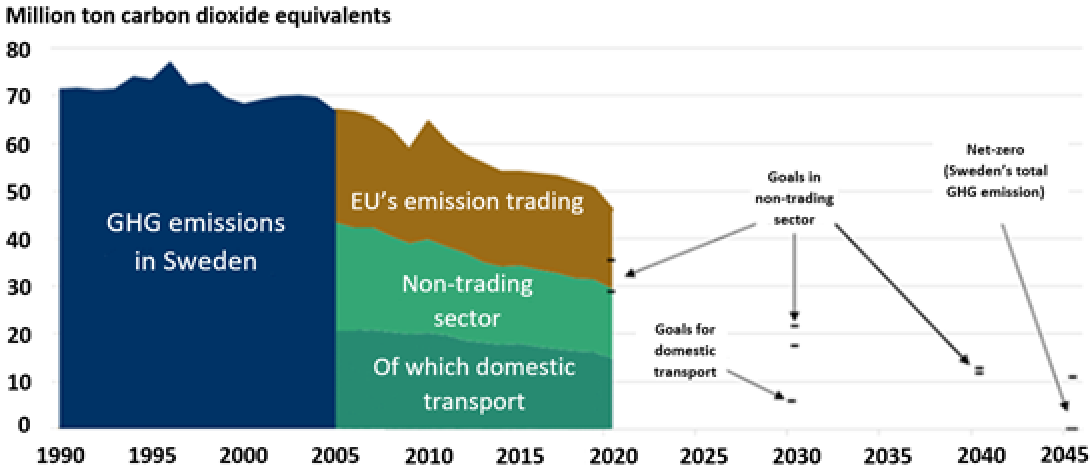


Figure 1.2: Sweden's emission targets from year 1990-2045 (a modified figure from Naturvårdsverket, n.d.).

1.2 Case Study

The municipality of Kungsbacka has a land area of approximately 610 square kilometres, and a population of approximately 85,000 inhabitants (Ekonomifakta, n.d). Kungsbacka is located along the west coast with a distance of 30 kilometres from Gothenburg in the north and 50 kilometres from Varberg in the south. The European routes E6 and E20, as well as the railway between Gothenburg and Malmö runs through the municipality. As a result, the area has a great amount of road transports, both through and to, and the demand is estimated to increase in the future (Kungsbacka, n.d-a). The close connection between Kungsbacka and Gothenburg is expected to continue to affect Kungsbacka and its development in the future. In Gothenburg, the number of inhabitants increased by 2,7% between 2018 – 2021 (SCB, 2022). As the city continues to grow, the neighbouring municipalities does so as well. Subsequently, Kungsbacka is assumed to face challenges within managing demand and expanding the use and implementation of infrastructure.

Kungsbacka has some road transportation policies addressed to its own government with the aim to utilise transportation that meet their safety and environmental criterium (Kungsbacka kommun, n.d-c). These requirements regard vehicles that the municipality purchase for municipal services. Moreover, the municipality of Kungsbacka is currently working on a traffic strategy that aims to develop transportation within the area in a way that is safe and sustainable (Kungsbacka kommun, n.d-b).

The strategy is expected to be complete and implemented in 2024. As of currently, there are no road transportation policies addressed to the public or urban logistics.

The area to be analysed is a shopping centre, Kungsmässan, located in the centre of Kungsbacka, approximately 25 kilometres from Gothenburg with an area of 11,000 square meters (see Figure 1.3). Adjacent to the shopping centre, is a senior high school to the north, a residence area along with some shops to the west, a residence area along with the railway in the east and a residence area with numerous offices to the south.

The study area constitutes of four roundabouts and one non-signalised T-intersection, see Figure 1.3. The minor road that is merged with the major road (i.e., Borgmästaregatan) creating a T-intersection is connected to a small parking area with approximately 20 parking spaces. The back entrance of the shopping mall which goes through Lindälvsgatan constitutes of a few parking spots for the public and a larger space for authorised personnel (personnel vehicles, urban freight traffic (UFT)). Furthermore, the streetscapes in the study area are also pedestrian and bicycle friendly for non-motorised users. There are sidewalks for pedestrians and bicyclists at Borgmästaregatan, as well as Lindälvsgatan (senior high school) and the north of Varlavägen (marked as N959). Overall, the study area is characterised for its open streets and low buildings. However, Borgmästaregatan is currently being densified with buildings up to 3-4 floors. Furthermore, the study area mainly constitutes 1+2 and 1+1 roads. Kungsmässan has approximately 100 boutiques, cafés, restaurants, and an average of five million visitors per year (Kungsmassan, n.d.).

1.3 Aim and Objectives

The aim of this master thesis is to evaluate the impact UFT has on the network and the environment by building a model of Kungsmässan in the software PTV VISSIM. The performance of the network with and without UFT will be evaluated through selected measures. An environmental impact analysis (EIA) will also be conducted to estimate the environmental influence that UFT has on the study area through PTV VISSIM's add-on EnViVer Pro. Furthermore, a future prognosis of the study area will be implemented with the aim of detecting potential issues regarding traffic flow and emissions. The aim of this master's thesis is also to contribute to research and development on ongoing policy making and technical solutions to achieve a sustainable urban logistics.

1.4 Research Questions

The study of this master's thesis will answer the following research questions:

1. What are the impacts of UFT on the operational quality of a traffic network in Kungsmässan in year 2021 and 2030?
2. How great is the environmental impact of UFT in Kungsmässan in year 2021 and 2030?

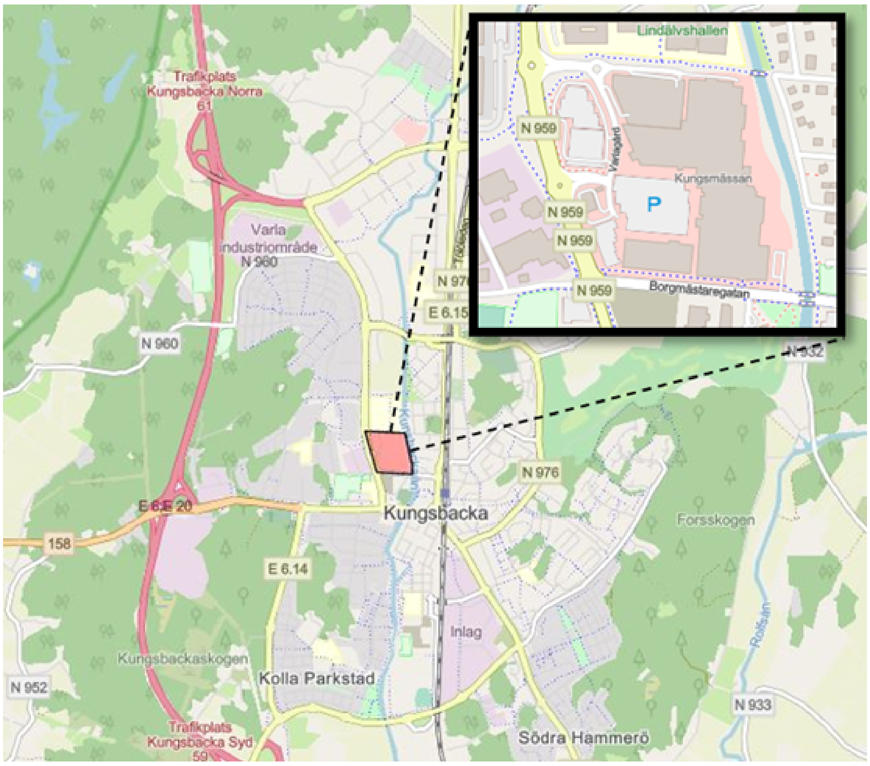


Figure 1.3: Map over the municipality of Kungsbacka. The red highlighted zone with black lines enfolding it is the study area (own figure).

1.5 Delimitations

To evaluate the impact UFT has on the network and the environment, a limited study area has been chosen – Kungsmässan, Kungsbacka. Furthermore, the type of UFT that will be considered in this study will solely be road transport. The provided traffic data from Aranäs AB was limited in terms of vehicle weight, i.e., notations of whether the vehicle was light or heavy. That is, vehicles less than 3,500 kg are considered to be light vehicles, and vehicles surpassing 3,500 kg are considered to be heavy vehicles. Thus, the consideration for motorcyclists, buses etc. could not be accounted for in this study. Furthermore, the provided traffic data has also been limited to certain roads of the study area. To calibrate the traffic flow in the entire Kungsmässan, data provided by Norconsult, data from a traffic report conducted by Ramboll in 2019, and The Swedish Administration of Transportation's database TIKK was also used. The data from TIKK and Ramboll was collected in 2014 and 2015, respectively. The data provided by Aranäs AB and Norconsult were both collected in 2021, with one month difference in the measured data. To calibrate the traffic flow with the assembled data from these different sources, an assumption was made that the traffic volume did not change during the timespan of the different data collections.

The build up model in PTV VISSIM is constrained to solely analyse the traffic situation in the study area and some adjacent roads that has a significant influence, see Figure 1.3. This is to consider the influence that the traffic volume of adjacent roads has on the study area when entering it. Furthermore, the topography of the study area was considered to be flat, and thus no regard to elevation levels in the traffic network model was made. The results of the network performance will be based on selected outputs in PTV VISSIM.

For the EIA, it was determined that two pollutants would be analysed: NO_x and PM_{10}. The performance of EIA had some constraints which were mainly based on the attributes of the interface EnViVer Pro. The interface is simplified and does not take into account some driveline technologies, it has thresholds for certain input values etc. To account for all these limitations and enable a representative emission model for the Swedish vehicle fleet, some assumptions have been made which are thoroughly addressed in Chapter 3.4. The EIA for the future prognosis also had some limitations, as predicted traffic data can never be fully certain.

Furthermore, this study will address the environmental impact in terms of air quality. It is worth to mention that it is common to address the generation of CO_2 when conducting traffic analysis. However, since the addressment of CO_2 is within the scope of climate issues, and not directly an indicator on air quality, this study will exclude the assessment of its emission. Nonetheless, among the pollutants that are common in the assessment of air quality is NO_x and PM_{10}. Thus, the aforementioned pollutants are on the focus when performing the EIA.

2
Theory

This chapter composes of essential theories and models for the comprehensive understanding of this study. Thus, a an overview of the emissions and its impact will be presented, as well as some modelling theories that are the core ground for the techniques used in the methodology. There will also be a section regarding the main network elements in the study area and its corresponding regulations, as well as some important software tools for the microscopic modelling.

2.1 Emissions

Emissions are usually classified into two groups: global and local emissions. Global emissions (tailpipe) cover pollutants such as CO_2, (from C-containing fuel, i.e., all fuels today), methane (from HD-dual fuel such as LNG) and N_2 O (occasionally in SCR systems). Local emissions cover pollutants such as CO and HC (from unburned fuel), NO_x (high temperature combustion), PM (pyrolysis at locally rich zones) and noises (Sims, R., et.al., 2014). These emissions are also grouped into exhaust and non-exhaust emissions. Exhaust emissions refer to pollutants from incomplete combustion of fuel, whereas non-exhaust emissions refer to pollutants from brake wear, tyre wear, road surface wear etc (Nriagu, 2019). Global and local emissions contribute to a series of adverse health issues as well as climate effects due to the indirect effect on GHG-emissions. According to WHO (2019), it is estimated that seven million people worldwide die every year due to air pollution. Researchers (T. Da Silva et al., 2021; Gustaffson et.al., 2014 etc.) have also proven a positive correlation with premature deaths and an increase in societal costs.

Emissions and pollutants are commonly assessed in weight or concentrations. The difference between the two measurements is that emissions in weight (e.g., gram), gives a quantitative indication on the pollutant released into the atmosphere and are usually based on a certain time interval. The latter measurement, concentration, quantitatively provides the amount of pollutants released into the atmosphere per volume and is an indication on the air quality. The two measurements have a positive correlation, whereas the generated emissions increase the concentrations. A combination of the two measurements provides a comprehensive understanding of the environmental impact.

Furthermore, emissions from road traffic mainly contributes to NO_x and particles but can also result in increased levels of other local emissions (Naturvårdsverket, 2019). There are also other local sources that could be contributing factors to the total produced emissions such as industries, wood burning etc. Depending on the local sources, the background concentration will vary geographically. The produced emissions are also affected by climate, and thus the number of produced emissions and the speed of its production will also vary depending on geographical locations. The contribution of emissions and its corresponding concentration is also highly dependent on topography and building structure. In areas where it is densified with buildings reaching 3-4 floors or higher, the circumstance for ventilation is worse which eventually contributes to increased concentrations. The concentrations could further increase by the fact that adjacent neighbourhoods constitute of equally high floors. The reason for this mechanism is that ventilation occurs between the buildings or such. The newly produced emissions from vehicles mixes with air between the buildings, and depending on the wind direction, the air might repeatedly circulate in the same area which will after a period of time increase the concentration of pollutants, see Figure 2.1. The latter figure shows how ventilation occurs between two buildings (red-marked), whereas the arrows represent the wind's direction and strength. The car to the right bottom emits pollutants, whereas the highest concentration of the pollutant is red-marked at the lower part of the streetscape. Clean air descends from the upper right part due to the driving force of the wind. The spread and ventilation of air is a key component to the gradient of air quality. Thus, it could be stated that the improvement of air quality is dependent on ventilation which is in turn dependent on the wind direction and its relation to the streetscape, circulation pattern, vortex formation, the dimensions of the buildings and such of the streetscape etc.

There are regulations based on the EU directive (dir 2008/50/EG; dir 2004/107/EF) on air quality that have been implemented in the Swedish legislation (Göteborgs stad, n.d). The Swedish regulations are the Air Quality Ordinance which is also called MKN (2010:477), and the regulations of Swedish Environmental Protection Agency's (NFS 2019:9). Furthermore, in addition to the regulations, there are objectives that Sweden potentially wants to achieve, as well as Gothenburg as a city (see Chapter 1.1).

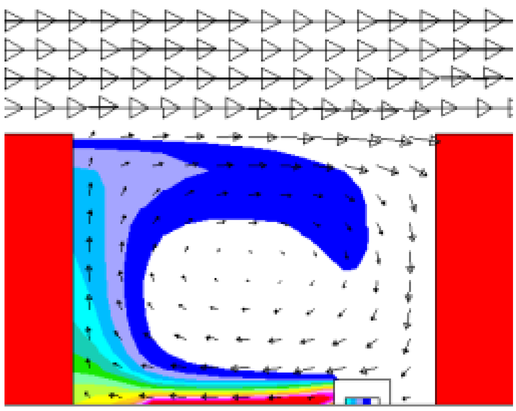


Figure 2.1: A vertical cross-section of the spread of pollutants in a streetscape and how it is ventilated.

2.1.1 NOx

Nitric oxides, which are local emissions, are formed in high temperature combustion processes, which is eventually oxidised in the air to NO_x (Karolinska Institutet, 2014). The term refers to both NO and NO_2. Furthermore, the exposure of the pollutant is mainly caused by traffic and reaches its peak in densified urban areas during winter season due to heating processes (cold start engines), traffic peak hours, and when the wind speed is low. The exposure of NO_x has decreased in past years since the introduction of catalysts and stricter exhaust gas requirements in the 1980s but have remained at a constant level since 2012 constituting of 42% of total emissions in Sweden. This is partly due to the increasing proportion of diesel vehicles (CI-engines) in traffic, which emits more NO_x than petroleum powered vehicles (SI-engines). Although there has been a significant decrease of NO_x in recent years, studies shows that the pollutant has exceeded the thresholds of MKN in many urban areas in Sweden (Naturvårdsverket, 2019).

MKN has set the annual, daily, and hourly average exposure of the pollutant to 40µg/m^3, 60µg/m^3 and 90µg/m^3 respectively (Naturvårdsverket, n.d.-d). It is specified in the regulations, that the average hourly exposure of the pollutant is solely allowed to exceed 175 times per year. The threshold for the average hourly exposure is on the 98th percentile. The thresholds set by MKN are not as stringent as the ones set by WHO which are 10µg/m^3 annually and 25µg/m^3 daily (WHO, 2021). WHO does not specify any thresholds for the hourly average exposure of the pollutant.

The levels corresponding to the current MKN indicate that the mortality in a population is 6% higher than that at a limit value of what WHO recommends (Karolinska Institutet, 2014a). A report by Gustafsson et al. (2014) presents studies showing a positive correlation with exposure of NO_x, increased societal costs, negative health effects and premature deaths. A prolonged exposure of NO_x has almost the same effect on mortality as $PM_{2.5}$, i.e., mortality due to e.g., cardiovascular diseases (Naturvårdsverket, 2019). Studies from the latter source, also provide evidence that short-term exposure of NO_x contributes to negative health impacts that consequently results in premature deaths. It has also been proven that low concentrations of NO_x, i.e., equal or below the thresholds of MKN, has shown negative health impacts for children's respiratory. Nevertheless, it is also evident that the pollutant has a negative impact on the environment as it is contributing to acidification (EPA, 2021c), the production of ozone which consequently results in greenhouse effect and other secondary aerosols which also have adverse health and climate effects (EEA, 2018).

2.1.2 PM

Particulate matters, which is a local emission, are along with the aforementioned emissions, one of the main pollutants in Europe. The pollutant constitutes primarily of solid particles made up of e.g., sulphate, nitrates, ammonia, black carbon (black carbon contributes to greenhouse effect) etc, and liquid droplets in the air (EPA, 2021b). PM are usually categorised into the following groups: $PM_{0.1}$, $PM_{2.5}$, and PM_{10}. The particles with the smallest size, i.e., an aerodynamic diameter [µ] of 0.1, are formed during the combustion of various fuels, whereas $PM_{2.5}$ is formed during incineration and industrial processes (Karolinska Institutet, 2014b). The particles with coarser size, PM_{10} is formed during mechanical processes, e.g., when brakes, tyres, road surfaces wear.

According to MKN, the thresholds for the annual and daily average exposure of PM_{10} respectively is 40µg/m^3 and 50µg/m^3 (Naturvårdsverket, n.d.-d). There are no thresholds for an hourly exposure of the pollutant. The thresholds set by MKN are well above the air quality guidelines levels set by WHO which are 15µg/m^3 annually and 45µg/m^3 daily (WHO, 2021). There are reports (Miljöförvaltningen, 2020 etc.) that have shown that the exposure of PM_{10} have been exceeded in many places in Sweden, especially in urban areas. Domestic transport in Sweden is the largest source of emissions of PM_{10} and accounts for 47% percent of Sweden's total emissions (Naturvårdsverket, n.d.-b).

There is a consensus among researchers that PM are the pollutants with the most severe effects on the human health (Karolinska Institutet, 2014b). This is because the small sized particles are inhaled into the lungs, and can consequently cause cardiovascular diseases, asthma, stroke etc. According to Naturvårdsverket (2019), particles with coarser size has a significant negative health impact on short-term. However, it is not known the impact of PM_{10} in a long-term perspective. According to Gustafsson et al. (2014) there is a study that estimates the number of premature deaths caused by PM_{10} to be 3,400 per year. The authors (2014) further states that the yearly societal costs are validated to estimate approximately 35 billion SEK in year 2010 in Sweden. Furthermore, the pollutant also has severe effects on the environment such as: acidic rain and water (lakes), depleting nutrients in soil, rubbing the ecosystem (biodiversity) and more (EPA, 2021a).

2.2 Modelling

A scientific approach to analyse a complex phenomenon is the concept of creating a model of a system. According to the Oxford English dictionary, a system is *"A collection of artificial objects organized for a particular purpose, as components of a mechanism, roads, architectural features etc"* (OED, n.d.). The purpose of creating a model is to comprehensively understand how a system operates by replicating a real-world scenario. There are different ways of modelling a system, and they all depend on what the objective of the model is. For this study, the types of models that will be used are microscopic traffic flow, calibration, and emission modelling. This chapter will present the fundamental theories that compose the aforementioned models and also provide relevant theory on network elements and important PTV VISSIM tools.

2.2.1 Traffic Flow

Traffic flow models have been introduced in the early 20th century to enable the understanding of dynamics of traffic flow and have been developed ever since (van Wageningen-Kessels et al., 2014). Moreover, it is important to distinguish the difference between transportation and traffic flow. According to Barcelo (2010), transportation generally considers aspects such as *"... efficient, safe, and sustainable movement of people and goods"*. Whereas traffic flow is a tool to analyse *"... the capacity and traffic operational quality of transportation facilities"*. I.e., traffic flow theories are based on analysing the operational quality (speed, delay, or travel time) within a traffic stream.

The author further explains that the key elements influencing the operational quality of traffic flow are the characteristics of the vehicle, the driver/traveller, and the environment, see Figure 2.2. The characteristic of the vehicle includes what type of vehicle (weight and size), the engine characteristics which influences the acceleration/deceleration, speed etc. Furthermore, the behaviour of the driver/traveller has a great influence on the operational quality. I.e., depending on whether the driver is aggressive (stressed), or distracted (stress-free), the reaction to choosing the shortest gap will differ. The stressed driver will try to choose the shortest gap, which will eventually, if all drivers have the same behaviour, increase the capacity in comparison to the case of the distracted driver. The last key element, environment, composes the design (such as grade and horizontal/vertical alignment), weather, traffic signal controllers, signs, urban, or rural area etc. The interaction of all these key elements has a significant influence on the operational quality of traffic flow.

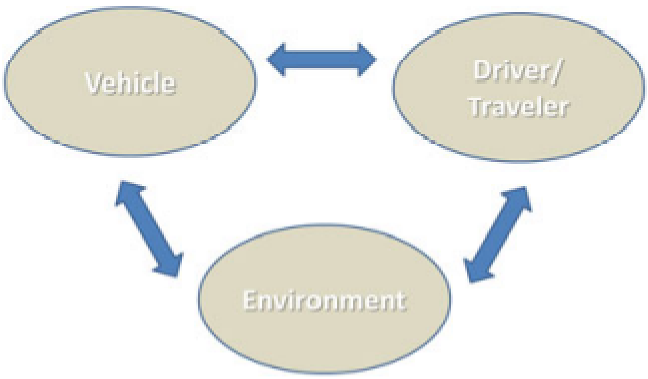


Figure 2.2: Key elements in operational quality for traffic flow (Barcelo, 2010).

Nevertheless, traffic flow models can be modelled macroscopically, mesoscopically, and microscopically. Macroscopic models are based on a holistic point of view, focusing on variables such as traffic density and traffic volume. The fundamental mathematical formula for traffic flow in macroscopic modelling is described in Equation 2.1 (Barcelo, 2010). The author refers to the formula as fundamental since it is the core ground for all other traffic flow models. Microscopic models are based on a more detailed level, focusing on describing the motion of individual vehicles, which collectively compose a traffic stream. Lastly, mesoscopic models are hybrid models of microscopic and macroscopic.

$$q(x,t) = k(x,t) \cdot u(x,t) \tag{2.1}$$

2.2.2 Microscopic Modelling of Traffic Flow

Microscopic models of traffic flow are based on the motion of individual vehicles that compose a traffic stream (Barcelo, 2010), as mentioned in Chapter 2.2.1. I.e., in addition to the fundamental relationship of traffic flow (see Eq. 2.1), acceleration, deceleration, and lane changes of individual vehicles are also considered. The microscopic model is mainly based on the car-following theory that was pioneered in the 1950s and further developed later. The authors Treiber. M, et al. (2013) define the car-following model as following: *"A car-following model is complete if it is able to describe all situations including acceleration and cruising in free traffic, following other vehicles in stationary and non-stationary situations, and approaching slow or standing vehicles, and red traffic lights"*.

The theory of car-following model is the description of the movement and trajectory of the following vehicle to the preceding vehicle. If the following vehicle has a desire for a high speed, then it will eventually enter a car-following state and its motion and trajectory will be dictated by the preceding vehicle. Fundamentally, the motion of vehicles in relation to each other can be described with Figure 2.3, as the main variables that compose the car-following theory are visualised (Elefteriadou, 2014). The preceding vehicle, Vehicle n, is followed by Vehicle n+1 at a time headway $h(n+1)_t$ and a distance $s(n+1)_t$. Eventually, after Δt, the distance between the Vehicle n, and Vehicle n+1 will become $s(n+1)_{(t+\Delta t)}$, and the time headway will be $h(n+1)_{(t+\Delta t)}$. The Δt is influenced by factors such as geometry, vehicle characteristics, traffic conditions which is first exposed to Vehicle n. The driving behaviour that Vehicle n uptakes according to these factors will then influence how Vehicle n+1 precedes to drive and the trajectory path it chooses to follow.

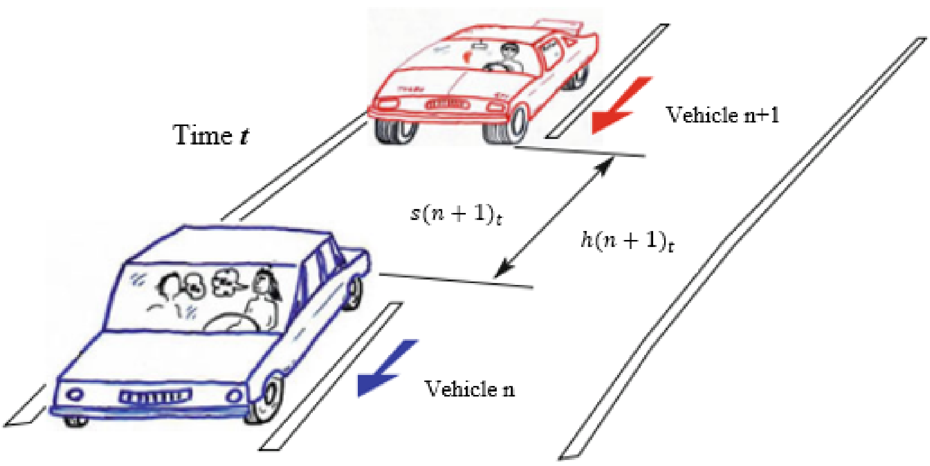


Figure 2.3: A conceptual model of the car-following theory (a modified figure from Barcelo, 2010).

The stimulus-response play an important factor in the car-following model and can be described with Equation 2.2 according to Barcelo (2010), where t is time and T is time lag.The sensitivity represents how the behaviour of the following vehicle influences the actions of the preceding vehicle. I.e., when the following vehicle closes upon the preceding vehicle, the more sensitive the reactions of the following vehicle will be to the actions of the preceding one. The stimulus represents the reaction of the driver to its surrounding.

$$Response(t + T) = Sensitivity \cdot Stimulus \tag{2.2}$$

There are currently many car-following models used in microscopic modelling such as the Wiedemann Model which is a discrete, stochastic and time-step based microscopic model (Elefteriadou, 2014). The Wiedemann model is used in the microsimulation software PTV VISSIM (PTV Group, 2011). The model is also referred to as a psychophysical model since it is based on the perception and action of the driver in different defined regimes. Figure 2.4 conspicuously displays the multi-regimes of the Wiedemann model which can fundamentally be categorised into four driving modes as following (Elefteriadou, 2014):

1. Free driving: no influence from the preceding vehicle, and the following vehicle seeks to reach or maintain its desired speed.
2. Approaching: when the following vehicle approaches the perception threshold SDV, and the process of the following vehicle adapting to the lower speed of the preceding vehicle. The following vehicle seeks to obtain a speed difference of zero to maintain a desired safety distance.
3. Following: this regime describes the driver's unconscious reaction to acceleration or deceleration but oscillates a speed difference around zero. Thus, approximately maintains a constant safety distance.
4. Braking/emergency: this regime constitutes mainly of the perception threshold AX and BX. The driver brakes in medium to high deceleration as the desired safety distance is smaller than the front to rear distance. An example of this scenario may occur when the preceding vehicle suddenly changes its speed or reacts to a sudden movement in the traffic stream.

In every regime, the acceleration/deceleration is based on the changes of speed, distance and the driving behaviour of the individual vehicle as explained by Elefteriadou (2014). The first driving mode, free driving, is represented by *"no reaction"* zone in Figure 2.4. The driver is not influenced by any traffic element and oscillates around its desired speed due to large relative space until it passes through the SDV threshold and enters approaching regime. The following vehicle reacts to the preceding vehicle and decelerates to avoid collision. The following vehicle then enters the following regime which constitutes of SDX, OPDV, BX and SDV, whereas the motion of the preceding vehicle affects the behaviour of following vehicle. The final regime represents the emergency regime. The emergency regime explains when the relative distance is smaller than the minimum safety distance between the following and preceding vehicle. The following vehicle must decelerate to avoid collision with the preceding vehicle.

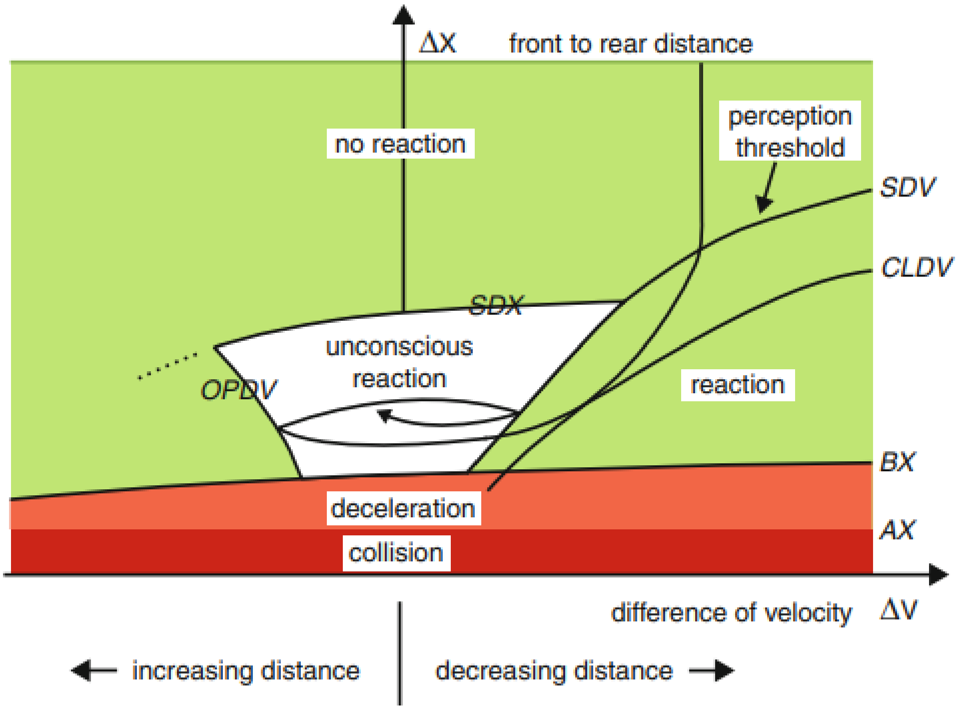


Figure 2.4: Illustration of the Wiedmann-model.

2.2.3 Calibration and Validation

The concept of model calibration is to find a unique set of model parameters that gives an accurate representation of a systems behaviour (The MBR Book, 2011). This can be achieved by confronting model predictions with factual measures that has been performed on the system. Model calibrations thereby enables probabilistic predictions that matches the real-world probabilities. As an example: there are two models, A and B, that each have an accuracy of 80%. Model A has a confidence of 0.81 of each prediction, whilst model B's corresponding value is 0.99. Since the values of model A's level of accuracy and confidence are the closest, it is the most dependable, realistic, and well-calibrated one (Naor, 2018). The model is confident that it will be correct about 80% of the times and it is indeed correct about 80% of the times. However, in model B, the confidence level exceeds the level of accuracy, and it is therefore not as reliable.

Formally, *"a model is perfectly calibrated if, for any p, a prediction of a class with confidence p is correct 100*p percent of the time"* (Naor, 2018). Mathematically, this can be expressed as:

$$P(\hat{Y} = Y|\hat{P} = p) = p, \forall p \in [0, 1] \tag{2.3}$$

Where:

$\hat{Y}$ is the label that the model gave the probability,
Y is the label for the real probability,
$\hat{P}$ is the label that the model gave the prediction,

p is the label for the real prediction,
P is the calibration

Essentially, this expression shows the perfect calibration, where the parameters of the model correspond perfectly to the real values, as Figure 2.5 visualises. Calibration of models are important if they compute probabilities (Vaicenavicius et al., 2019). The significance of the accuracy for the probability value varies for different types of models and the purpose that they fill. Models where the actual probability value is important are for instance once where several probability models are combined, where the predictions can affect each other. In many fields of engineering, uncertainty is a common factor in decision making due to lack of data (Mullins & Mahadevan, 2016). In such models, the accuracy of the probability value is essential. As technology has evolved and societies have developed a dependency on computer power, computer-aided engineering (CAE) has become a common instrument for decision-making in various fields of practice, including vehicles and traffic engineering (Lee et al., 2019). For these CAE models, it is crucial that the credibility is high and for models with unknown input variables, calibration can increase the reliability.

After a model has been calibrated, the credibility and accuracy of the calibration can be determined though model validation (Lee et al., 2019). This will determine how compatible the model is with the real phenomenon from the perspective of the use of the model. Model validation can also further improve the produced model based on the resulting findings. Testing of a model can be done either in parts of it or as a whole, using independent tests on a system level.

Since PTV VISSIM base their models on predicting the behaviour of each road user, it is important that they are calibrated and validated (Park & Schneeberger, 2003). Although traffic analysing techniques such as the ones used in PTV VISSIM are common within the transportation sector globally, there are no established formal or consistent guidelines as to how the models should be calibrated, validated, applied, or developed. However, in Sweden, the Swedish Transport Administration has published a manual for how traffic simulations can be used to determine capacities and passability. It includes method descriptions, as well as procedures for conducting calibration, validation, and sensitivity analysis (2014). These tools can thereby be applied to traffic analyses that are conducted in PTV VISSIM.

2.2.4 Sensitivity Analysis

Sensitivity analysis is the study of uncertainties of a mathematical model and how they can be allocated to sources of uncertainty in the inputs (Saltelli, 2002). By making alternative assumptions for variables and thereafter recalculating the outcomes, the impact of an input variable can be determined. This can for instance be used to analyse the model response, i.e., how the model neutralises the effect of uncertainties in the model (Hill et al., 2015). It can also better the understanding of the correlation between inputs and the affects it has on the output and detecting

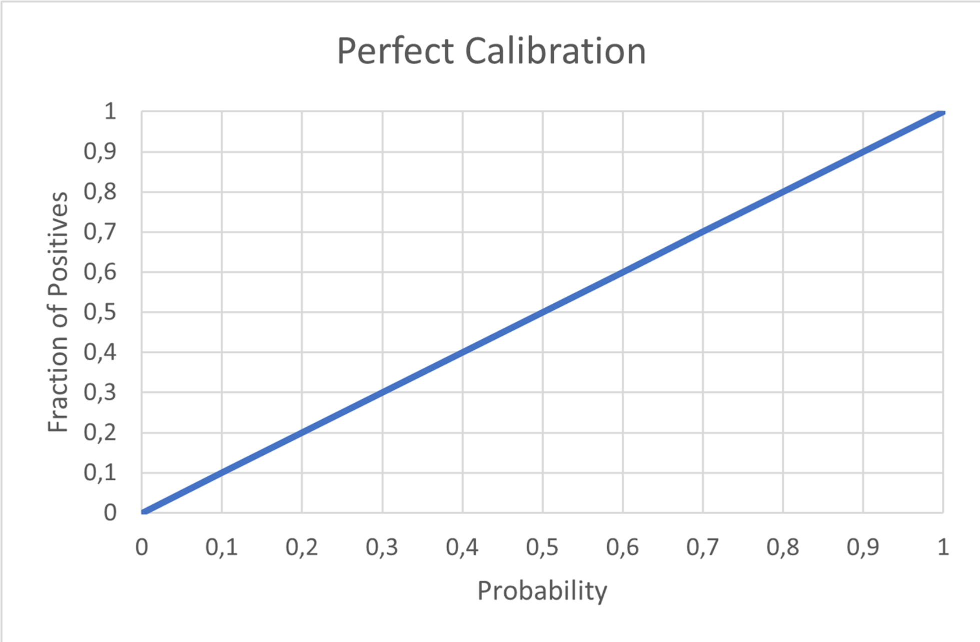


Figure 2.5: Visualisation of the perfect calibration (own illustration).

errors in the model. Furthermore, it can reduce uncertainties and help to simplify the model. Sensitivity analysis can thereby aid model calibration and validation and is an important methodology when it comes to uncertainty analysis (Trucano, 2006).

There are various methods to conduct a sensitivity analysis. A common and simple method is called one-at-a-time (OAT) and it usually involves changes within one input variable at a time and then changing it back to its original value (Saltelli & Annoni, 2010). This process is then repeated for each input variable. By examining the changes in the output values for each input modification using linear regression for example, the sensitivity of the model and the different parameters can be measured. Changes in the output will thereby be directly correlated to the source of uncertainty in the altered input variable. The method also allows comparation of how much different input variables affect the result. However, this method fails to consider the effect that different variables have on each other and is therefore not optional for non-linear models.

2.2.5 Emission Modelling

When analysing the EIA of a traffic network, it is important to consider the network elements. A traffic network constituting of e.g., roundabouts indicate on vehicles outside the roundabout having to stop due to priority rules for vehicles inside the roundabout, which is the case in Sweden. The process of when the vehicle stops includes e.g., braking and idling, which indicates on an increase of fuel consumption and thus more emissions. Depending on the vehicle and engine characteristics, the exhaust and non-exhaust emissions will vary. Which is why, in addition to network elements, it is crucial to also consider the vehicle, and engine characteristics in the emission modelling (You et al., 2013).

Researchers in recent years have created and developed models that represent a system that produces emissions from mobile sources. The authors You et al. (2013) classify these emission models into three main categories: *“Macroscopic emission model”*, *“Medium Emission model”*, and *“Microscopic emission model”*. The main difference of the main models is the scalability they are applied upon and what model parameter they are based on. "Macroscopic Emission Models" are commonly based on average speed, whereas *"Medium Emission Models"* are based on acceleration, speed and capacity ratio which is based on traffic facilities. As for *"Microscopic Emission Models"*, the parameter in focus is vehicle operation data per second.

2.2.5.1 EnViVer

TNO is a research organization in the field of sustainable mobility that have been among other research, collecting emission data and developing emission models (EnViVer, 2014). The EnViVer manual further states that the emission data for the models are based on a data collection of more than 20 000 vehicle types. The collected data has been used to develop emission models to replicate the real word and is yearly updated. The authors of the manual further states that the emission database also includes variables for the engine temperature, driving behaviour, traffic conditions (traffic jams, roundabouts, highway etc.), vehicle types (buses, passenger cars, and heavy goods vehicles (HGV)).

VERSIT+ is a module developed by TNO and is the base for the add-on EnViVer, see Figure 2.6. The module is based on European regulations for vehicle emission standards, Euro classes, and vehicle types (weights and sizes). The module constitutes of 246 emission model classes, which accounts for emissions for each vehicle type (Quaassdorff et al., 2016). Furthermore, the VERSIT+ module enables a statistical and empirical approach for the estimation of emissions. The empirical relationship is between the speed-time profile, emission factors, the engine temperature, fuel consumption, driving behaviour and other vehicle related variables. The microscopic simulations (e.g., PTV VISSIM simulations) along with the calculation algorithms in the software and the emission database from TNO, estimated emissions in the interface EnViVer can be derived. The interface computes CO_2,NO_x, and PM_{10} for different vehicle types.

The combination of traffic data from microscopic simulations in PTV VISSIM and the emission model in EnViVer has proven to be highly useful for microscale analysis in local hot spots (Quaassdorff et al., 2016). The local hot spots are areas that tends to be overburdened due to traffic, and consequently more emissions. The authors further present the formula that EnViVer is based on, see 2.4. The equation is composed of the emission factor, which represents the quantity of a pollutant produced and released into the atmosphere due to an activity, the traffic volume and the length of the road that is in question.

$$TE_j = \Sigma_{k,m} E^F_{j,k,l} \cdot TV_{k,m} \cdot L_m \tag{2.4}$$

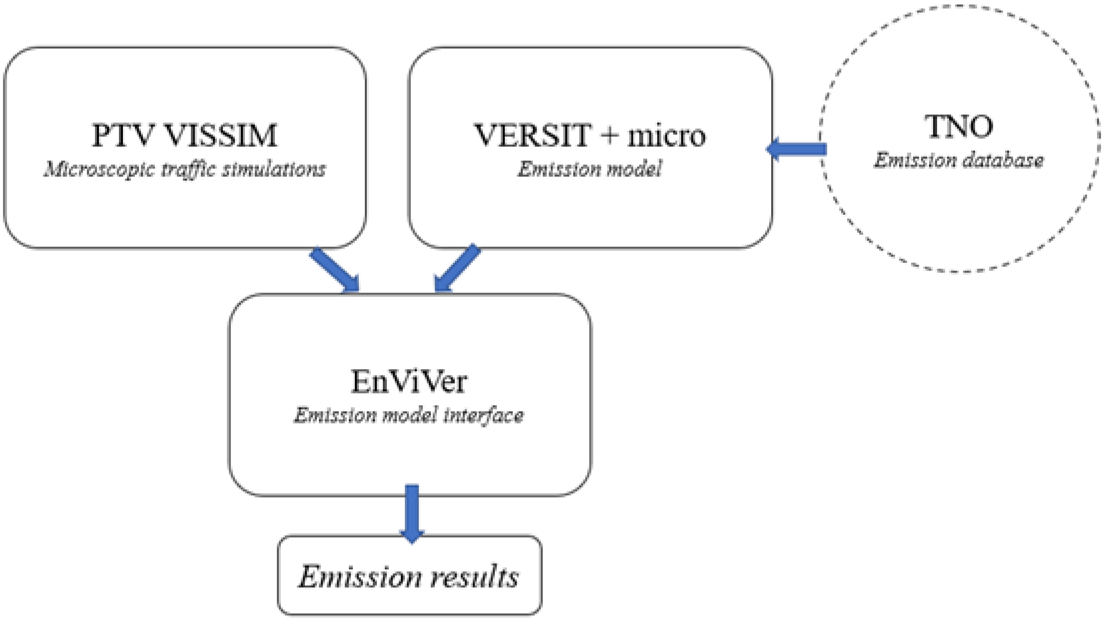


Figure 2.6: A conceptual model of the structure of the emission model EnViVer (own figure).

Where:

TE_j = Total amount of pollutant j produced
$\Sigma_{k,m} E^F_{j,k,l}$ = Mean emission factor [g/km] for pollutant j, vehicle class k and speed-time profile l
$TV_{k,m}$ = Traffic volume [veh/h] for vehicle class k and road section m L_m = Length of road section m [km]

2.3 Network Elements

The study area that is analysed in this thesis, constitutes of different network elements that play a vital role on how the traffic flows. A general description of the study area is presented in Chapter 1.2. In the following sections a brief description of the main network elements in the study area, their purpose and how they operate in PTV VISSIM and in accordance with the Swedish traffic regulations will be presented.

2.3.1 Roundabouts

A roundabout is defined as *"A road junction at which traffic moves in one direction round a central island to reach one of the roads converging on it."*, according to the Oxford Dictionary. The general objective of roundabouts is to constitute a self-regulating autonomous queuing system, but also decrease the speed of entering vehicles (Transportstyrelsen, 2022). A study (Rettings et al., 2001) has shown a remarkable decrease of accidents and injuries after the installation of roundabouts, reduction in global emissions and an increased efficiency. However, the efficiency

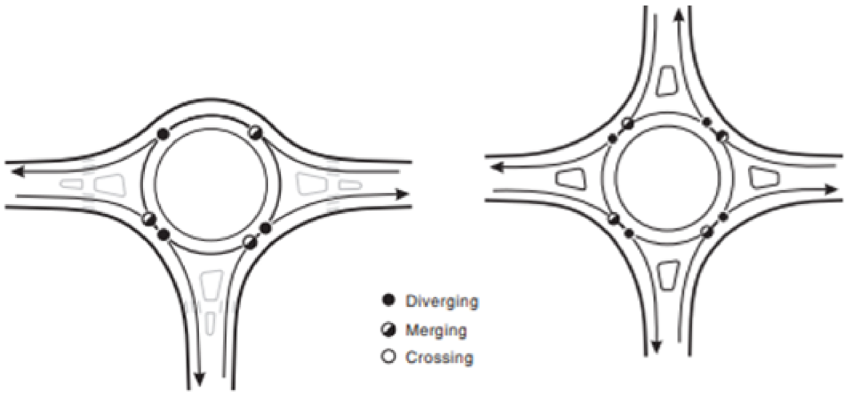


Figure 2.7: A conceptual model of the models in the study area. The small circles in the figure represent conflict points (Aashto, 2022b.)

decreases when the capacity of the roundabout is exceeded.

There are different kinds of roundabouts depending on factors such as the surrounding environmental speed (urban, suburban, or rural areas), and traffic demand (Aashto, 2022a). The roundabouts that the network constitutes of in the study area are presented in Figure 2.7. Furthermore, there are three three-legged roundabouts in the study area and one four-legged roundabout. Depending on the country, there are different driving rules applied for roundabouts. The Swedish traffic regulations states that all entering vehicles in the roundabout should drive anticlockwise direction and give way for vehicles that are already inside the roundabout. These traffic regulations result in a certain driving behaviour where the entering vehicle e.g., needs to reduce its speed as aforementioned.

2.3.2 Non-signalised T-intersection

A T-intersection is defined as *"A place where one road joins another but does not cross it, so that the roads form the shape of the letter T."* according to the Oxford Dictionary. A non-signalised T-intersection is an intersection with no signal controllers. The study area constitutes of one non-signalised T-intersection, as the one displayed in Figure 2.8. According to the Swedish traffic regulations, in junctions where there are no instructions, the right rule applies (Transportstyrelsen, 2014). The vehicles on the minor road should give way to the vehicles on the major road. This is the case for the T-intersection at Borgmästaregatan.

2.4 PTV VISSIM Tools

Priority rules in PTV VISSIM are defined by stop lines and conflict markers (see Figure 2.9). The stop lines mark where the priority rule begins and the conflict markers indicates the start point of the parameters that are assigned to the priority rules, which are minimum gap time, minimum clearance, and maximum speed (PTV

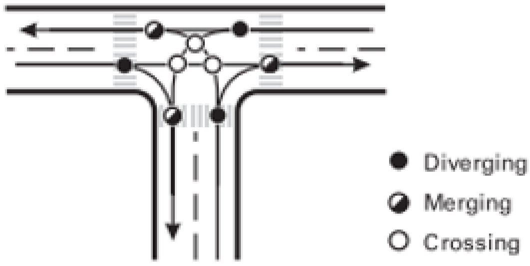


Figure 2.8: A conceptual model of a T-intersection with conflict points (Aashto, 2022b).

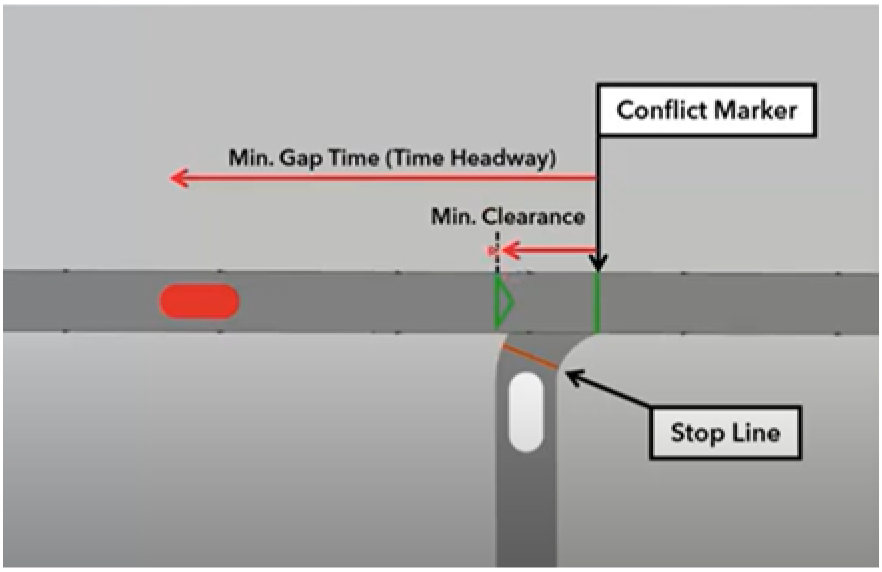


Figure 2.9: Visualises the parameters of priority rules (PTV America Knowledge Base, 2021)

America Knowledge Base, 2021). The minimum gap time is the time headway that the vehicle approaching the stop line (the white vehicle in Figure 2.9) must look at to decide when it should enter the traffic flow. I.e., how long it will take for the approaching vehicle in the traffic flow (the red vehicle in Figure 2.9) to reach the conflict marker. The minimum clearance distance is the clear space that a vehicle needs to enter the traffic flow and is defined by the green triangle that forms behind the conflict marker. Lastly, the maximum speed decides how fast the vehicles in the traffic flow can travel for the set priority rules to apply to them. Priority rules can be set for different vehicle types and different traffic conditions.

2.4.1 Evaluation Tools

There are several evaluation tools that can be used in PTV VISSIM to evaluate the network model performance. The evaluation tools are powerful tools and have many outputs to obtain the results from. For this study, the evaluation tools that were used were: Nodes, Queue counters and Vehicle Travel Times, see 3.4. Thus,

Table 2.1: Evaluation tools, and their respective parameters and descriptions (PTV Group, 2022).

Evaluation	Parameter	Description
Nodes	Average Queue Length	The total average queue length in meters
	Maximum Queue Length	The total maximum queue length in meters
Queue Counter	Queue Stops	Number of queue stops
Vehicle Travel Time	Travel Time	The average travel time of vehicles in seconds

the following sections will solely provide information about these evaluation tools.

2.4.1.1 Nodes

The purpose of Nodes is to mainly evaluate the performance of a user-defined zone, which usually constitutes of intersections. Nodes are defined with boundaries around an intersection. The tool provides the effectiveness of the intersection with regards to the motion of the individual vehicles, which is necessary for traffic analysis. Furthermore, the tool evaluates raw and specific data from intersections, without having to manually define elements to obtain the results. The evaluation tool also determines queue lengths, delay times, number of stops etc. The tool also produces results for exhaust emissions. However, the PTV VISSIM manual (2022) states that the calculation of emissions does not take into account individual vehicles and is also based on the North American vehicle fleet. Therefore, it is recommended to use EnViVer Pro/Enterprise for determination of emissions from individual vehicles. Thus, the output for exhaust emissions from the evaluation was not considered. The outputs from Node evaluations that are to be considered in this study are presented in Table 3.4.

2.4.1.2 Queue Counters

Queue counters can be placed at points in the network where queues may occur to yield results regarding the queue characteristics. For this tool, queues are measured from the position they are placed in upstream, up to the last vehicle in the queue. The queue lengths are outputs with the unit meters, whereas the number of Queue Stops are outputs in terms of number of vehicles.

2.4.1.3 Vehicle Travel Time

A vehicle's travel time is measured between two chosen points in the network: a "From Section" and a "To Section" (PTV Group, 2022). The software calculates the mean travel time between the points, including the waiting time and stop time on each lane. This gives an indication about the networks traffic flow.

2.4.2 Vehicle Input and Route

The vehicles in the network model with the same basic driving behaviour in traffic can be categorised in the same Vehicle Category (PTV Group, 2022). There are six different categories: Car, HGV, Bus, Tram, Pedestrian, and Bike. Based on

Vehicle Category, the vehicles can then be assigned into different “Vehicle Types” depending on their technical driving characteristics. The main difference between the two parameters is the operating principles of the car-following model. Vehicle Category are based on basic driving behaviour in traffic for different vehicle types, whereas Vehicle Types is more complex and considers for instance the gender of the driver which is most likely to have an influence on the driving behaviour. The user manual recommends grouping Vehicle Types into Vehicle Classes if the user want to define the same properties, for example route choice behaviour.

The parameter vehicle inputs allow for the user to assign traffic volume at the end points of the network model. The vehicle inputs can then eventually be simulated in exact or stochastic Volume Types. The exact Volume Type allows the specified number of vehicles that was assigned in vehicle inputs to flow through the traffic. Stochastic Volume Type allows for stochastic fluctuations of the traffic volume.

3

Methodology

For the execution of this study, the software's that were used were primarily PTV VISSIM and EnViVer Pro. PTV VISSIM was used for the microscopic simulations, whilst EnViVer Pro was used for the EIA. In addition to that, Excel was used to compile the traffic data.

Furthermore, the following sections will provide a comprehensive description of the calibration of the received traffic data, the construction of the network model in PTV VISSIM, the performance of the EIA, the conduction of the sensitivity analysis, and finally certain assumptions that were made. The numbers presented for the traffic counts have been rounded off to the closest tenths because of the uncertainties of the numbers due to all assumptions. However, more precise values were used for the inputs in the simulation.

3.1 Case Description

In order to meet the aims and objectives stated in Chapter 1.3, and also answer the research questions in Chapter 1.4, different cases have been created. By forming different cases, a more accurate analysis could be conducted. Thus, this was done by creating four cases, whereas two of the cases (Scenario 1 & 2) are providing a current situation analysis, and the two other cases are based on a prognosis for year 2030. All the case scenarios used the same network model that was developed in PTV VISSIM (see Chapter 3.3). The four scenarios are:

1. **Scenario 1: Base Case Scenario 2021**
   The first scenario is called the Base Case Scenario as it is the core ground for all other scenarios. The scenario includes all traffic, i.e., the calibrated traffic data from year 2021 for passenger cars and HGV.

2. **Scenario 2**
   The second scenario, similar to the Base Case Scenario, also unfolds in year 2021. The difference is that Scenario 2 does not take into account the traffic data from HGV (UFT). I.e., the only traffic data simulated in the model is that one of passenger cars. This is to analyse the impact that UFT has on the network and environment.

3. **Scenario 3: Prognosis of Base Case Scenario 2030**

The third scenario is a prognosis of how the Base Case Scenario unfolds in year 2030. The approach to the prognosis is based on the Swedish report from Ramboll called “Trafikanalyser Kungsbacka” (2019). The report states that the total traffic flow is expected to increase with 25-30% by 2030. Thus, in this scenario a factor of 1.25 multiplied with the calibrated data for Base Case Scenario 2021 was conducted. In combination with the report from Ramboll, a report from the Swedish Transport Administration called “Prognos för godstransporter 2040” (2020) was used. The report forecasts the growth of, inter alia UFT on road. It is estimated that road transport (including railway) is expected to increase by 1.6% per year. The report further states that the growth rate in the prognosis is based on results from the economic forecast according to the National Institute of Economic Research, and the calculations of the development of commodity value. The growth rate from the latter report was used to account for how much the UFT compose in the total traffic flow.

4. **Scenario 4**
   The fourth scenario is similar to Scenario 2, except that Scenario 4 unfolds in year 2030. The traffic flow from Scenario 3 is used in Scenario 4, with the exclusion of UFT.

It is important to emphasize that the approach of the two latter case scenarios is based on rough estimations and assumptions. The growth rate of UFT is an average estimation of all freight transport (road, rail, ocean, and air) nationally. I.e., this may not necessarily represent the growth of UFT in the study area. Nevertheless, the growth rate gives an indication on how the traffic flow will more or less unfold in the future.

3.2 Data Processing

The implementation of the simulation in PTV VISSIM required data input which had to be collected, analysed, and calibrated before it could be used in the simulation. These steps are explained in the following sections.

3.2.1 Data Collection

The initial data, received from Aranäs AB, was an Excel-file containing information about passing vehicles during a seven-day time span, in four given points (see Figure 3.1). The measurements were taken between November 16th and 22nd, 2021, and the traffic data was presented for all 24 hours of the day (see appendices A.1-A.22). For each hour, the number of vehicles were provided and the average speed. A compilation for all seven days was also provided, where the total number of all passing vehicles for each hour was given, as well as the number of heavy vehicles. Additionally, a similar data compilation was provided for the weekdays. However, this data was not sufficient to conduct the microsimulation that was intended, hence why further information was requested and sought after.

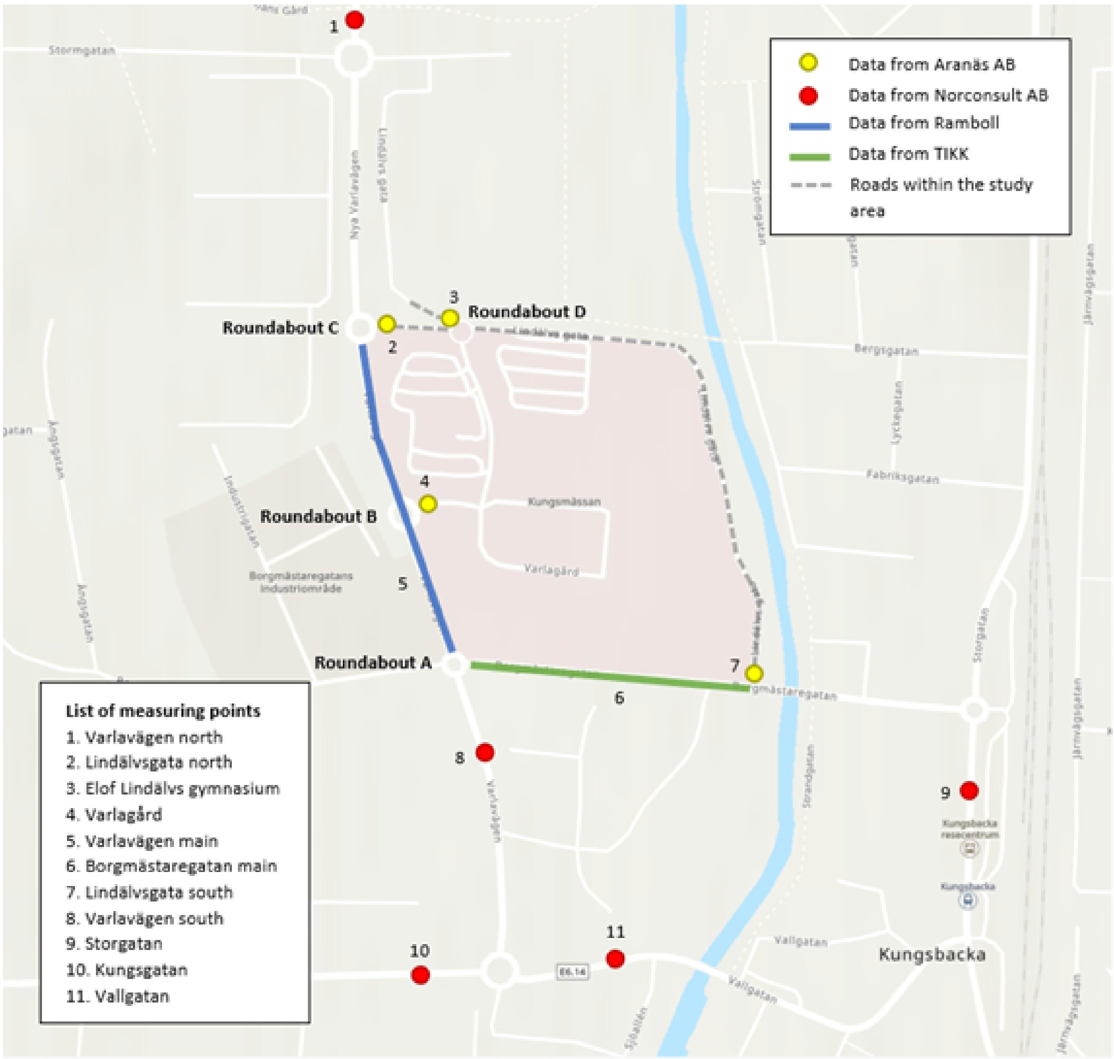


Figure 3.1: A map of all data collection points that were used for the study, a list with their names, and the terms of the four roundabouts (own figure).

Norconsult AB provided data of the traffic on the adjacent roads to Kungsmässan (see Figure 3.1). As with the previously received data, the information was provided in an Excel-file containing the same type of information about the traffic and vehicles that passed the measuring points (see appendices A.1-A.13). The measurements for this data collection were conducted between October 13th and 19th, 2021. Additional data was needed on the roads that are surrounding the study area, located to the west of the shopping mall and to the south. For that data, TIKK (n.d.) and a report from Ramboll (2019) was used (see Figure 3.1). However, these two sources did not provide the hourly distribution of passing vehicles. The information that TIKK gave was average daily, weekday, and weekend traffic, as well as average speed. The source from Ramboll only gave information about the average daily traffic. Furthermore, according to Ramboll's report (2019), this number had been rounded off to the closest thousand, which meant that the validity of this data was lower than the rest.

3.2.2 Data Compilation

After all data was gathered, it had to be assessed and compiled to be utilised in the simulation. This process involved several assumptions that had to be verified to be realistic and thereby applicable to the study. Furthermore, it should be noted that the four sources of data were collected on different occasions: the data received from Aranäs AB and Norconsult AB were both collected in late 2021, with one month's difference, whilst the data from Ramboll and TIKK was collected in 2015 and 2014, respectively, as aforementioned in Chapter 1.5.

Firstly, all irrelevant data that was received was outsourced, such as information about traffic on roads that was not included or connected to the study area. Thereafter, it was decided that the simulation should be executed using the data that represented a peak hour. The reasoning for this was because road freight transportation would arguably have the highest impact on the traffic flow during peak hours since the accessibility is limited. Thereby, performing a simulation for the most critical hour would be more efficient. By calculating the share of passing vehicles for each hour, it could be concluded that on average, the most critical peak hour was between 16:00-17:00. For this calculation to display the most critical hour, the data for all weekdays on the different roads were used. The reason for only using the data for the weekdays was that traffic on the weekends do not have the same peak hours as weekdays do, and the peaks are not as distinguished. Thereafter, the distribution of heavy and light vehicles was calculated to be able to make simulations with and without HGV and to see which hours HGV could have the largest impact on the traffic flow. An average hourly traffic distribution was therefore produced for light and heavy vehicles, as can be seen in Figure 3.2.

After sourcing out the relevant information from all data that was received, it was noted that there were some required information missing. Data on the traffic on Nya Varlavägen was crucial for the simulation and as seen in Figure 3.1, no data was received on that road. Moreover, the data that was obtained on the southern and the western roads of the study area, was as mentioned not as detailed as the collected information on the other roads. Therefore, assumptions and estimations were necessary.

3.2.3 Study Visit

On three occasions, study visits were made, where the first two took place between 8:00-12:00 and the third was conducted between 16:00-17:00. During the first one, the study area was compared to the maps that were used for the study: Google maps, PTV VISSIM, and ArcGis. Certain roads and their traffic marks were inspected and unloading places for the freight transport was investigated. By observations and asking employees of different stores and restaurants where their deliveries were made, it was noted that aside from a few delivers that delivered their goods in front of the mall, the unloading of trucks was made at the back of the mall, on the eastern road of the study area (marked with grey in Figure 3.1). Overall the traffic behaviour was also observed, as in speed, acceleration, deceleration, lane changes, to get an

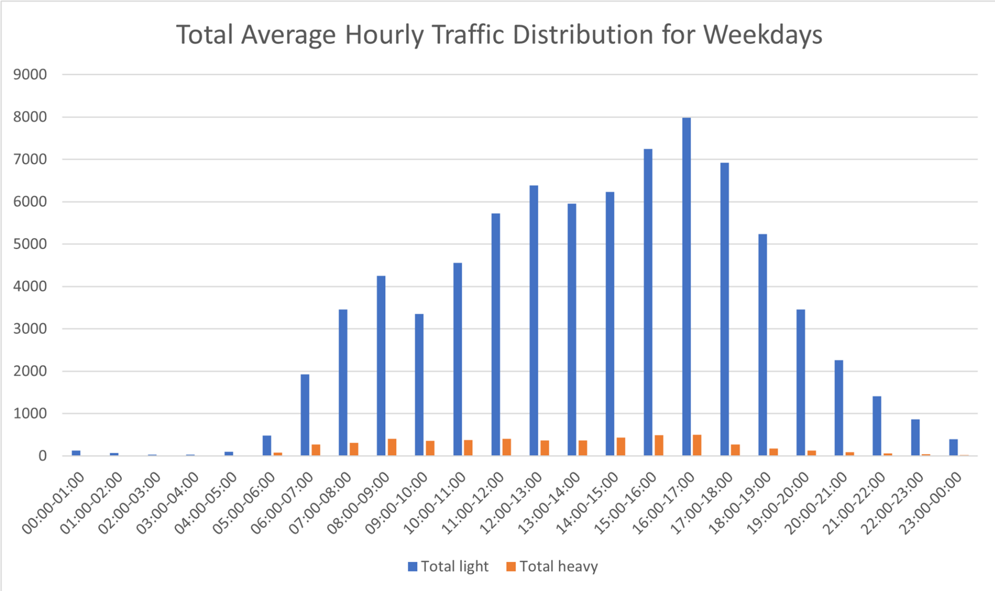


Figure 3.2: A chart demonstrating the average hourly traffic distribution for light and heavy vehicles, on all roads for five weekdays (own figure).

idea of the area and its road users. Further, it was noted that the bridge over the river on Borgmästaregatan was under construction which prohibited traffic passage. It should be noted that the construction work was not conducted between June to October due to environmental reasons, which meant that only the data from Norconsult AB could have been affected by this (Svevia, 2021). On the second study visit, the traffic behaviour was studied again.

The third study visit was made after the results were established, to compare the simulation results with the actual study area. This visit took place between the chosen peak-hour, 16:00-17:00, for a more representable comparison. During the visit, vehicles were counted for 10 minutes on the roads where most congestion were detected, i.e., Varlavägen south. The traffic counts were then multiplied by 6 to get an idea of how many vehicles would be passing during an hour. Due to lack of time, this counting technique was chosen. This gave an indication about the real number of vehicles that were operating in the study area during the peak-hour. Those numbers were then compared to the input numbers in the simulation. This was done to validate the data and the results that the simulation yielded. Traffic on the neglected roads were also examined to ensure that the decisions were reasonable. However, the bridge on Borgmästaregatan was still undergoing construction work, and therefore the traffic situation in the study area during the visit was not fully compatible with the simulation of this study.

3.2.4 Assumptions and Estimations

For the data input in PTV VISSIM, the number of southbound vehicles from Varlavägen north, northbound vehicles from Varlavägen south, westbound vehicles from Borgmästaregatan, and vehicles leaving the study area from Lindälvsgatan

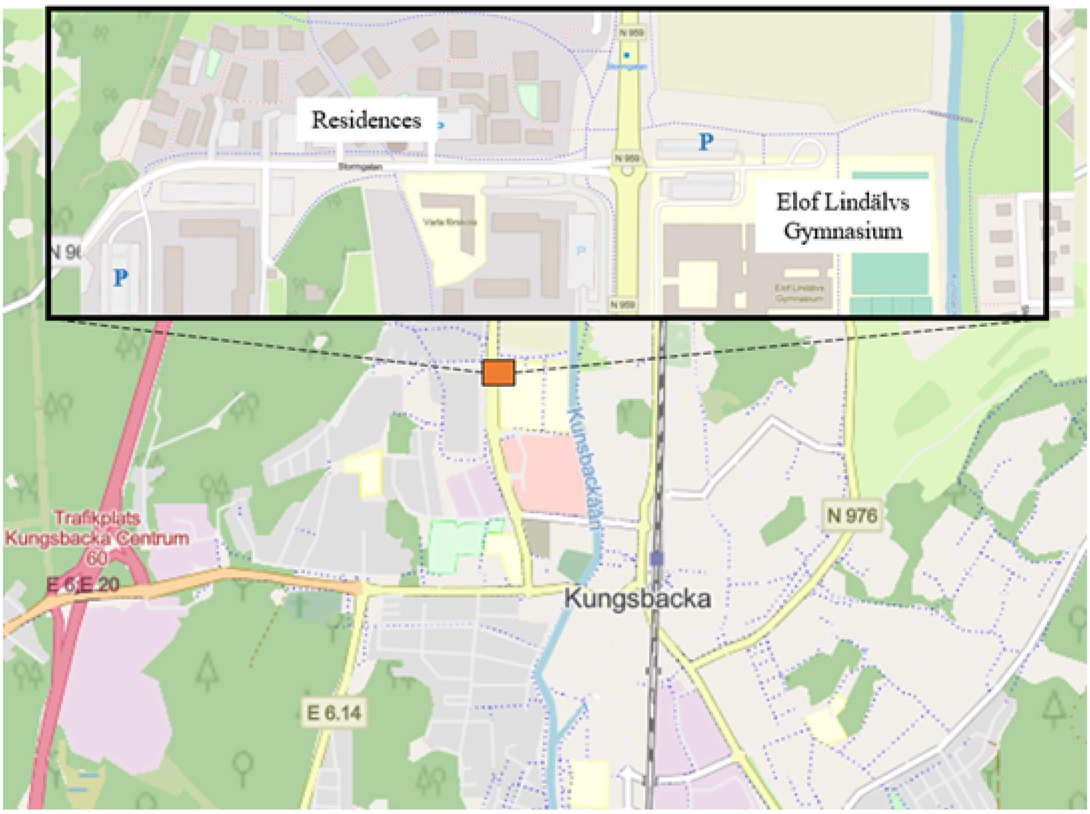


Figure 3.3: An illustration of the north part of the study area, where residences, the high school and the parking spaces are marked (own figure).

south and north, during the chosen peak-hour was needed. The collected data did not provide all of the required information for this, and it was therefore necessary to make assumptions about the traffic on certain roads.

Firstly, the data collected on Varlavägen north was assessed. The goal of this was to make assumptions about the traffic on Nya Varlavägen, the road between Roundabout C and the roundabout adjacent to the data collection point Varlavägen north (see Figure 3.3). The data collection point of Varlavägen north was located north of a roundabout with four legs, where Varlavägen north constituted the northern leg, Stormgatan (with residential areas) constituted the western leg, Nya Varlavägen the southern leg, and the senior high school Elof Lindälvs gymnasium the eastern leg (see Figure 3.3). The traffic going to and from the eastern leg is assumed to be negligible since no data regarding the traffic on this road could be found. Further, the road is small and only leads to parking spaces for Elof Lindälvs gymnasium and it could therefore be assumed that the volume of traffic on this leg would be relatively small.

The western leg leads to residential areas, with both villas and apartments. By investigating the population registration in these areas, the number of registered cars could be obtained, which was 540, none of which were heavy vehicles. The data that was assessed previously in the work progress showed that approximately 10.9%

of all vehicles detected during the data collection was operating during peak hours. This ratio was used for this assessment as well:

$540 \cdot 0.109 \approx 60$

Assuming that all residents with an operating vehicle during the peak-hour would be returning from work or another corresponding activity, an estimated 60 vehicles would be exiting the roundabout on the western leg, to Stormgatan. The road that connects to the northern leg of the roundabout eventually leads to E6, and according to Ramboll (2019), the roads located to the north of the roundabout generally have a higher traffic flow than the roads located to the south. Therefore, it was assumed that all 60 vehicles come from the northern leg of the roundabout. The resulting number of south bound vehicles on Nya Varlavägen that was estimated to enter the simulation were thereby:

$640 - 50 \approx 590$

To avoid making unnecessary assumptions, only the vehicles travelling southbound was estimated, since it was needed for the input in PTV VISSIM.

Since the data on Borgmästaregatan was taken from TIKK, there was limited information about the traffic on this road. The information only disclosed the average daily traffic on the road, without specifying the traffic count in each direction, hence why some assumptions were required. The average daily traffic was 7,220 vehicles in both directions combined. Firstly, it was assumed that the traffic was evenly distributed on the roads, with 50% of the vehicles going in each direction. To strengthen this assumption, the data from Aranäs AB and Norconsult AB were investigated to calculate the respective share distribution of the directions going to and from the study area. It showed that the distribution was indeed close to 50% for all roads combined. The average daily traffic in each direction of travel on Borgmästaregatan were therefore 3.610.

Following this step, the number of vehicles operating during the chosen peak-hour needed to be established. As earlier mentioned, the average share of vehicles operating between 16:00-17:00 among the provided data, was 10.9%. Consequently, this number was used for the calculation of traffic on this road too, which corresponded to:

$3,610 \cdot 0.109 \approx 390$

The traffic on Varlavägen main also needed to be established prior to the data input in the simulation. The data from Ramboll that was initially used for this road, gave the information that the average daily traffic was 13,000 vehicles. On the same basis as for Borgmästaregatan, it was assumed that the traffic was distributed equally in the two driving directions: 6,500 each. The number of vehicles during peak-hour on this road would be:

$6,500 \cdot 0,109 \approx 710$

No data was found for the traffic count on the western leg of Roundabout A. It was assumed that the activity on this road would be low since it mainly led to a few smaller businesses and a training facility. Therefore, this road was neglected in the simultation.

3.2.5 Calibration

After the input data was defined, it was then noted that the number of vehicles in the input was fewer than the number of vehicles that, according to the data, should be operating in the study area. Initially, the data on Varlavägen main was going to be calibrated, since this data was the least reliable, as explained in Chapter 3.2.1. However, since the road was located in the middle of the simulation, it would be more complicated to alter this compared to an input value in one of the endpoints of the network. Therefore, it was instead decided to disregard the assumptions and estimations made about the traffic data on Nya Varlavägen. It was instead assumed that the traffic data in the data collection point Varlavägen north would be the same as the traffic data on Nya Varlavägen (the received data from measuring point 1 in Figure 3.1). This resulted in the input data and the traffic data within the simulation correlated.

3.2.6 Validation

Lastly, to test how compatible the data calibrated for the model was with the real data, a validation process was needed. The data that was used as inputs in PTV VISSIM was therefore compared to the received data for the same points. Figure 3.4 shows a plot of the received data against the calibrated data. As the trend line indicates, the deviation is small which indicates that the model is representative of the actual network and its traffic. However, it should be noted there were only seven data sets that were compared in this validation process which is not enough to get a fully credible result. Nevertheless, although it may be assumed that the seven data sets are not sufficient for a thorough validation, the technique of estimating the traffic data provides a more or less indication on the traffic situation in the study area. Further, it is also a reliable approach to get a comprehensive overview on the traffic situation.

3.3 Network Development in PTV VISSIM

The construction of the model to replicate the real study area can be conducted by either inserting a background image in the software or by using the geographical map in the software. Since the geographical map was identical to the current study area, there was no need for a background image. This was concluded after the two visits to the study area that were described in Chapter 3.2.3. The geographical map

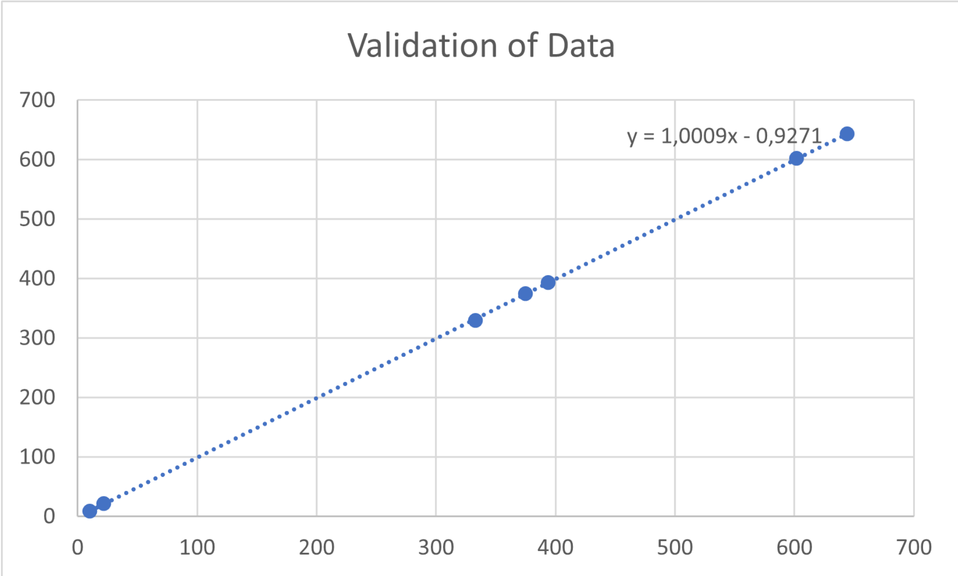


Figure 3.4: Visualisation of the roundabout located to the north of the study area (own figure).

was used as a guide to draw the links and connectors for lanes in specific directions to replicate the study area. Links represent a lane for the motion of traffic in a certain direction, whereas connectors are used to connect two elements, e.g., two links. This is to enable vehicles to travel from one element to another for instance.

The study area constitutes mainly of roundabouts and lanes of 1+2, and 1+1 as mentioned in Chapter 1.2. This was taken into consideration when constructing the network model (see Figure 3.5). Furthermore, the lanes in the network model were not assigned any gradients since the topography of the study area was flat and homogenous. Nevertheless, the network model was simplified by not including the left lane to Roundabout A (see Figure 3.6) at Borgmästaregatan. This was concluded mainly due to the lack of data from that area, but also due to the small influence the area has on the overall traffic since it is an area with few residencies, shops, and a desolated soccer field (conclusion from study visit). Further, during test runs of the simulations, it was noted that not all vehicles were able to enter the simulation on Borgmästaregatan and Varlavägen south for some scenarios. Therefore, the links on these two streets had to be extended for most vehicles to fit, for all scenarios except for Scenario 2, since it was the only one where it was not necessary.

3.3.1 Conflict Areas

As mentioned in Chapter 1.2, the network model constitutes of four roundabouts and one non-signalised T-intersections at Borgmästaregatan. In order to consider the interactions of vehicles from different routes in these junctions, the setups that are recommended to use are: Conflict Areas and Priority Rules (PTV VISSIM Guide User Manual, 2022). The manual further states that is better to use conflict areas to model the driving behaviour. Nevertheless, priority rules should be used when

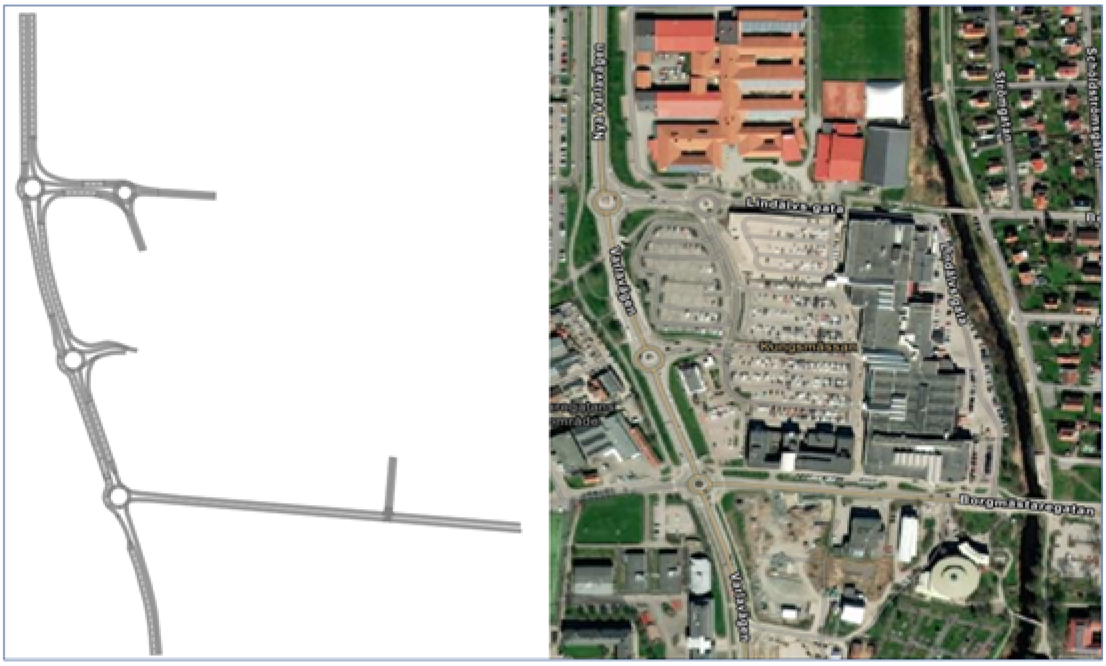


Figure 3.5: Overview of the network in the software (left) and in real-world (right), (own figure).

conflict areas solely are not sufficient for the anticipated results.

The conflict areas were set for each junction, such as the roundabouts and the non-signalised T-intersection in the network model. The conflict areas were applied in accordance with the Swedish traffic regulations as described in Chapter 2.3.1 for roundabouts and the T-intersection. Links in the right of way were marked with green, and links with the give way were marked with red (see Figure 3.6). Priority rules were only set for Roundabout A and the T-intersection. This is because conflict areas alone were not enough for the expected results. Furthermore, integrated parameters in conflict areas can be adjusted to account for a certain driving behaviour. However, it is recommended in the user manual by PTV Group (2022) to change the parameters solely if it can be justified. Since there is no data to justify an adjustment of these parameters (e.g., Visibility, Front Gap, Rear Gap, Safety Distance Factor), the default values were used.

The priority rules in Roundabout A and the T-intersection were set to account for normal and congested traffic condition, as well as for HGV. The conditions were derived from the manual by PTV Group (2022). As normal traffic conditions enable a normal flow of traffic, the gap time was set to 2.6 s, the minimum clearance to 0 m, and the maximum speed to 180 km/h. The congested traffic conditions are dictated by the slow moving traffic in the junctions. Thus, the gap time is set 0 s, the minimum clearance to 5 m and the maximum speed to 14 km/h. According to the manual by PTV Group (2022), the priority rules for slow moving traffic are not sufficient for long and heavy vehicles. Thus, a gap time of 0 s, a minimum clearance of 5 m, and a maximum speed by 180 km/h was set to account for HGV in the

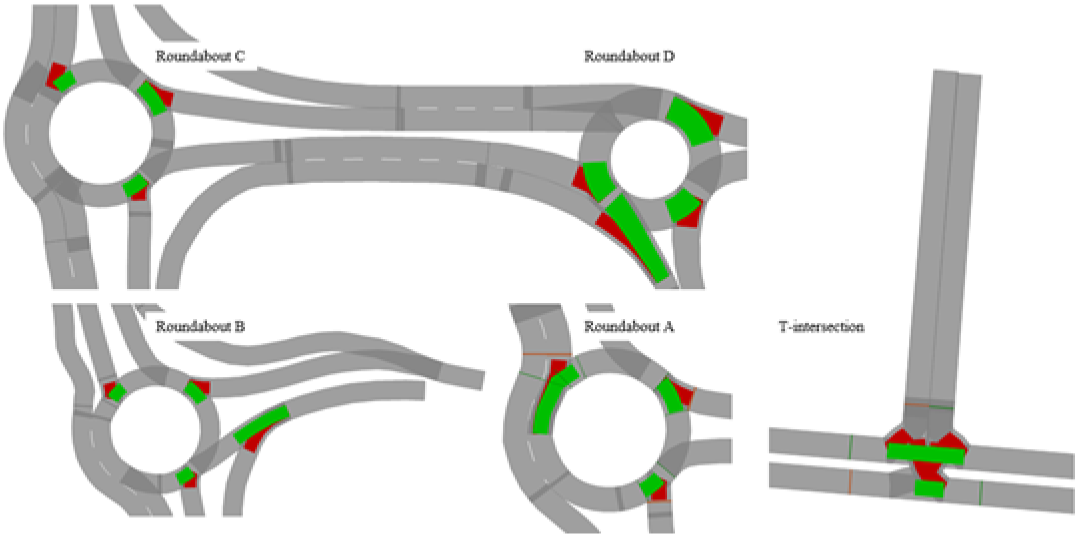


Figure 3.6: Conflict areas and priority rules applied in the network model.

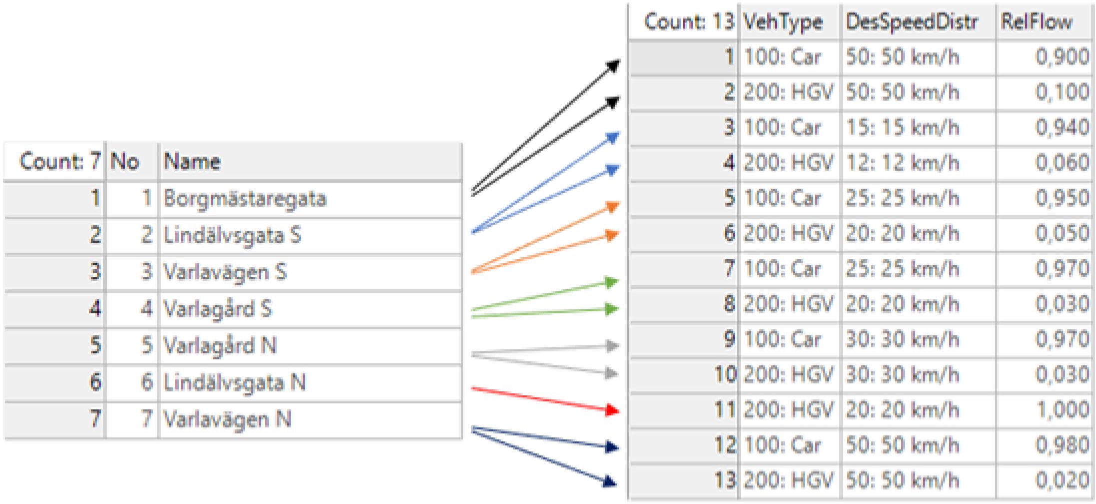
junctions. The placement of the priority rules and conflict areas are presented in Figure 3.6.

3.3.2 Vehicles, Inputs & Routes

Since there was a limitation of data with regards to pedestrians, buses, cyclists, etc., the model solely accounted for Car and HGV. Further, the data did not include parameters such as gender, hence why the Vehicle Types used were the same as Vehicle Category, which was in accordance with the manual by PTV Group (2022), as stated in Chapter 2.4.2.

In total, there were seven vehicle input points in the network model. Since the traffic volume data was calibrated, it was more fit to choose stochastic traffic distribution as Volume Type since it allows for stochastic fluctuations of the traffic volume, as explained in Chapter 2.4.2. The attributed vehicles were then composed in Vehicle Composition and assigned to the links (roads) in the network model, see Figure 3.7. All roads have a vehicle composition of Car and HGV, except for the right lane (westbound) of Roundabout D. This was concluded after the study visit, where there was a very small number of passenger cars using that road. Thus, solely HGV were accounted for in that road. The Desired Speed Distribution was adjusted in Vehicle Composition according to the received data by taking the average speed of adjacent roads to the road in question. The estimation of Desired Speed Decision is explained in Chapter 3.3.3, and represents the initial speed of vehicles on that assigned link. The same calculation was conducted to estimate the Relative Flow. The Relative Flow are assigned in percentage, e.g., 0.9 is 90% of the vehicle input data.

The different link segments were also assigned static vehicle routes and given vehicle inputs per hour based on the calibrated data (see Chapter 3.2.5). When applying



Count: 7	No	Name
1	1	Borgmästaregata
2	2	Lindälvsgata S
3	3	Varlavägen S
4	4	Varlagård S
5	5	Varlagård N
6	6	Lindälvsgata N
7	7	Varlavägen N

Count: 13	VehType	DesSpeedDistr	RelFlow
1	100: Car	50: 50 km/h	0,900
2	200: HGV	50: 50 km/h	0,100
3	100: Car	15: 15 km/h	0,940
4	200: HGV	12: 12 km/h	0,060
5	100: Car	25: 25 km/h	0,950
6	200: HGV	20: 20 km/h	0,050
7	100: Car	25: 25 km/h	0,970
8	200: HGV	20: 20 km/h	0,030
9	100: Car	30: 30 km/h	0,970
10	200: HGV	30: 30 km/h	0,030
11	200: HGV	20: 20 km/h	1,000
12	100: Car	50: 50 km/h	0,980
13	200: HGV	50: 50 km/h	0,020

Figure 3.7: Vehicle composition for different links (roads).

vehicle routes, it is of importance to define them as early as possible on the link. This is because the average driver usually knows what route to take. Thus, the static vehicle route should be assigned early on the link. The assigned static vehicle routes resulted in a total of 15 static vehicle routing decisions, and 49 vehicle routes. The relative flow for each route was calibrated (see Chapter 3.2.4 and 3.2.5). The input values for vehicle route decision are presented in Appendix.

3.3.3 Speed Control

The Desired Speed Distribution for the roads were defined in the function Vehicle Composition, as previously stated in Chapter 3.3.2. However, to account for hindrances that force the vehicles to reduce their speed, the function Reduced Speed Area and Desired Speed Decisions was used. As Desired Speed Distribution accounts for the initial speed of vehicles when entering the network model, the latter two functions account for the overall driving behaviour in the network model. Reduced Speed Areas are used to simulate temporary change in speed whereas Desired Speed Decisions are used to permanently simulate change speeds.

The reduced speed areas were placed at the entrance points and inside the roundabouts. In the T-intersection, the reduced speed areas were placed according to Figure 3.8. The Desired Speed Distribution for the Reduced Speed Areas were all set to 25 km/h for HGV and 30 km/h for Car, whereas the deceleration was set to 2 m/s^2. Note that there are no reduced speed areas at Roundabout D, western leg in westbound direction. This is because that leg is somewhat straight, and vehicles are usually accelerating in that area (conclusion from study visit).

As for the modelling of Desired Speed Decisions, the speed limits were placed at the beginning of each road and were given the same input values as the speed limit for each road. The limit speed for Varlavägen (i.e., Nya, main and south) was 50 km/h. The rest of the roads had a limit speed of 30 km/h. Furthermore, the Desired Speed

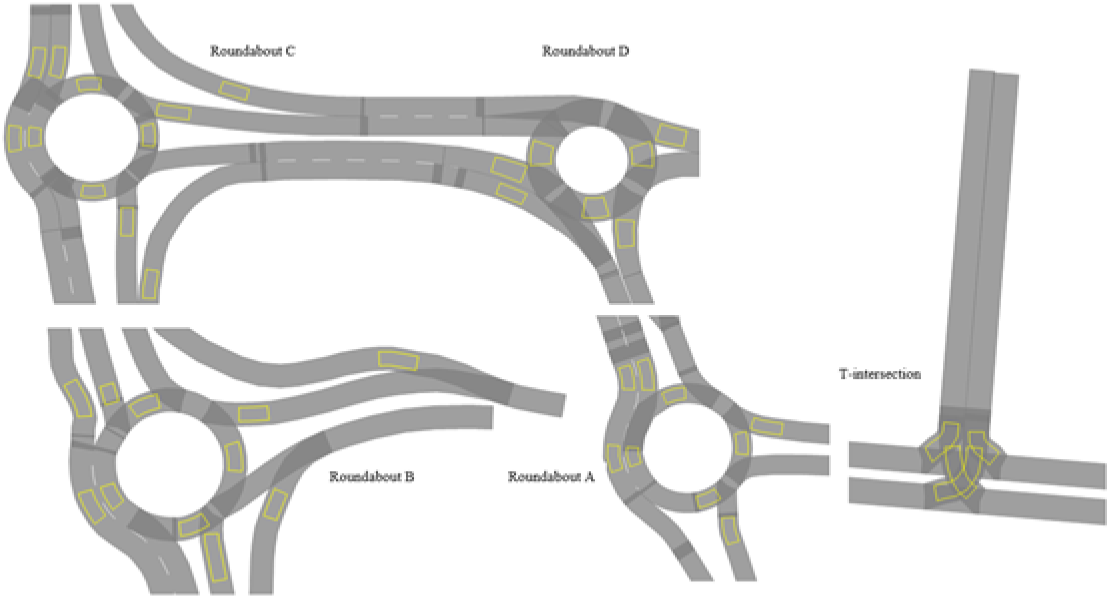


Figure 3.8: Reduced Speed Areas for roundabouts and T-intersection in the network model.

Decisions were assumed to be identical for the accounted vehicle classes.

3.3.4 Simulation Setup

The simulation setup is defined under "Simulation parameters" in the user interface. The simulation parameters are assigned before the simulation run of the model and are kept constant for the different scenarios. This is to enable consistency in the simulation results.

The simulation method was chosen to "Micro" and was given a period of 4,500 simulation seconds. Since the objective of the study is to analyse the impact of UFT (see Chapter 1.3) during peak hour from 16.00-17.00, a period of 3,600 seconds was of interest. This was configurated in the evaluation (see Chapter 3.2.2). The rest of the time is assigned as a "warm-up" period of 15 minutes to let the network model reach a steady state, and thus replicate the real system. This is because the software takes time before producing any vehicles and might not replicate the real system within the time period of interest. Thus, the start time was set to 15:45:00.

Simulation resolutions are a parameter that calculates vehicles in each time step in simulation seconds. The PTV VISSIM user manual by PTV Group (2022) recommends a simulation resolution between 5 – 10. The manual further states that a higher simulation resolution allows vehicles to make decisions on a higher frequency and enables a more realistic movement. Thus, a simulation resolution of 10 was chosen.

The Random Seed is a parameter which allows for a stochastic distribution of vehicle arrivals. Thus, the simulation results will give a more representative overview of the variations in real-world traffic conditions. If multiple simulation runs are chosen with varying random seed increment, the results will vary due to the sequence being assigned a stochastic distribution (PTV VISSIM User Manual, 2022). The Random Seed number was chosen to 70 in order to obtain stochastic distribution, and the Random Seed increment was left at default. As the simulation runs are time-consuming, the number of times the model will be run has been chosen to 5. This is to adequately account for variations that may occur in real-world. The results from the 5 simulation runs are used to get an average estimation of the network performance (see Chapter 3.3.5).

3.3.5 Evaluation

The software tools that were used for the evaluation are presented in Chapter 2.4. The placements of the evaluation tools are presented in Figure 3.9. In total there were five Nodes, 19 Queue Counters and 14 points for Vehicle Travel Time collection.

For each evaluation tool, a setup was defined in Evaluation Configuration. This was to enable the user to determine certain attributes that should be recorded during simulation. The defined evaluation setup was kept the same for all scenarios, excluding Vehicle Classes. This was to enable consistency throughout the simulation results. For Scenario 1 and 3, the defined Vehicle Classes were Car and HGV, whereas Scenario 2 and 4, solely accounted for Car. As described in Chapter 3.3.4, it is of interest to collect data after the warm-up period to the end. Thus, the time for which the data should be collected was defined under "From-time" to 900 s, and to the end "To-time" 4,500 s. The temporal resolution for the data collection in Node evaluation was chosen to 120 s time intervals.

The Queue Counters, Maximum Clearance, and Maximum Length were left at default. The distances between the intersections were also measured. An exceed of these measured distances would indicate on queue spillback. I.e., that the queue build-up in a road has an influence on the adjacent road.

As aforementioned in Chapter 3.3.4, the number of simulation runs was selected to 5. Each simulation run was assigned a stochastic distribution, enabling variations to resemble the real-world traffic conditions. The results of all simulation runs were compiled as an average.

3.4 EIA

The EIA was performed on the add-on interface EnViVer Pro (see Chapter 2.4). In order to calculate the produced emissions in the study area, the simulation results from PTV VISSIM that are admittable in EnViVer Pro were needed. Thus, the simulation results were configured in Direct Output under Evaluation. The output that was chosen was Vehicle Record and was assigned certain attributes (see Table 3.1) for a more representative emission-modelling. The attributes were chosen according to the EnViVer maual and were kept the same for all scenarios. This is to

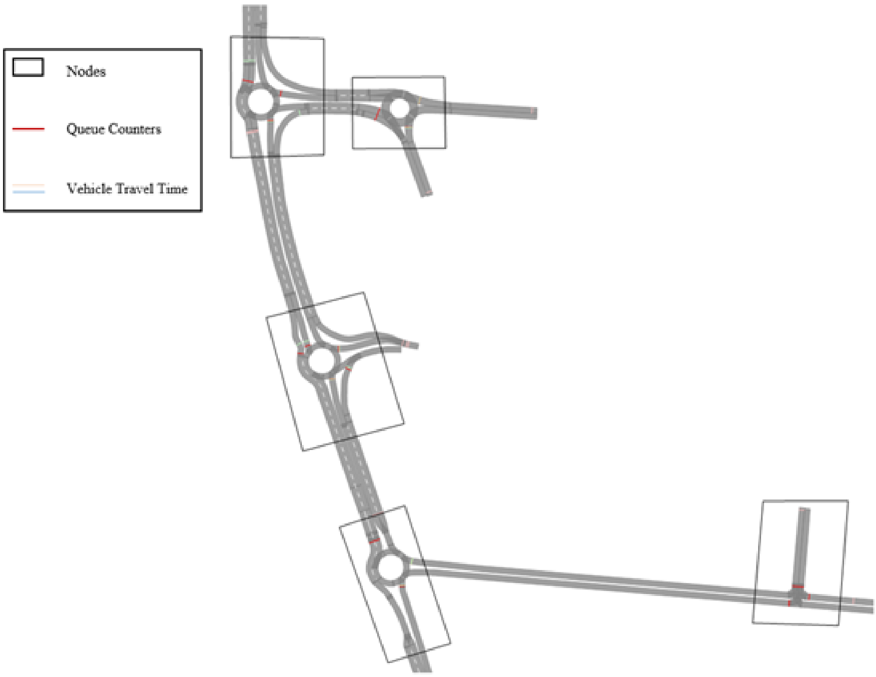


Figure 3.9: The position of Nodes and queue counters in the network model.

enable consistency in the emission-modelling.

In total, four simulation results were imported separately to the interface to evaluate the environmental impact for each scenario. In order to account for the Swedish vehicle fleet composition, the editor Custom Vehicle Parcs in the function Vehicle class assignments was chosen to define representative vehicle emission classes. Subsequently, the interface produced the following emissions: NO_x and PM_{10}.

The following section will provide a comprehensive description of the procedure for the EIA for the current situation (Scenario and 2), and for the prognosis (Scenario 3 and 4).

3.4.1 Base Case 2021

The driveline distribution for Car and HGV were derived from Trafa (2021) and the Swedish Transport Administration (2021). The drivelines distribution for HGV have been recalculated to account for newly registered vehicles in the market. Furthermore, the statistics provides that in year 2020, passenger cars accounted mainly of fossil fuels by 54% petroleum, and 35% diesel. The rest of the drivelines accounted for 4% ethanol, 1% gas (LPG, CNG), 3% hybrid electric, and 1% electric. The interface does not take into account drivelines such as ethanol, and hybrid electric. Thus, assumptions were made to account for that. Since the study area is an urban area, an assumption that hybrid electric vehicles are most likely to drive with an electric engine. Therefore, the share of percentage for hybrid electric were recalculated into electric. Furthermore, to account for ethanol, which is commonly used as a bio-

Table 3.1: The attributes chosen for the output "Vehicle Record" in PTV VISSIM. The attributes are the same for all scenarios.

Attributes
Number of vehicles
Vehicle Type Number
Vehicle Type Name
Simulation time (time of day)
Simulation second
Coordinates front (vehicle positioning
Weight
Power
Acceleration
Time in network (total)
Speed

Table 3.2: Evaluation tools, and their respective parameters and descriptions (PTV Group, 2022).

Road Type	Vehicle Class	Driveline distribution					Vehicle age distribution			
		Petrol	Diesel	LPG	CNG	Electric	Newer than 1 year	Average vehicle age	Average exit age	Max. age
Urban	Car	58%	37%	0.5%	0.5%	4%	6 years	10 years	17 years	Def.
	HGV	1.1%	96.5%	0.7%	1.4%	0.3%	7 years	11 years	15 years	Def.

fuel additive for petroleum, was categorised into the same group as petroleum. As for HGV, the driveline distribution accounted for 1.13% petroleum, 0.09% ethanol, 1.77% gas (LPG, CNG), 0.06% hybrid electric and 0.25% fully electric. The input values were adjusted to fit in to the emission model in the interface. Furthermore, the road type that was chosen for the emission modelling was Urban. See Table **??** for the input values for vehicle class assignment.

According to the Swedish Transport Adminstration (2021), the number of newly registered passenger cars and HGV were 6% and 7% respectively. The report further specifies the average vehicle exit age, which is 17 years for passenger cars. HGV have an average vehicle exit age of 15 years (Sveriges Åkeriföretag, 2016). The average vehicle age for Car, and HGV are estimated to be 10 and 11 years respectively.

The average regional CO_2 emission was derived from the handbook emission factors (HBEFA) which provides information such as emission factors for different vehicle categories in different traffic situations. The emission factors for different driveline technologies and vehicle categories are presented in Table 3.3. Since the interface has a limit value of 300 g/km, the representative values for HGV could not be integrated into the emission model. Hence, the input values were set as 300 g/km for both driveline technologies. This limitation would solely impact Scenario 1 and 3 since the vehicle composition of these scenario constitutes of both Car and HGV.

Table 3.3: Emission factor for different vehicle categories and driveline technologies (HBEFA, n.d.)

Vehicle Category	Driveline	Average regional CO2 emissions	Input value for Average regional CO2 emissions
Car	Petrol	142 g/km	142 g/km
	Diesel	180 g/km	180 g/km
HGV	Petrol	634 g/km	300 g/km
	Diesel	513 g/km	300 g/km

The produced emissions, NO_x and PM_{10}, were compiled in maps with corresponding charts. The spatial resolution was set to 5 x 5 m, which is recommended for microscale emission modelling according to Santiago et al. (2013).

Motorcyclists were not included in the emission model since there was no vehicle category for this mode, and also due to lack of data. Albeit a limitation, it is assumed from the study visits, those motorcyclists would not account for a great impact since there was very few of them in the study area. Another limitation is the exclusion of defining buses in the Custom Vehicle Parcs, which is mainly due to lack of data.

3.4.2 Prognosis

The performance of an EIA for the year 2030 is complex, and several factors such as technological development, climate and environmental objectives, economic and population growth, employment, urbanisation, instruments etc., are needed to be taken into consideration. All these factors have a significant impact on the size and development of the vehicle fleet. Furthermore, the assumptions for the current situation (see Chapter 3.4.1), were also implemented for the prognosis. The data used for this prognosis are based on the Swedish report *"Vägfordonsflottans utveckling till år 2030"* by Trafa (2020). The report predicts the size and composition of the Swedish vehicle fleet in year 2030.

Due to national and EU Commissions' climate and environmental objectives (see Chapter 1.1 and 1.1.1), it is predicted that a greater proportion of sustainable, and renewable driveline technologies will be used to replace fossil fuels. In the same report it is predicted that the share of driveline technologies for passenger cars in year 2030 will account to: 40% electric, 25% petroleum, 20% hybrid electric, 12% diesel, 2% gas and 1% ethanol (ETRAC, 2015). The driveline technologies in year 2030 for HGV are expected to account for: 60% diesel, 20% electric, 10% hybrid electric, and 10% gas. Unlike passenger cars, the dominating driveline for HGV is still expected to be diesel. The same assumptions for hybrid electric and ethanol in

Table 3.4: Vehicle class assignment for prognosis.

Road Type	Vehicle Class	Driveline distribution					Vehicle age distribution			
Urban		Petrol	Diesel	LPG	CNG	Electric	Newer than 1 year	Average vehicle age	Average exit age	Max. age
	Car	26%	12%	1%	1%	60%	6 years	10 years	17 years	Def.
	HGV		60%	5%	5%	30%	7 years	11 years	15 years	Def.

current situation analysis were made for the prognosis. Moreover, the age distribution was expected to be the same according to the report. Thus, the same input values as the current situation analysis were used. Furthermore, the road type that was chosen for the emission-modelling was Urban. See Table **??** for the input values for the Vehicle Class Assignments.

Similar to the current situation analysis, the average regional CO_2 emission was derived from the handbook emission factors (HBEFA) for year 2030, see Table 3.5. As aforementioned in the current situation analysis (see Chapter 3.4.1), the interface has a limit value of 300 g/km for average regional CO_2 emissions. To enable representative results, the same calculation procedure conducted for the current situation, was performed for the prognosis.

As the proportion of e.g., electric vehicles are increasing throughout the years, it is also important to consider the weight changes (due to changes in powertrain) in the vehicle fleet. This is because weight of the vehicle contributes to non-exhaust emissions such as PM_{10}. The report states that the general assessment of the model development for passenger cars, is that the changes will be small because the weight changes in the new vehicle do not differ dramatically, thus the total changes for the vehicle fleet will be small. As for HGV, the assessment is that the exchange of driveline technology is slow for trucks and given the composition of the estimated vehicle fleet in 2030, the shift in powertrain technology would still not be able to affect the average weight to a greater extent.

Table 3.5: Emission factor for different vehicle categories and driveline technologies (HBEFA, n.d.)

Vehicle Category	Driveline	Average regional CO2 emissions	Input value for Average regional CO2 emissions
Car	Petrol	146 g/km	146 g/km
	Diesel	124 g/km	180 g/km
HGV	Petrol	409 g/km	300 g/km
	Diesel	510 g/km	300 g/km

3.4.3 Sensitivity Analysis

Due to practical reasons and lack of calibration, validation and uncertainties in the emission modelling, OAT was conducted in this project to analyse the results.

To evaluate the uncertainties in the output from EnViVer Pro, a sensitivity analysis was conducted for the current situation and the 2030-year prognosis. It was decided to do this by changing parameters of the vehicle fuel types. Since the driveline distributions for particularly petroleum and electric held assumptions, the risk for uncertainties in the output was vastly probable. This is attributed to the fact that e.g., hybrid electric was accumulated with electric, and ethanol with petroleum. It was also determined that the analysis would be conducted for Scenario 1, which would be the base case for the current situation, and for Scenario 3, which would be the base case for the situation in 2030 (see Chapter 3.1). Since both scenarios represents traffic conditions that include both passenger cars and HGV, the two vehicle types were accounted for in the sensitivity analysis. See Chapter 3.4.1 for the fuel type input for the reference points.

Five scenarios were established for the analysis where the two chosen parameters would change a certain amount for each scenario:

1. **Scenario 0**
   This was the reference point for the sensitivity analysis, and it represented the fuel share that was used in the base case scenario.
2. **Scenario 1**
   The share of petroleum driven vehicles was increased with 5%, whilst the share of electric vehicles decreased with 5%, for both Car and HGV.
3. **Scenario 2**
   The share of petroleum driven vehicles was increased with 10%, whilst the share of electric vehicles decreased with 10%, for both Car and HGV.
4. **Scenario 3** The share of electric driven vehicles was increased with 15%, whilst the share of petroleum vehicles decreased with 15%, for both Car and HGV.
5. **Scenario 4** The share of electric driven vehicles was increased with 20%, whilst the share of petroleum vehicles decreased with 20%, for both Car and HGV.
6. **Scenario 5** The share of electric driven vehicles was increased with 25%, while the share of petroleum vehicles decreased with 25%, for both Car and HGV.

When altering the parameters, NO_x and PM_{10} values were analysed to investigate the affect that the changes had on the model response. As explained in Chapter 2.2.3, the greater the deviations are, the more sensitive the model is to changes.

4

Results and Analysis

In this chapter, the results of the four different scenarios (see Chapter 3.1) will be presented to depict the affect that HGV currently have and will have on the network performance as well as on the environment in the future. Thus, the results will be presented in three sections in order to achieve the aim and objectives of this study. The first section will present the traffic volume in the study area, followed by a section on the network performance and lastly on the EIA. This chapter will also provide an analysis for each section.

4.1 Study Area

From the aggregated traffic data for this study, the number of light and heavy vehicles operating in the study area between 16:00-17:00 was established, as presented in the sections of Chapter 3.2. As explained in that chapter, the input values for the simulation were determined for the base case, referred to as Scenario 1, as well as Scenario 2. In the first scenario, HGV made up approximately 5.3% of the total traffic during the peak hour. When evaluating the future scenarios, it was determined that the HGV would increase by 1.6% and the overall traffic would increase by 25%, as stated in Chapter 3.1. The share of HGV in the prognosis thereby constituted 4.3% of the total traffic. The resulting input values for the total traffic for each scenario are presented in Figure 4.1.

During the third study visit, northbound vehicles on Varlavägen south was estimated to 750 vehicles per hour, which was higher than the input value for the road. However, due to the closed passage on Borgmästaregatan, it was expected that the northbound traffic count on Varlavägen south would be slightly higher because road users will choose other routes to reach their destination, and thereby the estimation on this road was deemed realistic. The western leg on Roundabout A was examined during the study visit as well, and as expected, the activity on that road was significantly lower than the remaining legs, which further confirmed that the assumption made for this leg was realistic. The traffic on the other roads were not counted. However, their traffic was observed to ensure that the traffic was flowing similarly to the simulation, which it was.

Figure 4.1: Input values in PTV VISSIM for all four scenarios and their respective vehicle compositions (own figure).

4.2 Network Performance

As stated in Chapter 2.4.2, the parameters that were to be analysed were Average Queue Lengths, Maximum Queue Lengths, and Vehicle Travel Time. Queue Stops were also used as a further indication on the traffic flow of the network. The traffic volume for the different scenarios (see Figure 4.1) yielded the results from the five chosen Nodes (see Figure 3.10) that are presented in Table 4.1

In Table 4.1, QLen represent the Average Queue Lengths, QLenMax signify the Maximum Queue Length and Queue Stops are the number of times that the vehicles were considered to be in queues, i.e., they had to slow their speed down to 5 km/h due to congestion (see Chapter 2.4.2). The Queue Stops give an indication on how well the traffic is flowing, where higher numbers of Queues Stops suggests that there is more congestion. The values in Table 4.1 show that for all scenarios, Roundabout A had significantly higher numbers of Queue Stops than the rest of the Nodes, whilst Roundabout D had the fewest. For instance, in Scenario 1, the number of Queue Stops in Roundabout A was 25, whilst the corresponding numbers

Table 4.1: Simulation results from the five chosen Nodes for Scenario 1-4.

Scenario	Outputs	T-intersection	Roundabout A	Roundabout B	Roundabout C	Roundabout D
1	QLen (m)	114	83	2	1	0
	QLenMax (m)	252	251	39	27	10
	Queue Stops	14	25	4	2	0
2	QLen (m)	5	38	2	1	0
	QLenMax (m)	14	132	36	25	9
	Queue Stops	1	16	3	2	0
3	QLen (m)	246	202	6	6	0
	QLenMax (m)	500	381	66	55	14
	Queue Stops	9	61	7	6	1
4	QLen (m)	242	179	6	6	0
	QLenMax (m)	493	348	58	5	1
	Queue Stops	10	55	7	5	1

Figure 4.2: The queue build-up in Scenario 3 (own figure).

for Roundabout B, C and D were 4, 2, and 0, respectively. The number of Queue Stops in the T-intersection in Scenario 1 was 14, which was notably lower than the corresponding number for Roundabout A but much higher than the Queue Stops for the other roundabouts.

The proportion of the output values are roughly the same for all scenarios. As could be expected, the result for Queue Stops correlate with the Maximum and Average Queue Lengths of the five Nodes. For instance, Roundabout A's average and Maximum Queue Lengths were substantial, compared to the other roundabouts in the network. Nevertheless, the Node with the longest Maximum and Average Queue Lengths for all scenarios except Scenario 2, was the T-intersection (see Figure 4.2). It should however be noted that the queue on Borgmästaregatan was primarily caused by Roundabout A which in turn interfered with the queue of the T-intersection. Thereby, Borgmästaregatan had two points where the traffic flow got disrupted, which was likely the reason for the long queues.

In Scenario 2, Roundabout A had the most critical numbers for all three outputs. The output values for the Roundabout A and the T-intersection were significantly lower in this scenario compared to the other three scenarios. For instance, the Average Queue Length for Roundabout A was 38 m, whilst it was merely 5 m for the T-intersection, which was the second-to-longest Average Queue Length. The remaining three Nodes yielded values that were more similar to the values for the other scenarios.

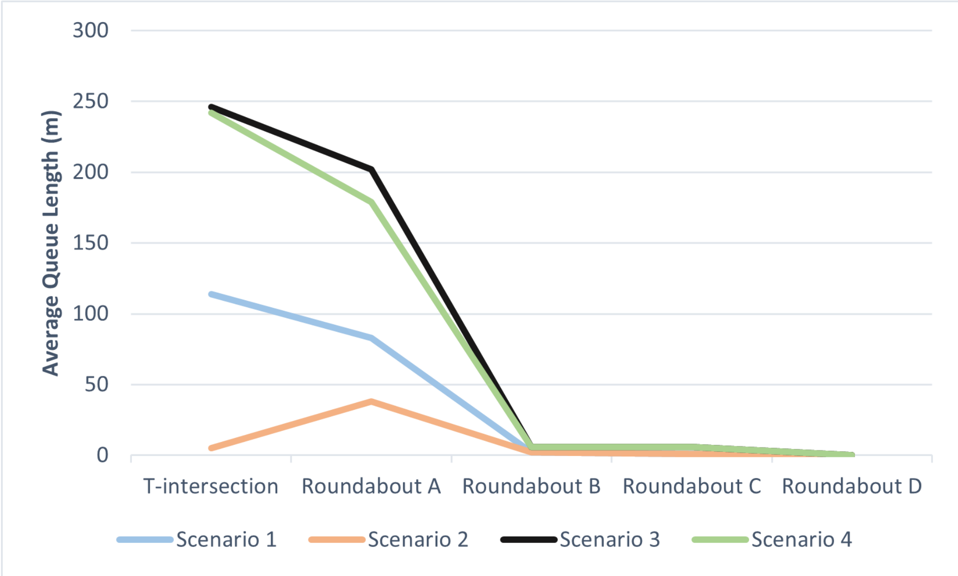


Figure 4.3: Average Queue Length based on Nodes.

Figure 4.3 further displays the Average Queue Lengths for the different Nodes and scenarios. When comparing Scenario 1 and Scenario 2, there was a significant difference in queue lengths for the T-intersection as well as Roundabout A. The Average Queue Length for the T-intersection was 114 m in Scenario 1, but only 5 m in Scenario 2. The difference was not as great for Roundabout A, however the Average Queue Length for Scenario 1 and 2 in that Node was 83 m and 38 m respectively. Since the only difference in these cases was the number of operating HGV, it can be assumed that they do indeed affect the traffic flow during the peak hour. The differences between Scenario 3 and Scenario 4 for the same areas of the network were minor (246 m and 242 m respectively), albeit the lengths were substantial and are likely to cause problems in the network if measures are not taken to prevent such developments. One reason to why Scenarios 3 and 4 do not differ as much as the first two can be that the share of HGV is lower in Scenario 3 than in Scenario 1, since the overall traffic was increased by 25% whilst the percentage for the increase of HGV only was 1.6%. Therefore, HGV will perhaps not have the same influence on the traffic flow in the future as it currently has. Another reason for this can be that the road capacity was closer to its maximum more frequently in both of the future scenarios, causing their Average Queue Lengths to be more similar.

When comparing the differences between Scenario 1 and 3, it could be noted that even though the traffic was increased by 25% for the future scenario, the Average Queue Lengths in both the T-intersection and Roundabout A was more than twice as long in Scenario 3 than in Scenario 1. That was likely because more vehicles in the simulation leads to longer queues, and the longer the queue is, the more the queuing delay will increase.

As mentioned in Chapter 3.3, the links on Borgmästaregatan and Varlavägen south had to be extended because the long queues prevented some vehicles from entering the simulations. The real length between Borgmästaregatan's connection to Roundabout A to the other roundabout at the eastern end of Borgmästaregatan is approximately 430 m (see Figure 4.4). The distance between Roundabout A and the T-intersection is about 240 meters, making the distance between the T-intersection to the eastern end of the road roughly 190 meters. On Varlavägen south, the distance between Roundabout A in the northern end to the roundabout in the southern end is approximately 260 meters. When comparing these lengths of the roads to the queue lengths presented in Table 4.1, it becomes evident that some of the queue lengths exceed the length of the actual roads. For instance, for the T-intersection, the Maximum Queue Lengths for Scenario 1, 3, and 4 (252 m, 500 m, and 493 m respectively) and the Average Queue Lengths for Scenario 3 and 4 (246 m and 242 m respectively), exceed the length of the road, that is 190 meters. Thus, in reality, if these queues were to go beyond the length of the roads as they do in the simulations, it would lead to queue spillback, meaning it would make adjacent roads less passable, as mentioned in Chapter 3.3.5. It could also lead to people choosing alternative routes to avoid the long queues, which could eventually lead to somewhat shorter queue lengths in the study area but could congest other traffic networks.

For Roundabout A, no queue lengths exceed the road capacity on Borgmästaregatan. However, there is a risk that the maximum capacity will be reached in Scenario 3 and 4 on Varlavägen south since their Maximum Queue Lengths were 381 meters and 348 meters respectively. Varlavägen south is a shorter road than Borgmästaregatan, but it has the higher input value, which means that the road runs a higher risk of causing queue spillback.

Figure 4.4: Distances between different points in the network (own figure).

The Vehicle Travel Times were measured on twelve routes in the network for each scenario. The results are presented in Figure 4.5. For the first three Vehicle Travel Time points (T-intersection to Roundabout A, endpoint of Borgmästaregatan to Roundabout A, and endpoint of Varlavägen south to Roundabout A), the values vary significantly more than the rest of the points and they are also notably higher. As could be expected based on the difference in Average and Maximum Queue Lengths, the Travel Times on Borgmästaregatan, the link between the T-intersection and Roundabout A, was a critical route for all scenarios. The most critical route for all scenarios is the link between Roundabout A to the end of the network at the end of Borgmästaregatan. For both Scenario 3 and 4, the Vehicle Travel Time is roughly 800 s, whilst for Scenario 1 and 2 the values are close to 380 s and 150 s respectively. It can also be noted that Scenarios 1 and 2 differ markedly more than Scenario 3 and 4, which are nearly identical. This gives a further indication on how UFT influences the network more today than it will in the future, based on the assumptions made in this thesis. For the rest of the Vehicle Travel Time points, they remain nearly the same for all four scenarios, which again, corresponds to the results of the queue lengths.

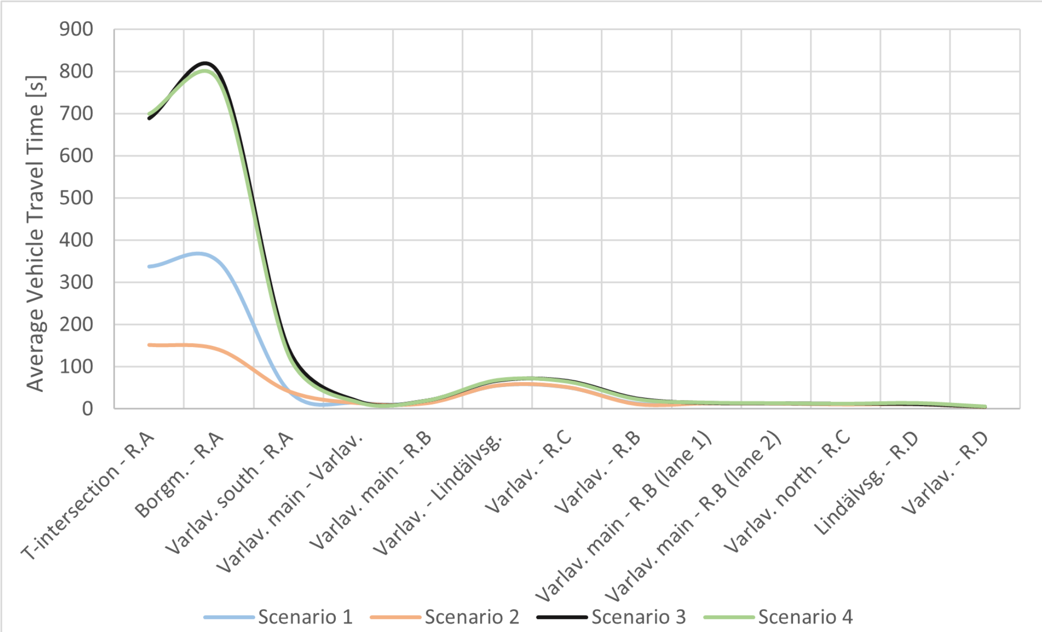


Figure 4.5: Vehicle Travel Times are displayed. Names of the points in the network has been shortened to fit the figure, where "R." is short for "roundabout", "v." is short for "vägen, and "g." is short for "gata/gatan".

4.3 Emissions

The results of the produced emissions for the different scenarios and for each vehicle types, are presented in Figure 4.6

It is evident that NO_x is the dominating pollutant for all scenarios. It is also evident that NO_x is highest for HGV compared to Car for the scenarios where HGV are taken into account (Scenario 1 and 3). This is associated with the driveline technology for each vehicle type. As stated in Chapter 2.1.1, the driveline technology diesel (CI-engines) emits more NO_x emissions. Since the proportion of HGV consuming diesel is greater than Car, it is reasonable that HGV accounts for the greatest share of NO_x emissions. This is regardless of the fact that the number of passenger cars are more than HGV in the study area. As NO_x accounts for the greatest proportion for HGV, PM_{10} is the dominating pollutant for passenger cars. Since PM_{10} are mainly produced due to mechanical processes, as stated in Chapter 2.1.2, the number of passenger cars are a vital component in the generation of the pollutant. Since the number of passenger cars are more than HGV in the study area, it is reasonable that this would reflect on the results.

Furthermore, it is conspicuous that there is a total reduction of NO_x emissions between the year 2021 and 2030. This is most likely attributed to the environmental objectives (see Chapter 1.1), the assumed share of renewable and sustainable driveline technologies, more efficient propulsion technologies, stricter EU-standards etc. All these factors, among others, are assumed to have an impact on the Swedish vehicle fleet in the future, and consequently on the environmental impact as well, which is reflected on the results. As for PM_{10}, there is a general total reduction of the pollutant when comparing Scenario 1 to Scenario 3, despite the increase of number of cars. However, it is also evident that there is an increase by 7% from Scenario 2 to Scenario 4. The cause for that could be due to various reasons such as the number of cars, although it was not the case for Scenario 1 and 3, and it should not be the case now neither. It is essential to denote that all the scenarios are based on stochastic distributions in PTV VISSIM (see Chapter 3.3), and the produced results may differ. Thus, the output values which have been assigned stochastic distributions will most likely have small fluctuations in the results.

Albeit the results from Chapter 4.2 presents an overload of the network performance in certain points (e.g., Borgmästaregatan and Varlavägen south) currently and in the future, the emission results show an overall decrease in the future. Again, this is assumed to be due to the aforementioned factors in the previous paragraph. It is worth to emphasize that the produced emissions are an indication on the environmental impact on the study area, and not necessarily how it is or will unfold in the future. However, they provide an overall view on the matter. The uncertainties that might have influenced the emission results are presented in Chapter 5.2.

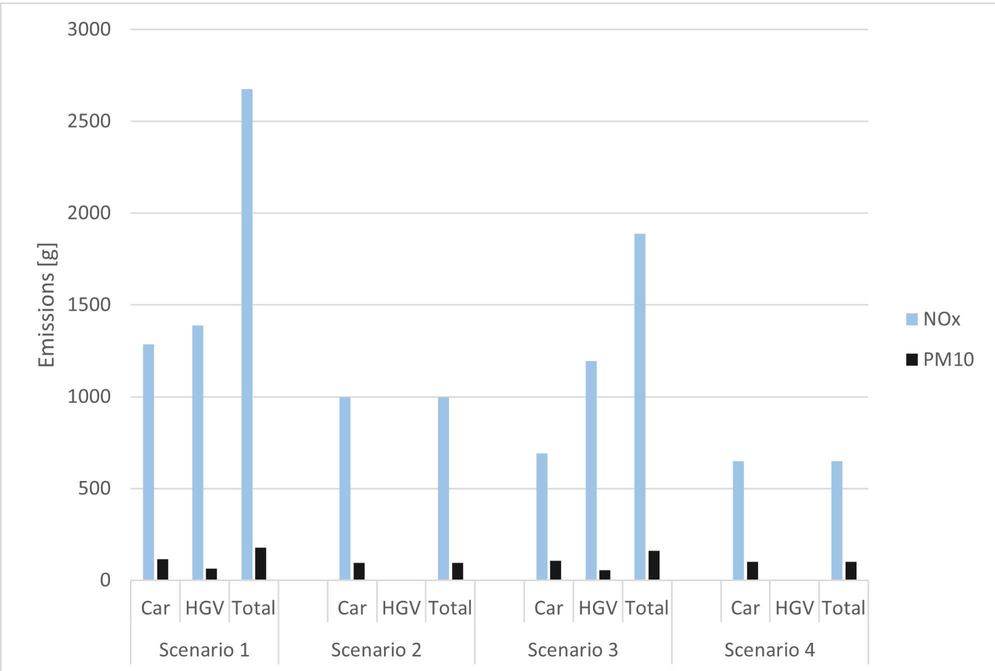


Figure 4.6: Emission results from EnViVer Pro for the different scenarios. The emissions are presented by each vehicle type, as well as in total in gram/hour.

4.3.1 Concentration of Pollutants

The results of NO_x and PM_{10} pollutants are presented in Figure 4.7 and 4.8 respectively for all scenarios. It is evident from the results for both pollutants, that the presence of HGV increases the amount of concentration in the area. PM_{10} decreased with 43% and 46% respectively for Scenario 2 and 4. For NO_x, the concentrations decreased with 61% and 73% respectively for Scenario 2 and 4. There is a more significant decrease in the case of NO_x than PM_{10}. This is attributed to the fact that diesel powered vehicles emits more NO_x than petroleum powered vehicles. Due to the fact there is an absence of HGV in Scenario 2 and 4, the decrease of NO_x is expected to be and is significant. The absence of HGV also indicates on less vehicle weight which is associated with engine loading and thus more emitted emissions.

It is also evident from the results that the highest concentration of both pollutants appears to be in the roundabouts. This is because these centroids are regarded as loading points in the study area. This is on the grounds that in these loading points the average speed is generally low due to the natural composition of roundabouts. I.e., mechanical processes such as acceleration, idling, deceleration, braking at small spatial, and temporal intervals is more frequent due to the natural behaviour of the driver when entering or exiting the roundabouts. Thus, an excess of emissions is emitted as a result compared to other areas in the study area. Furthermore, the results from the evaluation of network performance in Chapter 4.2 conspicuously presents how in addition to the roundabouts, the adjacent roads to Roundabout A: Borgmästaregatan and Varlavägen south are exceeding the road capacity. Consequently, this results in queues which is associated with mechanical processes and thus an excess of emitted emissions. This correlates to the emission results, as Borgmästaregatan and Varlavägen south are regarded as hot-spots due to the queue build-ups. Nevertheless, the results from the Vehicle Travel Time in Chapter 4.2 show that these roads are in average lower than during normal conditions, which is associated with the build-up of queues. Thus, this gives an indication that a great proportion of the vehicles operate in modes of mechanical processes, which is characterised by engine loading and consequently an excess of emissions.

It is also evident from the results, that the MKN are exceeded in all scenarios with regards to NO_x. Since the generated emissions are based on the results of one hour, the hourly threshold was used as a reference to monitor the concentration of pollutants present in the study area. The limit value 90µg/m^3 is exceeded for all scenarios. However, the scalability and magnitude of the concentrations differs in the scenarios. Among the worst performed scenarios is unambiguously Scenario 1, as the concentrations of NO_x are exceeded in Roundabout A, B, C and in adjacent roads Borgmästaregatan, Varlavägen main and to a certain extent in Varlavägen south. The rest of the study area, e.g., Roundabout D and Varlavägen north are on the threshold (or already passed the threshold) of exceeding the limit value. The maximum value obtained in Scenario 1 was 663µg/m^3, which most likely occurred in one of the red hotspots.

As for Scenario 2, there is a significant decrease of NO_x concentration in the absence of HGV. The only network elements that appear to exceed the MKN is Roundabout A, B and C, whereas the other roads are in the threshold of passing the limit value. In Scenario 3, there is an apparent decrease in NO_x concentrations compared to Scenario 1, despite the fact that the scenario unfolds in year 2030 with a greater traffic volume. This is due to the technical improvement of the average vehicle fleet. The concentrations of NO_x are greater than Scenario 2, which is most likely attributed to the presence of HGV. In Scenario 3, the exceed of the threshold is apparent in almost all network elements, e.g., Roundabout A, B, C, D, and adjacent roads excluding Varlavägen north. This is most likely due to the fact that there is an increase of vehicles, however it is still much less than Scenario 1. Lastly, the best performed scenario is Scenario 4 as almost all network elements are below the threshold. However, there is an instance where the maximum value was measured to 118µg/m^3 (e.g., exceeded the threshold), which is most likely occurring around Roundabout A as it is the most congested intersection in the network. Nevertheless, Scenario 4 performs the best out of all scenarios, and this is likely due to the absence of HGV and the improved propulsion technology.

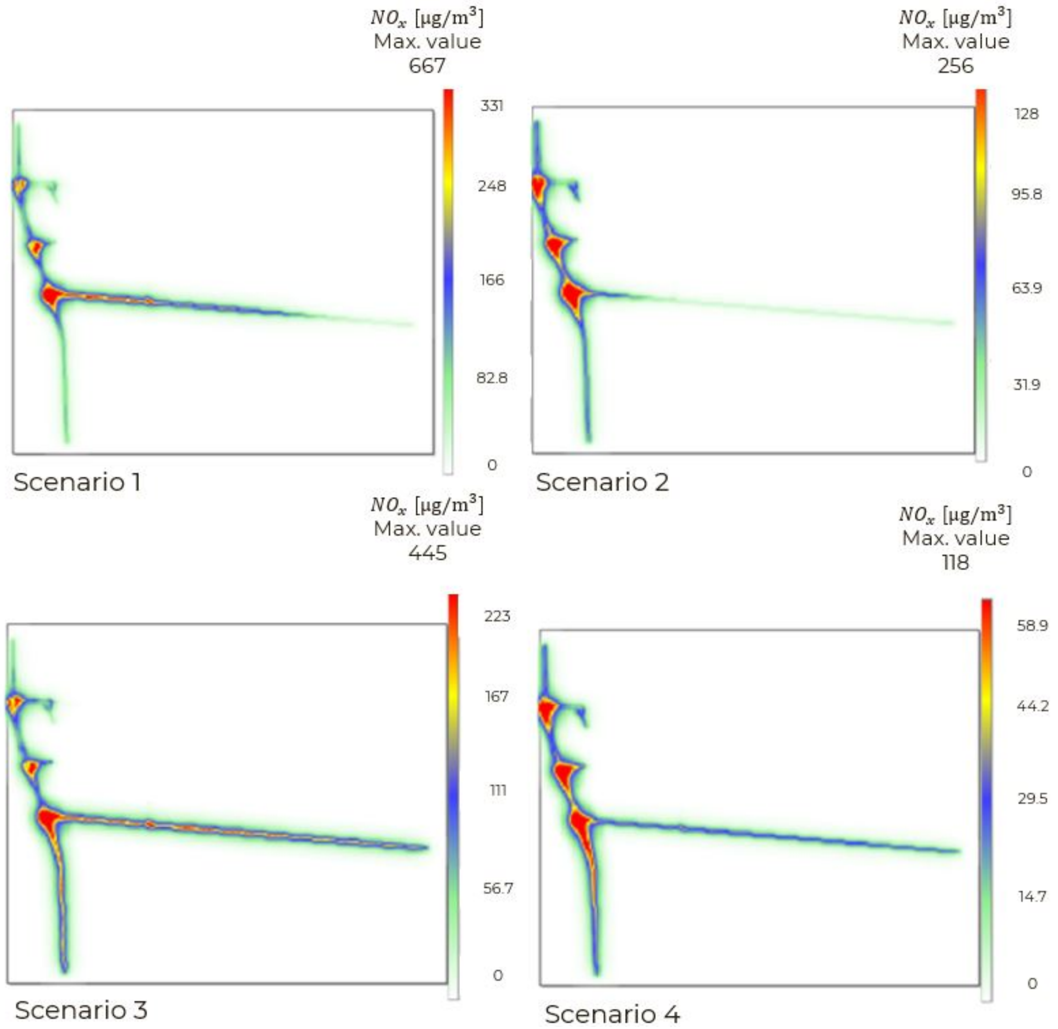


Figure 4.7: NO_x concentration maps in the study area, for scenario 1, 2, 3 and 4. The highest concentration of the pollutant is marked with red, followed by orange, yellow, blue, green and white.

The results in Figure 4.8 present the hourly concentrations exposure of PM_{10}. As stated in Chapter 2.1.2 there are no limit values for the hourly exposure of the pollutant. This was taken into consideration when analysing the results. From the results, it is assumed that the exposure of PM_{10} in the study area is not expected to exceed the daily limit value which is set to 50µg/m^3. Again, the results are obtained during peak hour, and it is assumed that during the rest of the hours, normal conditions will prevail and thus will have significantly lower concentrations of the pollutant. Nevertheless, it is evident that the concentrations of PM_{10} are highest at the defined loading points, which is as aforementioned associated with network performance (e.g., queues, travel times, traffic flow etc).

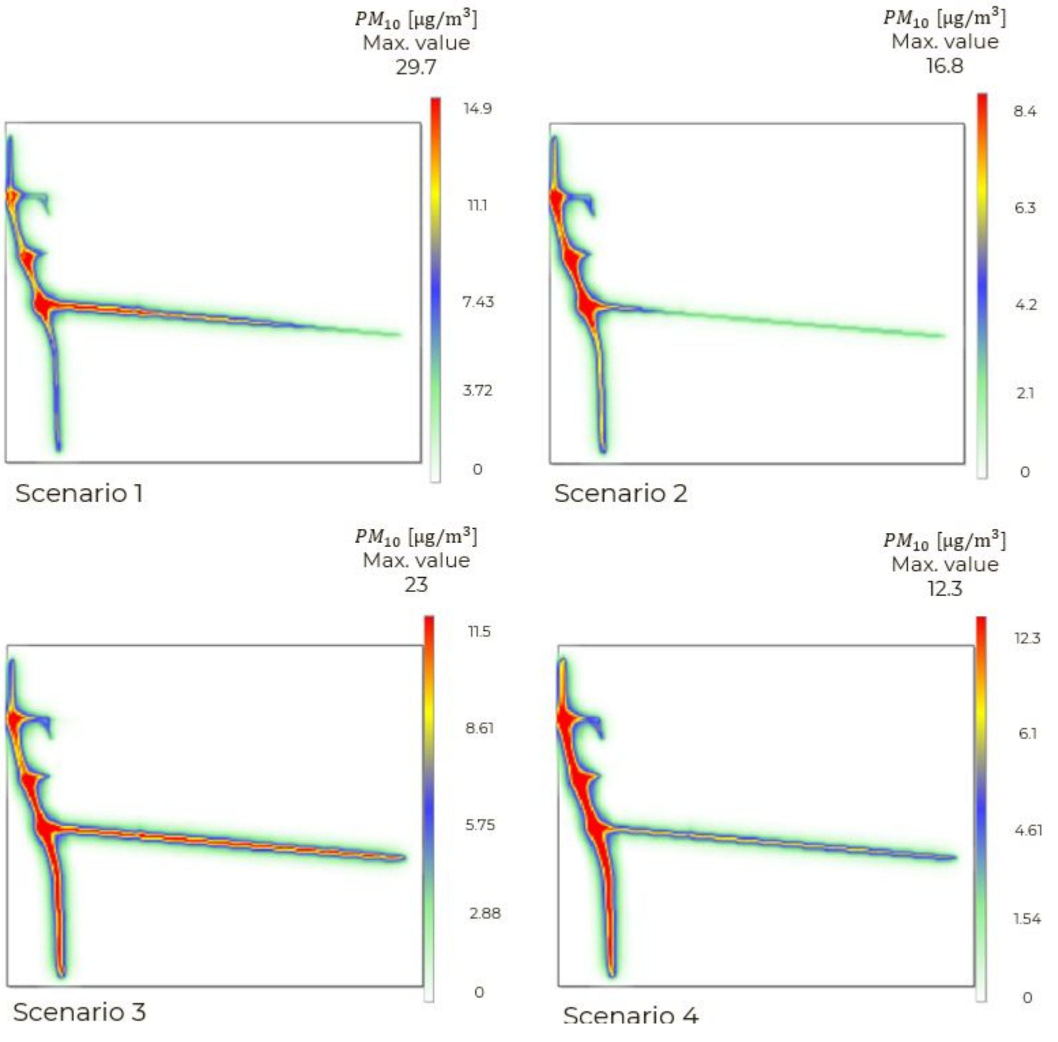


Figure 4.8: PM10 concentration maps in the study area, for scenario 1, 2, 3 and 4. The highest concentration of the pollutant is marked with red, followed by orange, yellow, blue, green and white.

4.3.2 Sensitivity Analysis

The emission modelling held certain limitations which can be interpreted as uncertainties. The most significant limitations in the interface were the driveline distributions as it did not consider certain driveline technologies (e.g., hybrid electric, ethanol, etc.) which are a vital component in the Swedish vehicle fleet. The results for the sensitivity analysis for the current situation and the prognosis are presented in Figure 4.9 and 4.10 respectively.

The results in Figure 4.9 shows that the different scenarios do not deviate drastically from Scenario 0, i.e., the reference point. The greatest deviations in the model response are allocated to Scenario 1 and 2. The results show an increase by 1% for both pollutants respectively. The reason for that is due to the successive increase of petroleum and the proportional decrease of electric. Nevertheless, the change in the outputs for Scenarios 1 and 2 are still small. As for Scenario 3, 4 and 5, the results are close to the Scenario 0. The reason for that is the share of electric fuel is approximately 4% and 0.3% for passenger cars and HGV respectively. Consequently, an increase of electric fuel and a proportional decrease of petroleum, would generate small to non-existent deviations from Scenario 0. I.e., due to the small share of electric fuel, the increase by 10%, 20% and 25% respectively would still not be generate significant deviations in the outputs.

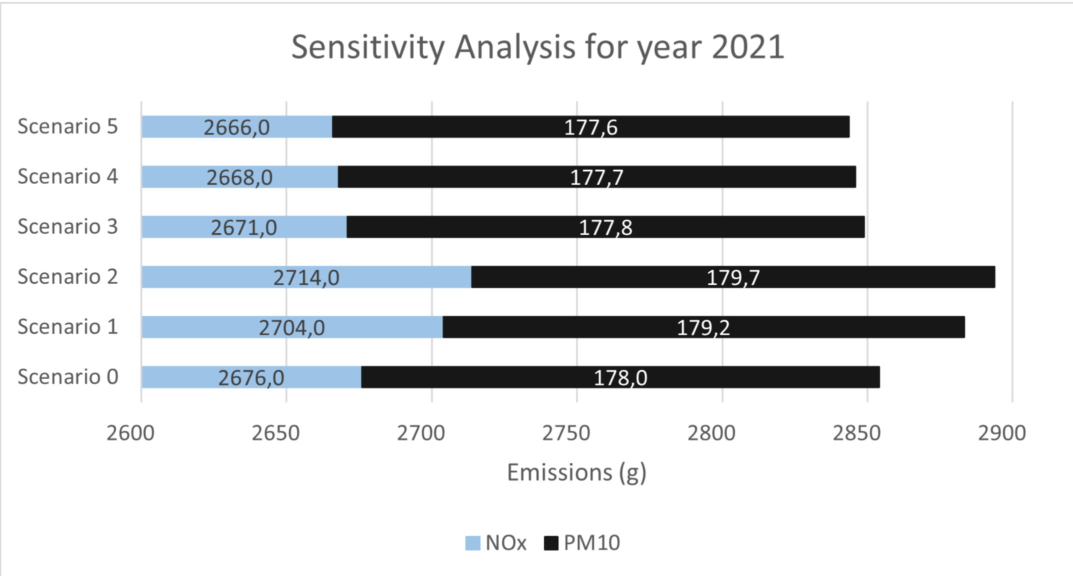


Figure 4.9: The results from the sensitivity analysis. Scenario 0 represents the reference point, whereas the rest of the scenarios constitute of changes in the input value.

On a similar note, the results for the prognosis do not deviate drastically from Scenario 0. It is conspicuous that both pollutants increase when it is assumed that the share of petroleum increases (e.g., Scenario 1, 2 and 3), and decreases when the share of electric increases (e.g., Scenario 4 and 5). In comparison to the model response for the current situation, it is apparent that there is a greater, however still small, deviations from Scenario 0. This is attributed to the fact that passenger cars account for a great proportion of electric and petroleum. Thus, a small increase, alternatively decrease would have an influential impact on the results. This is not the case for HGV, as the share of the latter driveline technologies is comparatively small and thus, a change in the input values would not have a significant impact on the results. Thus, it is not as sensitive for changes as in the case for passenger cars. Albeit the small changes do not generate significant impact on the outputs, it is worth to emphasize that HGV and passenger cars account for the absolute majority of NO_x and PM_{10} respectively.

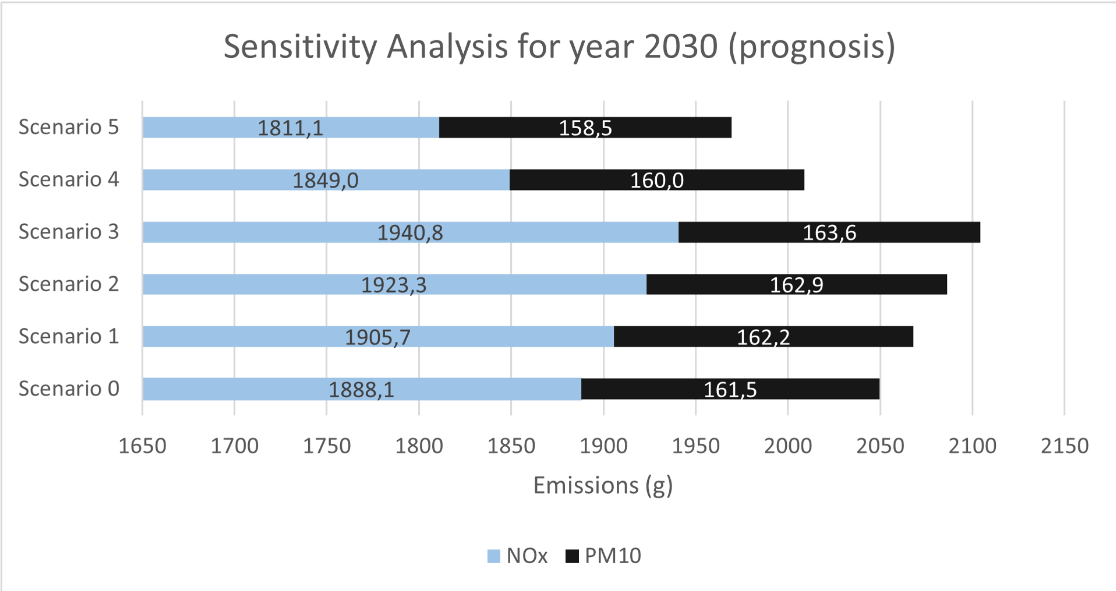


Figure 4.10: The results from the sensitivity analysis. Scenario 0 represents the reference point, whereas the rest of the scenarios constitute of changes in the input value.

Comprehensively, the evaluation from the sensitivity analysis indicate that the uncertainties of the input values do not affect the outputs significantly. I.e., the model response for the EIA is robust as the sensitivity of the results from these changes are small.

5
Discussion

This chapter will provide a comprehensive discussion on two key elements in this study. There will be a discussion on the results of the network performance and the EIA. There will also be a discussion regarding uncertainties associated with the constraints and assumptions that were made.

5.1 Results

As mentioned, in Chapter 3.2.3, a study visit was made after all results were compiled, to compare the results with the real network. During the study visit, Roundabout A and its adjacent roads were mainly examined, since they were the most critical elements in the simulation according to the results. The observations made during the study visit confirmed the input and results of the simulation. However, as mentioned in Chapter 3.2.3, the construction work on the bridge on Borgmästaregatan affected the network performances. Furthermore, the traffic counting technique used during the study visit accounted for uncertainties, since only ten minutes of the peak-hour represented the hour between 16:00-17:00. However, these uncertainties were taken into account when comparing them to the results of the simulation. Furthermore, both the comparison of the simulation results with the real network as well as the numerical validation showed that the results were correlating with the reality.

One of the research questions of this study (see Chapter 1.4) regarded the impact that UFT had on the network. To answer that question, both the simulation and the EIA results had to be taken into account. Starting with the results from the simulation, provided in Chapter 4.2. When comparing the results from Scenario 1 and 2, there is a distinct difference where Scenario 2 has lower values for all measured parameters. Since the only difference between the two scenarios were the presence of HGV, it can be assumed that UFT has a noticeable effect on the traffic flow. However, when comparing the corresponding scenarios for the prognosis, there is not such a distinct difference between their results. Nearly all values for Scenario 4 were lower than for Scenario 3 but the differences were small. This indicates that the UFT has less of an impact on the network performance in the future. However, as stated in Chapter 4.2, the similar results for Scenario 3 and 4 could be due to the fact that the share of HGV is lower in Scenario 3 than in Scenario 1, and thereby causing smaller differences between the prognosis scenarios. Another reason could be that the congested roads had reached their maximal capacity for both Scenario

3 and 4. Thereby, the small differences does not necessarily mean that HGV will not have an impact on the traffic flow in the future. Nevertheless, based solely on the results from the simulation, it could be assumed that the UFT currently has a significant impact on the traffic network in the study area, but the impact will decrease in the future.

Moreover, changes could be done in the network to improve both traffic flow and environmental conditions. In Chapter 4.2, all results for the network performances shows that Roundabout A is the most critical point in the network and its queues creates further problems for the T-intersection. When looking at the formation of Roundabout A and compare it to the other roundabouts in the network, it can be remarked that almost all legs on the other roundabouts have more than one lane or have a separate lane for incoming right-turning vehilces that does not connect to the roundabout and one lane that connects to the roundabout for the rest of the vehicles (see Figure 3.10). However, only half of Roundabout A consists of two lanes, whereas the other half, being the one that causes congestion, only consists of one lane. Therefore, one solution to avoid the long queues that occur in all scenarios, could be to expand the route choices in Roundabout A where there is only one lane. That could either be by adding separate lanes for incoming right-turning vehicles from Varlavägen south and particularly Borgmästaregatan (same formation as Roundabout B and Roundabout C, see Figure 3.6), or by expanding the roundabout so that all of it has two lanes. Hence this solution is most critical for Roundabout A since it is in this junction that the capacity is exceeded. This solution could potentially make it necessary to expand the connecting roads for vehicles leaving the roundabout on Varlavägen main and Varlavägen south. These roads currently have one lane that later expands to two, therefore the expansion of two lanes could be starting at the connection of the roundabout instead. However, it should be noted that an expansion of the roundabout and an improved traffic flow could potentially lead to an increase of capacity, which in turn would cause more emissions.

When evaluating the results from the EIA, the affects that HGV have on the study area becomes more evident. As pointed out in Chapter 4.3.1, the absence of HGV decreased both NO_x and PM_{10} significantly for the current situation and the prognosis. The emission maps in Figure 4.7 and 4.8 further shows that the entire study area, especially the roundabouts and the congested roads, are affected by the pollutants. Thus, the result of the study shows that UFT influences both the traffic flow of the study area, and it has a significant impact on its environmental conditions. Further, it is also worth to emphasize that although the results of this study are unfolding during peak hour, the outcome could and will most likely have severe consequences for the health of those passing by these hotspots, especially children. It can also have a negative impact on climate as these pollutants contribute to greenhouse effect. The results indicate that Roundabout A and Borgmästaregatan are the spots that are most burdened in terms of these emitted pollutants. As Borgmästaregatan is becoming more densified, the air quality is most likely to be worse than the rest of the study area. As aforementioned in Chapter 4.3, a short-term exposure of these pollutants could develop negative health issues for those passing by and could have even more severe consequences if exposed daily. As there are no industries nearby that could possibly contribute to the production of these pollutants, it is therefore assumed that the production of these pollutants is mainly caused by traffic. It is also evident from Figure 4.7 and 4.8, that the pollutants will decrease in the future due to technical improvements of the vehicle fleet. However, the decrease of NO_x is still exceeding the limit values set by MKN. Thus, indicating that there needs to be policies addressing these problems for a more sustainable and prosperous city.

Implementing policies can be a way to improve both the traffic flow in the area, as well as the environment. For instance, as Figure 3.2 visualises, the hour that most light vehicles are operating, most HGV are also operating. That indicates that a shift of operation times for UFT could improve the traffic flow of the network. One way to do that is to implement a policy that prohibits UFT to operate during peak hours, for instance. This could potentially affect and benefit business in the shopping mall too, since a policy such as this would lead to deliveries on off-peak hours that assumably would not be as busy for the businesses, leaving them time to handle the deliveries. Moreover, this solution would not only reduce congestion, but it would also diminish emissions, due to the large amounts of pollutants emitted by vehicles in queues. Further, considering the climate crisis and the environmental goals set by the EU and Sweden (see Chapter 1.1, the impact that the EIA showed that UFT has on the environment is a pressing issue that should be delt with. Thereby, the Kungsbacka municipality could for instance implement a policy to regulate the euro classes of the HGV that operate in the area. This would have a positive effect on the environment, and it would also push UFT companies to invest in more green vehicles, which would not only benefit the municipality of Kungsbacka, but possibly also other cities that the companies deliver to.

5.2 Uncertainties

In general, it is nearly impossible to conduct a fully accurate traffic analysis. The reason for that is due to the complexness of modelling a real-world traffic situation. The construction of a network model and the evaluation of its performance will always be associated with uncertainties, whether they are small or great. Thus, it is necessary to make justifiable assumptions with the aim to replicate the real-world traffic situation.

As stated in Chapter 3.2.1, additional traffic data from other sources were used to enable a comprehensive overview of the traffic situation in the study area and adjacent roads. The additional data was based on a daily traffic volume and was recalculated into an hourly traffic volume. I.e., indicating that the hourly traffic volume is not necessarily representative for peak-hour as the estimation is based on average calculations. Based on the combined traffic data, an estimation was made to establish a relative flow ratio for each vehicle type, and for each road. Although, there may be some uncertainties associated with the estimation of previously mentioned variables, they were essential to conduct for a comprehensive overview of the traffic situation. However, based on the measured data in combination with the study visit, the assumptions made are considered valid.

The calibration of traffic volume in the network model were conducted manually. I.e., adjustments in the traffic network were made manually to monitor the volume entering and existing the study area. By performing a manual calibration, the user can monitor the traffic demand and flow, as well as maintain a complete link to travel patterns. Throughout the calibration process, it was necessary to establish a system where the amount of entering vehicles, also exists the network model in accordance with the established ratios. Consequently, some calibrated traffic points were given a higher traffic volume than the measured values. This was to compensate for the traffic losses in other traffic points. This was particularly the case for Nya Varlavägen as it was given more traffic volume to compensate for the losses in other roads. Nevertheless, the measured, and calibrated traffic data had a strong positive correlation. Thus, the simulation results are considered to be valid and representative of the real-world traffic situation in defiance of the uncertainties associated with the assumptions.

The construction of the model was simplified due to the constraints in traffic data. Consequently, the left lane to Roundabout A was excluded from the network model due to lack of traffic data from that area. It was concluded from the study visit that the area do not generate an influential impact on the roundabout and thus for the purpose of simplification, it was excluded.

The approach for the EIA in Chapter 4.3 and 4.3.1 is limited to a certain extent and based on several assumptions (see Chapter 3.4). The network model did not include traffic modes such as buses, motorcyclists, pedestrians etc., which would certainly have a significant impact on the results. The interaction of these excluded traffic modes would have most likely increased the generation of NO_x and PM_{10}. This is because it would have increased certain mechanical processes, and the traffic flow overall.

Furthermore, the limit values for average regional CO_2 emissions for petroleum and diesel were also restricted to a certain threshold which would not necessarily produce representative emission results for HGV. Thus, it is assumed that the concentrations of pollutants in the emission maps are likely to be higher. Nevertheless, the emission maps provide a ratio between the different network elements in terms of emission loading and given an overall indication on the environmental impact in the study area.

Moreover, it is probable that the greatest uncertainty is the prognosis of how the Swedish vehicle fleet will unfold in the year 2030. Due to the complexness of future predictions, there are always uncertainties associated with them. The assessment of the prognosis, which was used in this study, are based on political objectives, legal and economical instruments in the transportation sector, national and international trends, studies conducted by IVL and other institutions, price development for fuels and vehicles, historical and economic development, studies conducted in the study area, development of HGV etc. Nevertheless, there are still uncertainties as the unfolding of future events can never be guaranteed.

It is necessary to emphasize that the EIA in the study area does not necessarily equal to the real-world scenario. The performance of the emission modelling for current situation and the prognosis of year 2030 is as aforementioned complex and depends on many factors. Hence, a sensitivity analysis was conducted indicating that the model-response is not drastically sensitive for any changes. Nevertheless, there are contributing factors as mentioned in the previous paragraph that could indirectly increase the sensitivity of the model-response. However, it is equitable to state that the generated result from the EIA provides a more or less indication on how it will be unfolding in the real-world.

6 Conclusion

With regards to this study's research questions, as well as the aim and objectives, it is evident that UFT has a significant impact on the network performance and the environment now and in the future. Albeit limited, the framework of this study obtained findings indicating on the importance of establishing a sustainable urban logistics plan in order to achieve the national and international objectives for the years 2030 and 2045.

The results of the network performance indicate that the capacity is exceeded in certain zones in the study area (e.g., particularly Borgmästaregatan and Roundabout A). The present findings confirm that it is necessary to reconstruct Roundabout A in order to increase the traffic flow and improve the network performance. This in regard to the present traffic conditions as well as the predicted traffic flow.

The findings of this study also indicate on a positive correlation between the network performance and the environmental impact. The results in Chapter 4.3.1, conspicuously display an increase on the concentration of pollutants, particularly in junctions where potential for mechanical processes is demonstrated. I.e., an increase on queues and Vehicle Travel Time is positively correlated with the environmental burden. This may be considered a further validation of the importance of reconstructing Roundabout A for an efficient and increased traffic flow. Furthermore, the findings from this study evidently suggests that an exceed of the hourly exposure of particularly NO_x is demonstrated in the study area. As stated in previous chapters, HGV account for a great amount of NO_x due to the driveline technology they are encompassed by. On this basis, it is also evident that there is a significant decrease of NO_x when HGV are absent. As for the exposure of PM_{10}, it can be concluded that it is assumed that the concentration of the pollutant will not exceed the daily exposure thresholds. Nonetheless, it should be reduced further as the environmental objectives and standards are becoming more stringent. This further implies that a sustainable urban logistic planning is essential in order to limit the environmental burden and achieve the environmental objectives and standards.

Lastly, this aspect of research in this study is limited due to the discussed uncertainties in Chapter 5.2. It can also be concluded that a further expanded approach is needed in order to estimate precise results, which is further discussed in Chapter 7. Nonetheless, the authors argue that the findings in this study provide a general and justifiable overview on the impact of UFT in the study area, as well as present an indication on how the impact of UFT will unfold in the future.

7
Future research

With the introduction of this study's framework, there are potential for challenging opportunities to contribute and improve the addressed constraints as well as extend the work in other aspects. This paves the avenue for future research and potential development in some areas of the study.

It has been reiterated that the results of this study provide a comprehensive as well as a general overview of the impact that UFT accounts for. The aggregated traffic data presented the traffic volume for one week and in few traffic points. To enable even more precise and representative results, it is of favour to collect traffic data for a longer period of time and in several traffic points. The traffic data should also include other traffic modes and if possible, their characterisation (e.g., EU-class, weight, driveline technology etc.) to enable more realistic simulation results. This approach will serve to provide less uncertainty in the results and pave the avenue for a greater insight on the impact of UFT.

On a similar note, it has been reiterated that the emission results provide a more or less indication on the environmental impact. However, the approach for the emission modelling requires further development to enable more precise results. The interface should be extended to include more options in driveline technologies and increase the constraints of regional CO_2 emissions for HGV.

As stated in Chapter 6, it is evident that it is essential to plan for a sustainable urban logistic to achieve the national and international objectives set for year 2030 and 2045. Thus, a continuation of this study could include research on the evaluation of possible policies to reduce the negative impact of UFT. The policies should be evaluated in terms of criterium attributed to the network performance, environmental impact, and costs.

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A
Appendix

A.1 Appendix 1

Table A.1: The given data from Norconsult for the point referred to as 'Kungsgatan' in the report, with the total direction of travel.

Measuring point: Kungsgatan, Westbound, Kungsbacka, Varlavägen West (70496). Direction of travel: Total. Speed limit: 40 km/h

	2021-10-13 (wed)		2021-10-14 (thur)		2021-10-15 (fri)		2021-10-16 (sat)		2021-10-17 (sun)		2021-10-18 (mon)		2021-10-19 (tue)		Total				Weekday			
Hour	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Heavy	Light	Speed	Quantity	Heavy	Light	Speed
00:00-01:00	18	42,6	26	44	16	43,8	63	42	94	42,7	13	44,3	9	40,6	239	8	231	42,7	82	0	82	43,3
01:00-02:00	9	53,4	13	51,1	17	46,7	62	43,1	80	42,1	7	46,4	14	47	202	14	188	44,4	60	6	54	48,7
02:00-03:00	5	46	4	39,9	5	42,5	46	43,7	73	45,5	3	45	3	51,1	139	10	129	44,8	20	4	16	44,5
03:00-04:00	3	46,7	2	47,2	6	45,6	37	46,2	55	45,5	6	47,3	2	46,1	111	2	109	45,9	19	0	19	46,5
04:00-05:00	10	48	21	44,2	8	46,9	17	47,2	21	45,8	13	45,4	8	45,9	98	6	92	46	60	5	55	45,7
05:00-06:00	76	43,3	69	41,2	82	42,2	11	43,9	17	48	68	42,7	81	41,5	404	39	365	42,5	376	38	338	42,2
06:00-07:00	266	41,3	232	41	244	40,5	43	41,8	37	43,9	263	41	270	40,2	1355	156	1199	40,9	1275	149	1126	40,8
07:00-08:00	392	36,8	395	39,1	358	39,3	61	43,6	62	43,3	402	37,6	381	36,9	2051	185	1866	38,3	1928	172	1756	37,9
08:00-09:00	424	39,5	405	39,2	366	39,1	104	42,1	78	41,3	405	38,5	368	38,4	2150	210	1940	39,2	1968	190	1778	38,9
09:00-10:00	297	39,7	290	39,5	322	40,3	181	42,3	145	42	295	40,4	280	40,2	1810	165	1645	40,4	1484	151	1333	40
10:00-11:00	399	38,3	375	38,6	396	39,7	343	40,8	281	42,2	399	39,3	367	38,2	2560	208	2352	39,5	1936	186	1750	38,8
11:00-12:00	477	39,8	424	39,6	500	39,7	554	38,9	451	39,9	490	38,6	468	38,6	3364	160	3204	39,3	2359	136	2223	39,3
12:00-13:00	552	39,6	610	38,9	699	37,4	629	37,5	570	39,1	517	39,9	567	37	4144	156	3988	38,4	2945	130	2815	38,5
13:00-14:00	532	39,8	553	39,1	662	39,1	739	36,4	588	40,3	519	38,8	565	38,1	4158	180	3978	38,7	2831	152	2679	39
14:00-15:00	619	36,9	611	37,1	756	36	790	37,2	660	38,2	577	37,9	604	36,6	4617	231	4386	37,1	3167	207	2960	36,9
15:00-16:00	767	36,2	749	37	884	34,5	714	37,7	598	38,2	748	35,7	756	35,1	5216	219	4997	36,2	3904	198	3706	35,6
16:00-17:00	1050	36,7	902	33,9	836	33,9	673	37,7	565	39,1	839	35,7	898	33,2	5763	149	5614	35,5	4525	135	4390	34,7
17:00-18:00	843	35	772	37,3	726	37,3	584	39,3	539	39,3	753	35,4	849	31,8	5066	105	4961	36,2	3943	86	3857	35,3
18:00-19:00	711	35,5	658	36,6	593	37,2	422	38,5	420	39,4	676	35,5	633	33,9	4113	78	4035	36,4	3271	61	3210	35,7
19:00-20:00	481	38,2	499	37,8	440	37,3	201	40,9	238	39,7	477	37,7	479	36,4	2815	62	2753	37,9	2376	54	2322	37,5
20:00-21:00	350	39,5	332	40,1	260	39,7	214	39,6	209	40,2	323	38,1	366	37,5	2054	62	1992	39,1	1631	47	1584	38,9
21:00-22:00	203	41,1	203	42	213	39,6	169	41,5	128	42,5	206	40,4	177	39,6	1299	36	1263	40,9	1002	25	977	40,5
22:00-23:00	107	41,4	102	42	181	41,6	166	41,5	71	42,8	84	44	116	42,3	827	32	795	42,1	590	23	567	42,1
23:00-00:00	49	40,8	52	40,1	137	40,6	128	39,4	44	43	25	43	32	40	467	18	449	40,5	295	15	280	40,7
Total	8640	37,9	8299	38	8707	37,7	6951	38,8	6024	39,9	8108	37,8	8293	36,3	55022	2491	52531	38	42047	2170	39877	37,5

A.2 Appendix 2

Table A.2: The given data from Norconsult for the point referred to as 'Kungsgatan' in the report, with the total direction of travel.

Measuring point: Kungsgatan, Westbound, Kungsbacka, Varlavägen West (70496). Direction of travel: Total. Speed limit: 40 km/h

	2021-10-13 (wed)		2021-10-14 (thur)		2021-10-15 (fri)		2021-10-16 (sat)		2021-10-17 (sun)		2021-10-18 (mon)		2021-10-19 (tue)		Total				Weekday			
Hour	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Heavy	Light	Speed	Quantity	Heavy	Light	Speed
00:00-01:00	18	42,6	26	44	16	43,8	63	42	94	42,7	13	44,3	9	40,6	239	8	231	42,7	82	0	82	43,3
01:00-02:00	9	53,4	13	51,1	17	46,7	62	43,1	80	42,1	7	46,4	14	47	202	14	188	44,4	60	6	54	48,7
02:00-03:00	5	46	4	39,9	5	42,5	46	43,7	73	45,5	3	45	3	51,1	139	10	129	44,8	20	4	16	44,5
03:00-04:00	3	46,7	2	47,2	6	45,6	37	46,2	55	45,5	6	47,3	2	46,1	111	2	109	45,9	19	0	19	46,5
04:00-05:00	10	48	21	44,2	8	46,9	17	47,2	21	45,8	13	45,4	8	45,9	98	6	92	46	60	5	55	45,7
05:00-06:00	76	43,3	69	41,2	82	42,2	11	43,9	17	48	68	42,7	81	41,5	404	39	365	42,5	376	38	338	42,2
06:00-07:00	266	41,3	232	41	244	40,5	43	41,8	37	43,9	263	41	270	40,2	1355	156	1199	40,9	1275	149	1126	40,8
07:00-08:00	392	36,8	395	39,1	358	39,3	61	43,6	62	43,3	402	37,6	381	36,9	2051	185	1866	38,3	1928	172	1756	37,9
08:00-09:00	424	39,5	405	39,2	366	39,1	104	42,1	78	41,3	405	38,5	368	38,4	2150	210	1940	39,2	1968	190	1778	38,9
09:00-10:00	297	39,7	290	39,5	322	40,3	181	42,3	145	42	295	40,4	280	40,2	1810	165	1645	40,4	1484	151	1333	40
10:00-11:00	399	38,3	375	38,6	396	39,7	343	40,8	281	42,2	399	39,3	367	38,2	2560	208	2352	39,5	1936	186	1750	38,8
11:00-12:00	477	39,8	424	39,6	500	39,7	554	38,9	451	39,9	490	38,6	468	38,6	3364	160	3204	39,3	2359	136	2223	39,3
12:00-13:00	552	39,6	610	38,9	699	37,4	629	37,5	570	39,1	517	39,9	567	37	4144	156	3988	38,4	2945	130	2815	38,5
13:00-14:00	532	39,8	553	39,1	662	39,1	739	36,4	588	40,3	519	38,8	565	38,1	4158	180	3978	38,7	2831	152	2679	39
14:00-15:00	619	36,9	611	37,1	756	36	790	37,2	660	38,2	577	37,9	604	36,6	4617	231	4386	37,1	3167	207	2960	36,9
15:00-16:00	767	36,2	749	37	884	34,5	714	37,7	598	38,2	748	35,7	756	35,1	5216	219	4997	36,2	3904	198	3706	35,6
16:00-17:00	1050	36,7	902	33,9	836	33,9	673	37,7	565	39,1	839	35,7	898	33,2	5763	149	5614	35,5	4525	135	4390	34,7
17:00-18:00	843	35	772	37,3	726	37,3	584	39,3	539	39,3	753	35,4	849	31,8	5066	105	4961	36,2	3943	86	3857	35,3
18:00-19:00	711	35,5	658	36,6	593	37,2	422	38,5	420	39,4	676	35,5	633	33,9	4113	78	4035	36,4	3271	61	3210	35,7
19:00-20:00	481	38,2	499	37,8	440	37,3	201	40,9	238	39,7	477	37,7	479	36,4	2815	62	2753	37,9	2376	54	2322	37,5
20:00-21:00	350	39,5	332	40,1	260	39,7	214	39,6	209	40,2	323	38,1	366	37,5	2054	62	1992	39,1	1631	47	1584	38,9
21:00-22:00	203	41,1	203	42	213	39,6	169	41,5	128	42,5	206	40,4	177	39,6	1299	36	1263	40,9	1002	25	977	40,5
22:00-23:00	107	41,4	102	42	181	41,6	166	41,5	71	42,8	84	44	116	42,3	827	32	795	42,1	590	23	567	42,1
23:00-00:00	49	40,8	52	40,1	137	40,6	128	39,4	44	43	25	43	32	40	467	18	449	40,5	295	15	280	40,7
Total	8640	37,9	8299	38	8707	37,7	6951	38,8	6024	39,9	8108	37,8	8293	36,3	55022	2491	52531	38	42047	2170	39877	37,5

A.3 Appendix 3

Table A.3: The given data from Norconsult for the point referred to as 'Storgatan' in the report, with the total direction of travel.

Measuring point: Storgatan, Kungsbacka, Varbergsvägen North (70298). Direction of travel: Total. Speed limit: 40 km/h

	2021-10-13 (wed)		2021-10-14 (thur)		2021-10-15 (fri)		2021-10-16 (sat)		2021-10-17 (sun)		2021-10-18 (mon)		2021-10-19 (tue)		Total				Weekday			
Timme	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal [veh/w]	Heavy	Light	Hastighet	Antal	Tung	Light	Hastighet
00:00-01:00	15	33,3	24	37,7	19	36	78	34,6	83	34,6	22	36,9	16	36,5	257	31	226	35,2	96	6	90	36,3
01:00-02:00	9	39,4	12	40,5	10	37,2	40	34,9	64	36,5	13	41,1	15	37,8	163	12	151	37,1	59	0	59	39,2
02:00-03:00	6	40,6	6	40,1	3	40,9	34	36,5	64	35,4	8	41,5	6	39,3	127	12	115	36,9	29	1	28	40,5
03:00-04:00	9	40,2	10	41,9	4	45,5	14	36,4	46	39,8	5	38,4	6	41,7	94	6	88	39,8	34	1	33	41,3
04:00-05:00	36	37,6	28	35,7	21	39,7	9	42	13	36,7	31	36,7	25	37,8	163	10	153	37,6	141	9	132	37,4
05:00-06:00	113	34,9	109	33,8	128	33,4	27	36,1	15	39,1	118	34,5	122	34,3	632	113	519	34,4	590	112	478	34,2
06:00-07:00	434	33,9	400	33,1	410	33,4	86	36,9	56	36,3	421	34,3	412	32,9	2219	284	1935	33,7	2077	276	1801	33,5
07:00-08:00	700	32,5	703	33,3	627	33,1	114	37,8	59	36,7	687	32,7	666	32,5	3556	360	3196	33	3383	345	3038	32,8
08:00-09:00	688	31,9	717	31,5	639	32,1	197	35,3	99	35,7	647	32,3	691	32,1	3678	434	3244	32,3	3382	402	2980	32
09:00-10:00	508	32,2	569	31,9	563	32,8	340	34,6	193	36,2	501	33,5	529	32	3203	421	2782	32,9	2670	380	2290	32,5
10:00-11:00	613	32,9	608	32,3	668	32,8	542	33,4	367	34,8	603	33,5	629	31,7	4030	378	3652	33	3121	330	2791	32,7
11:00-12:00	700	32,9	793	32,3	870	32,8	801	33,3	615	33,9	737	33	808	30,6	5324	435	4889	32,7	3908	392	3516	32,3
12:00-13:00	786	33	954	31,8	1011	30,9	934	31,8	644	33,8	732	32,3	993	31,2	6054	474	5580	32	4476	407	4069	31,8
13:00-14:00	859	32,1	880	31,5	949	31,1	899	32,3	692	33,5	719	32	831	32,6	5829	476	5353	32,1	4238	396	3842	31,8
14:00-15:00	777	32	834	31,2	1000	29,4	880	32,2	630	33,8	758	32	886	30,1	5765	539	5226	31,4	4255	475	3780	30,8
15:00-16:00	942	30,8	1040	29,8	1060	29,5	708	32,9	648	33,5	984	29,4	1025	28,7	6407	678	5729	30,4	5051	622	4429	29,6
16:00-17:00	1177	31,3	1198	29,6	1079	27,6	573	33,7	605	33,1	1079	29,3	1154	26,2	6865	694	6171	29,6	5687	651	5036	28,8
17:00-18:00	810	31,7	927	29,8	826	30,4	477	32,8	465	33,2	913	30,5	912	29,5	5330	483	4847	30,8	4388	428	3960	30,3
18:00-19:00	585	31,8	612	31,3	585	32,1	375	33	442	33,2	667	31	622	31,7	3888	280	3608	31,9	3071	229	2842	31,6
19:00-20:00	436	33,4	420	33,2	410	32,2	276	33,5	254	34	426	32,8	407	32,7	2629	175	2454	33	2099	137	1962	32,9
20:00-21:00	266	34,6	329	33,3	229	34	196	34	189	33,9	275	34,1	252	33,4	1736	143	1593	33,9	1351	110	1241	33,8
21:00-22:00	192	34	174	34,8	209	33,6	160	34	114	34,2	185	33,8	188	34,8	1222	108	1114	34,2	948	84	864	34,2
22:00-23:00	105	35,2	129	35,1	143	34,3	149	34,5	71	37,5	86	36,7	78	36,2	761	78	683	35,4	541	57	484	35,3
23:00-00:00	48	35,8	40	34,4	117	34,9	110	35,1	33	36,6	30	35,6	36	33,7	414	49	365	35,1	271	30	241	34,9
Totalt	10814	32,4	11516	31,6	11580	31,3	8019	33,2	6461	34	10647	32	11309	30,9	70346	6673	63673	32	55866	5880	49986	31,6

A.4 Appendix 4

Table A.4: The given data from Norconsult for the point referred to as 'Storgatan' in the report, with the north direction of travel.

Measuring point: Storgatan, Kungsbacka, Varbergsvägen North (70298). Direction of travel: North. Speed limit: 40 km/h

	2021-10-13 (wed)		2021-10-14 (thur)		2021-10-15 (fri)		2021-10-16 (sat)		2021-10-17 (sun)		2021-10-18 (mon)		2021-10-19 (tue)		Total				Weekday			
Timme	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal [veh/w]	Heavy	Light	Hastighet	Antal	Tung	Light	Hastighet
00:00-01:00	5	32,7	9	33,1	9	36	23	35,6	35	37	10	37,4	7	33,8	98	3	95	35,8	40	2	38	34,9
01:00-02:00	2	37,1	6	39,7	5	35,1	17	36,1	26	37,9	6	38,5	8	37,8	70	1	69	37,4	27	0	27	37,8
02:00-03:00	2	42,8	2	41,4	2	36	16	38,8	29	36,2	4	41,8	2	44,3	57	2	55	38	12	1	11	41,4
03:00-04:00	5	41,5	5	42,2	4	45,5	8	36,8	22	40,5	2	39,4	4	45,4	50	0	50	40,9	20	0	20	43
04:00-05:00	17	36,2	14	32,4	9	36,6	4	41,7	8	36,1	16	33,9	13	35,6	81	4	77	35,3	69	4	65	34,8
05:00-06:00	72	35,9	68	36,5	76	35	18	36,5	10	38,2	74	35,2	72	36,4	390	19	371	35,9	362	19	343	35,8
06:00-07:00	287	34,8	277	34	262	34,7	52	38,3	33	37,3	267	34,9	265	34,2	1443	112	1331	34,7	1358	110	1248	34,5
07:00-08:00	436	33,6	421	34,5	380	34	48	36,3	20	36,3	378	34	393	34,3	2076	120	1956	34,1	2008	119	1889	34,1
08:00-09:00	339	33,7	348	33,3	303	33,7	89	35,9	42	36,3	354	33,8	346	34,6	1821	127	1694	34	1690	119	1571	33,8
09:00-10:00	222	34	271	32,7	227	35,1	151	35,1	100	37,1	229	34,9	246	33,9	1446	106	1340	34,4	1195	97	1098	34,1
10:00-11:00	313	33,7	277	33,8	329	33,7	276	34	196	35,1	276	34,6	302	33,1	1969	122	1847	33,9	1497	114	1383	33,8
11:00-12:00	353	33,9	384	33,1	412	34,3	399	34,1	272	34,6	339	34,6	390	32,4	2549	131	2418	33,8	1878	128	1750	33,6
12:00-13:00	333	34,4	417	34,7	439	34,2	443	33,3	307	35,4	329	33,9	439	34,1	2707	128	2579	34,2	1957	109	1848	34,3
13:00-14:00	382	34,3	398	33,3	416	34,1	414	33,6	361	34,7	292	34,7	383	34,7	2646	141	2505	34,2	1871	123	1748	34,2
14:00-15:00	353	34,3	388	34,4	426	34,1	387	33,9	271	34,8	342	34,2	340	34,1	2507	118	2389	34,2	1849	108	1741	34,2
15:00-16:00	362	32,9	477	32,9	392	33,8	306	34,2	309	35	428	33,5	354	34,4	2628	159	2469	33,7	2013	143	1870	33,5
16:00-17:00	445	34,8	544	34	476	33,7	238	35	243	34,2	408	33,1	431	33,6	2785	166	2619	34	2304	158	2146	33,9
17:00-18:00	322	34,6	322	35,3	303	34,4	197	34,9	196	34,2	382	34,7	340	33,7	2062	84	1978	34,6	1669	73	1596	34,6
18:00-19:00	212	34,1	232	34,2	214	34,9	142	35	214	34,7	247	33,4	238	35,2	1499	35	1464	34,4	1143	30	1113	34,3
19:00-20:00	172	36,2	180	35	154	35,1	118	35,3	102	36,6	150	35,1	137	36,8	1013	22	991	35,7	793	19	774	35,6
20:00-21:00	135	36,7	149	35,3	97	35,5	95	35,7	76	36,8	107	36	110	35,2	769	8	761	35,9	598	5	593	35,8
21:00-22:00	97	35,4	87	36	107	35,2	69	35,7	52	38,5	69	35,1	77	37,5	558	4	554	36	437	3	434	35,8
22:00-23:00	41	35,7	56	36,9	62	36,6	56	36,4	29	38,5	40	38,3	23	40,5	307	4	303	37,2	222	3	219	37,2
23:00-00:00	19	37,9	16	34,6	45	37,2	42	37,1	9	39,4	11	38,9	10	35,7	152	2	150	37,1	101	2	99	37
Totalt	4926	34,3	5348	34,1	5149	34,3	3608	34,5	2962	35,3	4760	34,3	4930	34,2	31683	1618	30065	34,4	25113	1489	23624	34,2

A.5 Appendix 5

Table A.5: The given data from Norconsult for the point referred to as ‘Storgatan’ in the report, with the south direction of travel.

Measuring point: Storgatan, Kungsbacka, Varbergsvägen North (70298). Direction of travel: South. Speed limit: 40 km/h

	2021-10-13 (wed)		2021-10-14 (thur)		2021-10-15 (fri)		2021-10-16 (sat)		2021-10-17 (sun)		2021-10-18 (mon)		2021-10-19 (tue)		Total				Weekday			
Timme	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal [veh/w]	Heavy	Light	Hastighet	Antal	Tung	Light	Hastighet
00:00-01:00	10	33,5	15	40,5	10	36	55	34,2	48	32,9	12	36,5	9	38,5	159	28	131	34,9	56	4	52	37,3
01:00-02:00	7	40	6	41,2	5	39,2	23	34	38	35,6	7	43,3	7	37,8	93	11	82	36,8	32	0	32	40,3
02:00-03:00	4	39,5	4	39,5	1	50,8	18	34,5	35	34,8	4	41,1	4	36,8	70	10	60	35,9	17	0	17	39,9
03:00-04:00	4	38,6	5	41,5	0	-	6	35,9	24	39,2	3	37,8	2	34,4	44	6	38	38,6	14	1	13	38,9
04:00-05:00	19	38,8	14	38,9	12	42,1	5	42,2	5	37,6	15	39,7	12	40,1	82	6	76	39,8	72	5	67	39,8
05:00-06:00	41	33,3	41	29,3	52	31,1	9	35,4	5	41	44	33,3	50	31,3	242	94	148	32	228	93	135	31,6
06:00-07:00	147	32,1	123	30,9	148	31,3	34	34,9	23	34,7	154	33,1	147	30,4	776	172	604	31,8	719	166	553	31,6
07:00-08:00	264	30,6	282	31,5	247	31,7	66	38,9	39	36,9	309	31,3	273	29,8	1480	240	1240	31,5	1375	226	1149	31
08:00-09:00	349	30,2	369	29,9	336	30,6	108	34,8	57	35,3	293	30,6	345	29,7	1857	307	1550	30,6	1692	283	1409	30,2
09:00-10:00	286	30,9	298	31,1	336	31,2	189	34,2	93	35,3	272	32,4	283	30,3	1757	315	1442	31,7	1475	283	1192	31,2
10:00-11:00	300	32	331	31,1	339	32	266	32,9	171	34,6	327	32,7	327	30,5	2061	256	1805	32,1	1624	216	1408	31,7
11:00-12:00	347	31,8	409	31,6	458	31,5	402	32,5	343	33,4	398	31,7	418	28,9	2775	304	2471	31,6	2030	264	1766	31,1
12:00-13:00	453	32	537	29,5	572	28,4	491	30,6	337	32,3	403	31,1	554	28,9	3347	346	3001	30,2	2519	298	2221	29,8
13:00-14:00	477	30,4	482	30	533	28,8	485	31,3	331	32,2	427	30,2	448	30,7	3183	335	2848	30,4	2367	273	2094	30
14:00-15:00	424	30	446	28,5	574	26	493	30,8	359	33	416	30,1	546	27,6	3258	421	2837	29,2	2406	367	2039	28,2
15:00-16:00	580	29,4	563	27,2	668	27	402	31,8	339	32,1	556	26,4	671	25,7	3779	519	3260	28,1	3038	479	2559	27,1
16:00-17:00	732	29,1	654	26	603	22,7	335	32,7	362	32,3	671	27,1	723	21,8	4080	528	3552	26,6	3383	493	2890	25,4
17:00-18:00	488	29,8	605	26,8	523	28,1	280	31,2	269	32,6	531	27,5	572	27	3268	399	2869	28,5	2719	355	2364	27,8
18:00-19:00	373	30,5	380	29,5	371	30,6	233	31,8	228	31,9	420	29,6	384	29,6	2389	245	2144	30,3	1928	199	1729	29,9
19:00-20:00	264	31,6	240	31,9	256	30,4	158	32,2	152	32,3	276	31,6	270	30,6	1616	153	1463	31,4	1306	118	1188	31,2
20:00-21:00	131	32,5	180	31,6	132	32,8	101	32,4	113	32	168	32,8	142	32	967	135	832	32,3	753	105	648	32,3
21:00-22:00	95	32,6	87	33,6	102	31,9	91	32,8	62	30,6	116	33,1	111	33	664	104	560	32,6	511	81	430	32,8
22:00-23:00	64	34,8	73	33,8	81	32,5	93	33,3	42	36,9	46	35,3	55	34,4	454	74	380	34,1	319	54	265	34
23:00-00:00	29	34,4	24	34,2	72	33,5	68	33,8	24	35,6	19	33,6	26	33	262	47	215	33,9	170	28	142	33,7
Totalt	5888	30,7	6168	29,4	6431	28,9	4411	32,2	3499	32,9	5887	30,1	6379	28,3	38663	5055	33608	30,1	30753	4391	26362	29,4

A.6 Appendix 6

Table A.6: The given data from Norconsult for the point referred to as ‘Vallgatan’ in the report, with the total direction of travel.

Measuring point: Vallgatan, Westbound, Kungsbacka, Varlavägen East (70497). Direction of travel: Total. Speed limit: 30 km/h

	2021-10-13 (wed)		2021-10-14 (thur)		2021-10-15 (fri)		2021-10-16 (sat)		2021-10-17 (sun)		2021-10-18 (mon)		2021-10-19 (tue)		Total				Weekday			
Timme	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal [veh/w]	Heavy	Light	Hastighet	Antal	Tung	Light	Hastighet
00:00-01:00	16	27,8	27	27,7	17	26,3	61	25,4	83	25	12	28,2	6	26,2	222	12	210	25,9	78	0	78	27,4
01:00-02:00	9	31,2	11	30,3	16	29,1	51	27,8	86	25,2	7	24,9	11	28,7	191	10	181	27	54	3	51	29,1
02:00-03:00	3	29,8	1	15,8	2	25,6	40	26,9	62	25,4	5	30,4	2	27,7	115	10	105	26,2	13	3	10	28
03:00-04:00	5	28,9	2	24,7	1	37,1	35	26,4	56	27,4	7	30,5	2	24,1	108	2	106	27,3	17	0	17	29
04:00-05:00	6	31,3	14	26	6	25,6	21	29,2	25	27,4	6	29,3	7	28,3	85	3	82	28	39	2	37	27,7
05:00-06:00	73	27,1	63	25,9	x	x	11	29,5	13	31	71	26,1	75	26,5	306	46	260	26,7	282	45	237	26,4
06:00-07:00	213	25,4	192	25,7	x	x	37	26,1	25	26,6	219	25,4	218	25,2	904	120	784	25,5	842	114	728	25,4
07:00-08:00	328	23,5	333	23,8	x	x	45	27,3	41	25,7	370	23,3	354	23,3	1471	136	1335	23,7	1385	126	1259	23,5
08:00-09:00	423	22,6	397	22,5	x	x	91	25,8	72	26,2	390	21,9	371	23	1744	121	1623	22,8	1581	97	1484	22,5
09:00-10:00	342	23,3	315	23,5	x	x	185	25,3	155	25,6	335	23,7	297	23,4	1629	141	1488	23,9	1289	125	1164	23,5
10:00-11:00	510	21	460	21,6	451	22,4	366	23,2	279	24,9	437	22,7	438	22,1	2941	190	2751	22,4	2296	166	2130	21,9
11:00-12:00	461	23	519	21,4	593	21	620	21,3	390	23,4	506	22,5	485	21,8	3574	232	3342	21,9	2564	211	2353	21,9
12:00-13:00	526	22,8	594	22,1	634	21,5	678	20,6	462	23,1	439	22,5	609	20,8	3942	190	3752	21,8	2802	163	2639	21,9
13:00-14:00	494	22	502	22,1	600	21,3	605	21,5	494	22	485	22	521	22	3701	219	3482	21,8	2602	175	2427	21,8
14:00-15:00	685	19,6	617	20,7	794	19,7	740	20,3	485	22	491	22,4	557	21,7	4369	245	4124	20,7	3144	216	2928	20,7
15:00-16:00	774	20,5	688	20,1	821	21,2	534	21,3	418	22,5	753	20,3	863	19,9	4851	247	4604	20,7	3899	222	3677	20,4
16:00-17:00	1189	17,8	1024	19,1	771	20,5	389	22,3	416	23,1	895	18,8	1092	18,7	5776	458	5318	19,4	4971	438	4533	18,9
17:00-18:00	819	19,5	700	20,3	580	20,7	372	23,2	348	23,1	630	20,9	740	19,3	4189	104	4085	20,6	3469	86	3383	20,1
18:00-19:00	445	22,8	451	22,6	467	22,4	279	23,4	313	24	429	22,1	413	22,4	2797	118	2679	22,7	2205	98	2107	22,5
19:00-20:00	302	23,9	301	24,7	290	22,8	192	24	205	24,5	291	23,3	286	24	1867	96	1771	23,8	1470	73	1397	23,7
20:00-21:00	179	24,7	224	25,5	201	23,6	194	24,4	161	25,8	183	25,1	211	24,8	1353	59	1294	24,8	998	46	952	24,8
21:00-22:00	155	25,8	118	26,9	216	23,5	146	25	91	26,2	139	26,2	113	25,6	978	47	931	25,4	741	34	707	25,4
22:00-23:00	68	25,9	76	25,5	144	25,9	133	24,7	49	25,6	64	28,5	62	26,6	596	40	556	25,9	414	28	386	26,3
23:00-00:00	41	26,4	23	26,1	95	25	103	23,8	26	26,4	19	25,2	24	26,3	331	25	306	25,1	202	19	183	25,6
Totalt	8066	21,4	7652	21,8	6699	21,5	5928	22,4	4755	23,6	7183	22,1	7757	21,5	48040	2871	45169	21,9	37357	2490	34867	21,7

A.7 Appendix 7

Table A.7: The given data from Norconsult for the point referred to as ‘Vallgatan’ in the report, with the total direction of travel.

Measuring point: Vallgatan, Eastbound, Kungsbacka, Varlavägen East (70297). Direction of travel: Total. Speed limit: 40 km/h

	2021-10-13 (wed)		2021-10-14 (thur)		2021-10-15 (fri)		2021-10-16 (sat)		2021-10-17 (sun)		2021-10-18 (mon)		2021-10-19 (tue)		Total				Weekday			
Timme	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal [veh/w]	Heavy	Light	Hastighet	Antal	Tung	Light	Hastighet
00:00-01:00	19	35,1	25	32	15	30,8	65	31	95	31	13	33,2	10	29,3	242	16	226	31,5	82	7	75	32,4
01:00-02:00	8	33,4	10	36,8	10	35,8	39	31,4	65	31,1	5	36,1	1	31,3	138	10	128	32,3	34	0	34	35,4
02:00-03:00	5	35,4	3	30	3	39,1	32	33,4	45	33,8	4	34,8	4	39,3	96	7	89	34,1	19	1	18	35,8
03:00-04:00	4	33,3	4	34,2	6	31,8	25	35,4	32	34,9	5	34,5	2	36,7	78	4	74	34,7	21	0	21	33,7
04:00-05:00	10	35,9	10	35,3	10	34,3	10	35,9	16	31,5	7	32,9	9	30,5	72	4	68	33,7	46	4	42	33,9
05:00-06:00	46	31,6	47	32	46	30,9	8	32,5	7	38,7	49	32,8	44	30,5	247	42	205	31,8	232	42	190	31,6
06:00-07:00	209	29	191	29,3	215	30,1	35	31,3	29	32,2	223	28,7	211	29	1113	124	989	29,4	1049	119	930	29,2
07:00-08:00	376	28,5	379	27,2	335	28	54	31,9	41	33,7	365	27,1	390	27,1	1940	132	1808	27,8	1845	123	1722	27,6
08:00-09:00	582	25,5	532	26,1	559	25,2	124	31,5	70	32,9	550	24,2	555	25,2	2972	307	2665	25,7	2778	289	2489	25,3
09:00-10:00	336	28	387	26,4	391	27,6	227	30,2	151	32,1	349	28,9	367	27,9	2208	240	1968	28,3	1830	213	1617	27,8
10:00-11:00	409	28,5	409	27,1	462	29,7	329	30,8	241	30,4	349	29,6	413	27,3	2612	198	2414	28,9	2042	174	1868	28,4
11:00-12:00	464	29,2	488	26,3	575	26,9	437	29,1	335	30,2	487	28	448	26,7	3234	199	3035	27,9	2462	174	2288	27,4
12:00-13:00	574	26,2	488	28,5	567	26,6	551	26,2	410	29,6	504	27,8	576	25,3	3670	172	3498	27	2709	143	2566	26,8
13:00-14:00	458	28,3	510	27,8	607	26,3	489	28,3	424	28,9	478	28,8	458	27,5	3424	141	3283	27,9	2511	118	2393	27,7
14:00-15:00	522	26,6	774	22,4	646	25,5	507	28,6	449	29,3	469	28,4	572	26,3	3939	210	3729	26,3	2983	182	2801	25,5
15:00-16:00	643	25,2	973	21,5	630	25,5	389	28,6	412	29,4	741	25,7	704	24	4492	313	4179	25	3691	287	3404	24,1
16:00-17:00	621	26,2	674	26,5	665	27,2	379	28,9	416	29,3	627	26,4	848	21,7	4230	451	3779	26,1	3435	422	3013	25,4
17:00-18:00	575	26	574	27,2	552	26,6	413	27,5	346	28,7	507	27,4	546	26,1	3513	154	3359	26,9	2754	132	2622	26,6
18:00-19:00	412	28	431	27,4	474	27,6	300	28,7	308	29,1	415	27,1	373	26,8	2713	115	2598	27,7	2105	96	2009	27,4
19:00-20:00	263	28,4	296	28,9	290	27,8	181	29,1	184	29,9	241	28,5	273	28,4	1728	99	1629	28,6	1363	82	1281	28,4
20:00-21:00	183	29,8	193	30,3	224	28,5	191	30,6	134	30,8	195	29,8	196	29,2	1316	90	1226	29,8	991	72	919	29,5
21:00-22:00	131	30,5	151	30,6	144	29,3	128	31	91	31	106	30	120	29,5	871	57	814	30,2	652	43	609	30
22:00-23:00	76	30,3	81	30,7	130	30,3	143	30	44	29,5	61	30,9	55	31,1	590	39	551	30,4	403	28	375	30,6
23:00-00:00	25	30,8	31	33	90	30,9	113	29,8	27	30	20	30,1	33	29,4	339	32	307	30,5	199	22	177	30,9
Totalt	6951	27,4	7661	26,3	7646	27,2	5169	29	4372	29,9	6770	27,6	7208	26	45777	3156	42621	27,4	36236	2773	33463	26,9

A.8 Appendix 8

Table A.8: The given data from Norconsult for the point referred to as ‘Varlavägen’ in the report, with the total direction of travel.

Measuring point: Varlavägen, Kungsbacka, Kungsgatan North (70296). Direction of travel: Total. Speed limit: 40 km/h

	2021-10-13 (wed)		2021-10-14 (thur)		2021-10-15 (fri)		2021-10-16 (sat)		2021-10-17 (sun)		2021-10-18 (mon)		2021-10-19 (tue)		Total				Weekday			
Timme	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal [veh/w]	Heavy	Light	Hastighet	Antal	Tung	Light	Hastighet
00:00-01:00	26	27,4	25	27,9	24	26,6	73	24,7	102	26	15	26,3	21	25,8	286	6	280	26	111	0	111	26,9
01:00-02:00	8	26,1	9	23,2	14	27,7	64	26,2	62	25,9	7	29,7	4	26,2	168	5	163	26,2	42	4	38	26,6
02:00-03:00	8	31	6	26	7	25,6	29	29,4	52	26,4	5	32,4	4	31,7	111	6	105	27,9	30	4	26	29,1
03:00-04:00	4	28,6	2	24,8	8	26,9	27	28,5	26	28,3	8	30,7	1	21,2	76	2	74	28,3	23	0	23	28,1
04:00-05:00	10	28,8	14	29,2	13	27,3	6	28,7	19	28,8	18	29	10	26,3	90	5	85	28,4	65	5	60	28,2
05:00-06:00	80	27	87	26,3	77	26,9	17	27,6	12	29,3	73	27,6	85	26,5	431	34	397	26,9	402	33	369	26,8
06:00-07:00	365	25,8	318	26,1	371	25,8	61	26,9	43	27,9	338	25,7	335	26,2	1831	189	1642	26	1727	184	1543	25,9
07:00-08:00	614	25,1	549	25,3	570	24,8	95	26,2	71	26,5	637	24,2	601	24,2	3137	258	2879	24,8	2971	253	2718	24,7
08:00-09:00	788	24,7	714	24,2	753	24,5	198	26,1	118	26,6	719	24,5	754	24	4044	342	3702	24,5	3728	332	3396	24,4
09:00-10:00	690	24,7	642	24,4	649	24,9	405	26	326	25,9	632	25,2	631	24,4	3975	333	3642	24,9	3244	317	2927	24,7
10:00-11:00	920	24,8	766	24,9	907	24,1	824	25	663	25	859	24,4	872	23,3	5811	344	5467	24,5	4324	325	3999	24,3
11:00-12:00	1072	24,6	1003	24,1	1172	24,8	1204	24,8	951	25,1	980	24,8	1035	23,7	7417	402	7015	24,6	5262	370	4892	24,4
12:00-13:00	1019	24,7	1136	24,5	1260	24,4	1362	23,1	1126	24,4	1129	25,5	1162	23,9	8194	380	7814	24,3	5706	336	5370	24,6
13:00-14:00	1001	24,8	1035	24,6	1232	25,3	1359	23,9	1156	24	961	24,3	1079	24,3	7823	345	7478	24,5	5308	270	5038	24,7
14:00-15:00	1057	24,1	1088	24,8	1248	24,3	1344	23,9	1134	24,6	999	24,8	1060	23,9	7930	488	7442	24,3	5452	395	5057	24,4
15:00-16:00	1229	24,3	1252	23,8	1407	24,6	1173	24,7	1010	24,8	1213	24,3	1318	23,4	8602	583	8019	24,3	6419	481	5938	24,1
16:00-17:00	1360	23,7	1312	23,5	1348	24,1	1078	24,3	988	25,2	1223	24	1406	24,6	8715	358	8357	24,2	6649	306	6343	24
17:00-18:00	1267	22,9	1192	24,6	1143	24,4	842	25,2	773	25	1139	24,2	1282	23,6	7638	240	7398	24,2	6023	211	5812	23,9
18:00-19:00	1047	24,2	1025	24,2	884	24,8	582	25,4	582	25,1	962	24,5	968	25,2	6050	139	5911	24,7	4886	105	4781	24,6
19:00-20:00	705	25,2	713	24,9	559	25	302	25,6	351	25,8	677	25	698	25,7	4005	57	3948	25,2	3352	51	3301	25,2
20:00-21:00	458	25,9	403	25,9	425	25,5	359	26,2	251	26,2	427	25	484	25	2807	72	2735	25,6	2197	58	2139	25,4
21:00-22:00	253	25,9	270	25,8	304	25,5	277	26,4	178	26,3	211	25,7	243	26,8	1736	37	1699	26	1281	26	1255	25,9
22:00-23:00	147	26	151	26,3	217	26,1	241	25,6	109	26,2	113	29,4	149	27,3	1127	28	1099	26,5	777	21	756	26,8
23:00-00:00	49	25,6	57	27,4	171	25,4	195	25	52	27,4	33	27,5	41	26,1	598	14	584	25,8	351	11	340	26
Totalt	14177	24,5	13769	24,5	14763	24,7	12117	24,7	10155	25	13378	24,7	14243	24,3	92602	4667	87935	24,6	70330	4098	66232	24,6

A.9 Appendix 9

Table A.9: The given data from Norconsult for the point referred to as ‘Varlavägen’ in the report, with the north direction of travel.

Measuring point: Varlavägen, Kungsbacka, Kungsgatan North (70296). Direction of travel: North. Speed limit: 40 km/h

	2021-10-13 (wed)		2021-10-14 (thur)		2021-10-15 (fri)		2021-10-16 (sat)		2021-10-17 (sun)		2021-10-18 (mon)		2021-10-19 (tue)		Total				Weekday			
Timme	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal [veh/w]	Heavy	Light	Hastighet	Antal	Tung	Light	Hastighet
00:00-01:00	12	28,5	11	31,2	9	28,6	37	26	43	27,4	8	29,4	9	26,3	129	5	124	27,6	49	0	49	28,9
01:00-02:00	4	30,1	6	24,3	6	27,1	32	27,1	32	27,2	4	30	2	26,8	86	2	84	27,2	22	1	21	27,4
02:00-03:00	3	32,6	3	30,8	2	23,6	18	31	25	27,5	4	31,1	2	34,8	57	4	53	29,4	14	2	12	30,8
03:00-04:00	3	31,2	0	-	1	31,3	14	29,3	18	29,3	5	30,7	0	-	41	2	39	29,6	9	0	9	30,9
04:00-05:00	6	30,9	6	30,4	7	28,8	4	31,9	10	28,4	10	30,3	6	27,8	49	2	47	29,6	35	2	33	29,7
05:00-06:00	50	28,1	57	26,5	42	27,8	10	27,9	5	33	45	29,6	53	28,1	262	23	239	28,1	247	22	225	28
06:00-07:00	256	25,9	184	26,5	218	26,6	39	27,8	23	28,3	207	26,7	192	27	1119	117	1002	26,6	1057	117	940	26,5
07:00-08:00	433	24,7	325	26	317	25,8	50	27,2	39	26,2	400	24,2	355	24,3	1919	168	1751	25	1830	167	1663	25
08:00-09:00	541	24,5	446	24,6	431	25,3	116	26,8	69	26,8	440	24,8	492	24,2	2535	207	2328	24,8	2350	201	2149	24,6
09:00-10:00	470	24,4	413	24,7	403	24,8	260	26,3	221	26,7	416	25,6	381	24,2	2564	209	2355	25,1	2083	196	1887	24,7
10:00-11:00	640	24,6	504	25,3	540	24,9	530	25,4	397	25,7	516	24,5	555	23,3	3682	205	3477	24,8	2755	197	2558	24,5
11:00-12:00	684	24,5	605	24,1	619	25,1	662	25,1	530	25,6	529	25	535	23,9	4164	209	3955	24,7	2972	185	2787	24,5
12:00-13:00	493	25,4	584	24,3	684	24,8	801	22,6	674	24,9	563	26	633	23,6	4432	288	4144	24,4	2957	255	2702	24,8
13:00-14:00	507	25,6	513	25,3	617	26,1	684	24,6	595	24,8	485	24,7	561	24,5	3962	143	3819	25,1	2683	128	2555	25,3
14:00-15:00	556	24,3	550	25,7	536	25,5	696	24	561	25,3	466	25,9	515	24,8	3880	216	3664	25	2623	157	2466	25,2
15:00-16:00	573	25,1	626	24,9	648	25,8	482	25,5	499	25,7	507	25,3	619	23,5	3954	246	3708	25,1	2973	224	2749	24,9
16:00-17:00	624	23,9	712	23,4	633	24,4	446	25,2	467	26	586	24,6	747	25,3	4215	198	4017	24,7	3302	172	3130	24,3
17:00-18:00	594	23,9	613	25,4	496	25,2	354	25,7	294	26,8	580	24,8	625	23,7	3556	152	3404	24,9	2908	140	2768	24,6
18:00-19:00	464	25,1	389	25,1	367	24,8	191	26,2	228	25,6	416	24,9	417	26,3	2472	78	2394	25,4	2053	64	1989	25,3
19:00-20:00	301	25,8	231	26,4	215	25,2	135	26	165	26,3	272	25,9	247	27,3	1566	27	1539	26,1	1266	23	1243	26,1
20:00-21:00	156	27,1	147	27,7	185	25,1	174	27,3	103	26,9	149	25,2	174	25,6	1088	35	1053	26,4	811	30	781	26,1
21:00-22:00	105	26,2	89	27,1	174	25,5	133	26,6	73	26,7	85	26,5	93	27,3	752	16	736	26,4	546	13	533	26,4
22:00-23:00	51	27,4	61	26,2	94	26,4	110	26,5	42	26,9	53	32	55	27,4	466	17	449	27,3	314	15	299	27,6
23:00-00:00	21	25,9	16	29,4	79	26	79	25,3	17	28,9	17	28,1	17	27,4	246	9	237	26,4	150	8	142	26,8
Totalt	7547	24,9	7091	25	7323	25,3	6057	25	5130	25,7	6763	25,3	7285	24,6	47196	2578	44618	25,1	36009	2319	33690	25

A.10 Appendix 10

Table A.10: The given data from Norconsult for the point referred to as ‘Varlavägen’ in the report, with the south direction of travel.

Measuring point: Varlavägen, Kungsbacka, Kungsgatan North (70296). Direction of travel: South. Speed limit: 40 km/h

	2021-10-13 (wed)		2021-10-14 (thur)		2021-10-15 (fri)		2021-10-16 (sat)		2021-10-17 (sun)		2021-10-18 (mon)		2021-10-19 (tue)		Total				Weekday			
Timme	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal [veh/w]	Heavy	Light	Hastighet	Antal	Tung	Light	Hastighet
00:00-01:00	14	26,5	14	25,3	15	25,4	36	23,4	59	25	7	22,7	12	25,4	157	1	156	24,8	62	0	62	25,3
01:00-02:00	4	22,1	3	21,1	8	28,2	32	25,3	30	24,6	3	29,3	2	25,6	82	3	79	25,2	20	3	17	25,8
02:00-03:00	5	30	3	21,3	5	26,5	11	26,7	27	25,5	1	37,8	2	28,6	54	2	52	26,4	16	2	14	27,6
03:00-04:00	1	20,9	2	24,8	7	26,3	13	27,6	8	26,2	3	30,6	1	21,2	35	0	35	26,7	14	0	14	26,3
04:00-05:00	4	25,6	8	28,3	6	25,5	2	22,3	9	29,2	8	27,3	4	24	41	3	38	26,9	30	3	27	26,5
05:00-06:00	30	25	30	25,8	35	25,8	7	27,2	7	26,6	28	24,3	32	23,7	169	11	158	25,1	155	11	144	25
06:00-07:00	109	25,4	134	25,4	153	24,5	22	25,4	20	27,4	131	24	143	25,2	712	72	640	25	670	67	603	24,9
07:00-08:00	181	26	224	24,3	253	23,6	45	25,1	32	26,8	237	24,2	246	23,9	1218	90	1128	24,4	1141	86	1055	24,3
08:00-09:00	247	25,2	268	23,5	322	23,4	82	25	49	26,4	279	24	262	23,6	1509	135	1374	24,1	1378	131	1247	23,9
09:00-10:00	220	25,2	229	23,9	246	24,9	145	25,6	105	24,4	216	24,3	250	24,7	1411	124	1287	24,7	1161	121	1040	24,6
10:00-11:00	280	25,1	262	24,1	367	23	294	24,3	266	24,1	343	24,3	317	23,3	2129	139	1990	24	1569	128	1441	23,9
11:00-12:00	388	24,8	398	24,2	553	24,4	542	24,4	421	24,5	451	24,5	500	23,6	3253	193	3060	24,3	2290	185	2105	24,3
12:00-13:00	526	24,1	552	24,7	576	24	561	23,9	452	23,7	566	25	529	24,2	3762	92	3670	24,2	2749	81	2668	24,4
13:00-14:00	494	24,1	522	23,9	615	24,5	675	23,3	561	23,2	476	23,8	518	24,1	3861	202	3659	23,8	2625	142	2483	24,1
14:00-15:00	501	24	538	23,9	712	23,4	648	23,8	573	23,9	533	23,8	545	23	4050	272	3778	23,7	2829	238	2591	23,6
15:00-16:00	656	23,7	626	22,7	759	23,6	691	24,2	511	23,8	706	23,6	699	23,2	4648	337	4311	23,5	3446	257	3189	23,4
16:00-17:00	736	23,6	600	23,6	715	23,9	632	23,7	521	24,5	637	23,5	659	23,9	4500	160	4340	23,8	3347	134	3213	23,7
17:00-18:00	673	22,1	579	23,7	647	23,8	488	24,8	479	24	559	23,7	657	23,6	4082	88	3994	23,6	3115	71	3044	23,4
18:00-19:00	583	23,4	636	23,6	517	24,7	391	25	354	24,8	546	24,1	551	24,4	3578	61	3517	24,2	2833	41	2792	24
19:00-20:00	404	24,8	482	24,3	344	24,9	167	25,2	186	25,3	405	24,3	451	24,8	2439	30	2409	24,7	2086	28	2058	24,6
20:00-21:00	302	25,3	256	24,8	240	25,8	185	25,2	148	25,7	278	24,9	310	24,7	1719	37	1682	25,1	1386	28	1358	25,1
21:00-22:00	148	25,7	181	25,2	130	25,6	144	26,1	105	25,9	126	25,1	150	26,5	984	21	963	25,7	735	13	722	25,6
22:00-23:00	96	25,3	90	26,3	123	26	131	24,8	67	25,8	60	27	94	27,3	661	11	650	25,9	463	6	457	26,3
23:00-00:00	28	25,3	41	26,6	92	24,8	116	24,9	35	26,6	16	26,9	24	25,1	352	5	347	25,4	201	3	198	25,5
Totalt	6630	24,1	6678	24	7440	24,1	6060	24,3	5025	24,3	6615	24,1	6958	24	45406	2089	43317	24,1	34321	1779	32542	24,1

A.11 Appendix 11

Table A.11: The given data from Norconsult for the point referred to as 'Varlavägen' in the report, with the total direction of travel.

Measuring point: Varlavägen, Kungsbacka, Lindaregatan South (70291). Direction of travel: Total. Speed limit: 60 km/h

	2021-10-13 (wed)		2021-10-14 (thur)		2021-10-15 (fri)		2021-10-16 (sat)		2021-10-17 (sun)		2021-10-18 (mon)		2021-10-19 (tue)		Total				Weekday			
Timme	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal [veh/w]	Heavy	Light	Hastighet	Antal	Tung	Light	Hastighet
00:00-01:00	24	58,8	19	58,1	16	61,3	62	56	77	54,3	15	60,3	16	56,6	229	2	227	56,6	90	0	90	58,9
01:00-02:00	6	52,8	13	57,7	13	56,4	50	53,8	49	59,5	8	65,6	6	54,8	145	3	142	57	46	3	43	57,7
02:00-03:00	6	57,3	2	56,7	6	56,9	30	57,7	34	54,9	7	61,9	6	59,6	91	6	85	57	27	4	23	58,9
03:00-04:00	3	55,9	3	57,5	8	58,1	18	60,1	23	57,7	6	60,3	1	69,5	62	1	61	58,8	21	0	21	58,9
04:00-05:00	16	61,6	13	58,1	14	63,8	8	60,1	18	60,2	19	66,3	15	60,5	103	5	98	61,8	77	5	72	62,3
05:00-06:00	84	59,7	88	57,2	73	57,4	24	56,7	18	61,4	78	58,5	80	58,7	445	48	397	58,4	403	45	358	58,3
06:00-07:00	353	56,3	344	55,3	354	56,3	52	58,5	47	57,8	348	57	343	55	1841	200	1641	56,1	1742	195	1547	56
07:00-08:00	630	53,3	617	54,1	605	52,8	81	60	53	58,9	600	53,7	616	52,9	3202	244	2958	53,6	3068	241	2827	53,4
08:00-09:00	743	53,2	753	51,2	774	52,2	173	58,8	110	57,6	736	53,5	774	51,8	4063	348	3715	52,8	3780	337	3443	52,4
09:00-10:00	533	54,6	601	51,6	563	54	352	57,9	299	58,3	574	54,6	592	52,9	3514	322	3192	54,4	2863	297	2566	53,5
10:00-11:00	811	53,6	713	51,8	824	53,4	776	55,2	659	55,9	726	54,5	766	51	5275	341	4934	53,6	3840	310	3530	52,9
11:00-12:00	1008	52,9	1022	50,9	1107	52,6	1151	54	949	53,6	908	53,2	994	50,9	7139	351	6788	52,6	5039	308	4731	52,1
12:00-13:00	1026	53,4	1139	52,1	1238	52,6	1406	51,7	1119	53,2	1094	52,1	1135	52,2	8157	285	7872	52,4	5632	249	5383	52,5
13:00-14:00	1012	52	996	52	1232	51,6	1387	52,1	1134	53,8	947	53	996	51,3	7704	305	7399	52,3	5183	268	4915	51,9
14:00-15:00	980	51,4	1063	51,3	1286	53,2	1383	51,8	1126	54,2	973	51,8	1065	52,4	7876	349	7527	52,3	5367	299	5068	52,1
15:00-16:00	1199	52,5	1222	51,4	1415	51,4	1183	51,9	1070	54	1143	51,4	1233	51,3	8465	334	8131	51,9	6212	288	5924	51,6
16:00-17:00	1401	50,9	1439	51,1	1350	52,6	1013	53,1	957	54,5	1304	52,6	1377	51,9	8841	207	8634	52,2	6871	178	6693	51,8
17:00-18:00	1314	52,6	1170	53,9	1150	53,3	770	55,2	714	54,7	1098	53	1186	52,8	7402	162	7240	53,5	5918	136	5782	53,1
18:00-19:00	961	51,4	979	52,6	771	52,9	528	53,8	496	54,3	937	52	836	51,7	5508	124	5384	52,4	4484	99	4385	52,1
19:00-20:00	579	53,7	616	52,9	477	54	283	53,9	325	57,1	585	53,5	582	52,8	3447	86	3361	53,8	2839	73	2766	53,4
20:00-21:00	372	54,7	365	55,9	320	54,7	229	55,1	210	57,1	343	54,2	362	54,2	2201	53	2148	55	1762	42	1720	54,8
21:00-22:00	227	54,3	235	55,2	224	53,1	204	54,5	164	56,9	187	55,3	195	56,6	1436	35	1401	55	1068	28	1040	54,9
22:00-23:00	120	56,7	151	56,9	185	55,3	157	54,8	89	57,1	96	58,1	122	56,2	920	21	899	56,2	674	15	659	56,5
23:00-00:00	46	58,3	43	55	120	56,2	132	54,5	40	63,5	33	58,2	45	58,8	459	12	447	56,8	287	8	279	57
Totalt	13454	52,8	13606	52,4	14125	52,9	11452	53,4	9780	54,7	12765	53,1	13343	52,3	88525	3844	84681	53	67293	3428	63865	52,7

A.12 Appendix 12

Table A.12: The given data from Norconsult for the point referred to as 'Varlavägen' in the report, with the north direction of travel.

Measuring point: Varlavägen, Kungsbacka, Lindaregatan South (70291). Direction of travel: North. Speed limit: 60 km/h

	2021-10-13 (wed)		2021-10-14 (thur)		2021-10-15 (fri)		2021-10-16 (sat)		2021-10-17 (sun)		2021-10-18 (mon)		2021-10-19 (tue)		Total				Weekday			
Timme	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal [veh/w]	Heavy	Light	Hastighet	Antal	Tung	Light	Hastighet
00:00-01:00	11	53,4	10	57,6	4	64,4	33	59,3	35	55,2	10	60,3	7	58,3	110	2	108	57,4	42	0	42	57,9
01:00-02:00	1	52,6	7	59	4	52,5	26	53,4	22	61,5	4	64,9	3	58,3	67	0	67	57,5	19	0	19	58,4
02:00-03:00	4	60	1	64,4	3	61,7	18	57,2	15	56,2	5	58,4	4	65,7	50	5	45	58,3	17	3	14	61,4
03:00-04:00	2	52,9	1	56,9	1	72	9	60,6	16	56,5	4	58,3	0	-	33	1	32	58,1	8	0	8	58,5
04:00-05:00	9	63,9	6	57,9	9	60,9	5	60,2	12	59,1	10	65,2	9	61,4	60	2	58	61,4	43	2	41	62,2
05:00-06:00	55	60,6	49	58,1	43	56,2	8	56,4	8	65,6	48	59,4	51	59,5	262	22	240	59	246	21	225	58,9
06:00-07:00	212	55,8	197	56,1	216	57,1	28	62,5	25	60,2	209	57	202	56	1089	84	1005	56,7	1036	84	952	56,4
07:00-08:00	335	52,7	321	54	320	53,4	39	61,8	22	58,4	333	54,1	311	52,4	1681	109	1572	53,6	1620	108	1512	53,3
08:00-09:00	354	54,1	359	52,4	365	53,8	90	58,8	62	57,2	357	54,6	384	52,8	1971	141	1830	53,9	1819	138	1681	53,5
09:00-10:00	244	54,3	287	52,5	269	53,8	168	58	142	58,6	305	54,1	267	53,1	1682	163	1519	54,4	1372	149	1223	53,6
10:00-11:00	376	52,4	336	51,4	372	54,1	371	54,5	307	56	350	54,4	387	51	2499	164	2335	53,3	1821	151	1670	52,7
11:00-12:00	525	52,5	535	50,5	563	50,8	568	53,4	435	52,7	461	53,1	492	50,3	3579	185	3394	51,9	2576	160	2416	51,4
12:00-13:00	520	52,6	591	51,5	609	52,7	672	51,7	555	52,5	549	51,6	586	51,9	4082	140	3942	52	2855	122	2733	52
13:00-14:00	565	50,8	501	51,3	637	49,8	688	51,1	547	53,4	492	53	525	50,7	3955	148	3807	51,4	2720	134	2586	51
14:00-15:00	483	51,5	548	50,6	622	51,9	697	51,2	590	53,2	485	51,1	531	52,6	3956	189	3767	51,7	2669	161	2508	51,6
15:00-16:00	581	51,3	618	51,3	715	50,2	626	50,8	590	52,8	614	50	658	50,3	4402	197	4205	50,9	3186	172	3014	50,6
16:00-17:00	656	49,8	687	50,3	633	51,7	537	52,8	537	53,5	622	52,1	662	51,6	4334	97	4237	51,6	3260	84	3176	51,1
17:00-18:00	626	52,8	544	54,4	544	52,9	438	54,3	377	53,5	511	52,3	549	53,8	3589	81	3508	53,4	2774	69	2705	53,2
18:00-19:00	495	51,2	459	53,2	383	52,5	296	53,7	261	53,3	446	52,5	430	51,6	2770	57	2713	52,4	2213	45	2168	52,2
19:00-20:00	289	53,5	308	53,9	231	54	129	53,6	147	58,1	294	53,9	283	53	1681	44	1637	54	1405	37	1368	53,6
20:00-21:00	211	55,1	200	56,5	170	54,8	105	56,2	95	58,1	175	54,4	169	53,8	1125	26	1099	55,4	925	22	903	55
21:00-22:00	111	54,9	115	55	121	53,4	100	55,4	84	57,8	88	56,1	99	57,2	718	19	699	55,5	534	15	519	55,2
22:00-23:00	60	56	73	58,2	91	54,8	87	56,5	37	56,5	53	58,9	51	57,3	452	11	441	56,7	328	8	320	56,8
23:00-00:00	26	59,6	20	53,6	64	55,3	76	53,8	23	64,8	23	57,7	28	58,5	260	6	254	56,5	161	4	157	56,7
Totalt	6751	52,4	6773	52,3	6989	52,4	5814	53	4944	54	6448	53	6688	52,2	44407	1893	42514	52,7	33649	1689	31960	52,5

A.13 Appendix 13

Table A.13: The given data from Norconsult for the point referred to as 'Varlavägen' in the report, with the south direction of travel.

Measuring point: Varlavägen, Kungsbacka, Lindaregatan South (70291). Direction of travel: South. Speed limit: 60 km/h

	2021-10-13 (wed)		2021-10-14 (thur)		2021-10-15 (fri)		2021-10-16 (sat)		2021-10-17 (sun)		2021-10-18 (mon)		2021-10-19 (tue)		Total				Weekday			
Timme	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal	Hastighet	Antal [veh/w]	Heavy	Light	Hastighet	Antal	Tung	Light	Hastighet
00:00-01:00	13	63,3	9	58,6	12	60,2	29	52,2	42	53,6	5	60,2	9	55,2	119	0	119	55,8	48	0	48	59,8
01:00-02:00	5	52,9	6	56,2	9	58,2	24	54,2	27	57,9	4	66,2	3	51,2	78	3	75	56,5	27	3	24	57,2
02:00-03:00	2	52	1	49	3	52,1	12	58,4	19	53,8	2	70,6	2	47,5	41	1	40	55,3	10	1	9	54,6
03:00-04:00	1	61,9	2	57,8	7	56,1	9	59,6	7	60,5	2	64,3	1	69,5	29	0	29	59,6	13	0	13	59,1
04:00-05:00	7	58,7	7	58,3	5	69	3	59,9	6	62,3	9	67,4	6	59	43	3	40	62,3	34	3	31	62,5
05:00-06:00	29	58,1	39	56	30	59,3	16	56,8	10	58,1	30	57	29	57,4	183	26	157	57,4	157	24	133	57,5
06:00-07:00	141	56,9	147	54,4	138	54,9	24	53,9	22	55,1	139	57	141	53,5	752	116	636	55,3	706	111	595	55,3
07:00-08:00	295	54	296	54,2	285	52,3	42	58,3	31	59,3	267	53,3	305	53,5	1521	135	1386	53,7	1448	133	1315	53,5
08:00-09:00	389	52,4	394	50,1	409	50,7	83	58,7	48	58,2	379	52,5	390	50,7	2092	207	1885	51,7	1961	199	1762	51,3
09:00-10:00	289	54,9	314	50,8	294	54,1	184	57,8	157	58	269	55,3	325	52,7	1832	159	1673	54,3	1491	148	1343	53,5
10:00-11:00	435	54,6	377	52,2	452	52,8	405	55,8	352	55,8	376	54,6	379	51,1	2776	177	2599	53,8	2019	159	1860	53,1
11:00-12:00	483	53,3	487	51,3	544	54,6	583	54,5	514	54,4	447	53,3	502	51,5	3560	166	3394	53,3	2463	148	2315	52,8
12:00-13:00	506	54,2	548	52,9	629	52,4	734	51,8	564	53,9	545	52,6	549	52,5	4075	145	3930	52,8	2777	127	2650	52,9
13:00-14:00	447	53,5	495	52,8	595	53,4	699	53,2	587	54,2	455	53	471	51,9	3749	157	3592	53,2	2463	134	2329	53
14:00-15:00	497	51,2	515	52,1	664	54,4	686	52,4	536	55,4	488	52,6	534	52,1	3920	160	3760	52,9	2698	138	2560	52,6
15:00-16:00	618	53,6	604	51,6	700	52,7	557	53,1	480	55,4	529	53	575	52,5	4063	137	3926	53,1	3026	116	2910	52,7
16:00-17:00	745	51,8	752	51,7	717	53,3	476	53,6	420	55,8	682	53	715	52,2	4507	110	4397	52,8	3611	94	3517	52,4
17:00-18:00	688	52,5	626	53,5	606	53,6	332	56,3	337	56	587	53,6	637	52	3813	81	3732	53,6	3144	67	3077	53
18:00-19:00	466	51,6	520	52	388	53,2	232	54	235	55,4	491	51,6	406	51,8	2738	67	2671	52,5	2271	54	2217	52
19:00-20:00	290	53,9	308	52	246	54	154	54,2	178	56,4	291	53,2	299	52,6	1766	42	1724	53,5	1434	36	1398	53,1
20:00-21:00	161	54,2	165	55,2	150	54,6	124	54,2	115	56,3	168	53,9	193	54,6	1076	27	1049	54,6	837	20	817	54,5
21:00-22:00	116	53,7	120	55,5	103	52,9	104	53,6	80	56	99	54,6	96	56	718	16	702	54,5	534	13	521	54,5
22:00-23:00	60	57,5	78	55,6	94	55,7	70	52,7	52	57,6	43	57	71	55,5	468	10	458	55,8	346	7	339	56,1
23:00-00:00	20	56,6	23	56,2	56	57,3	56	55,6	17	61,6	10	59,4	17	59,2	199	6	193	57,3	126	4	122	57,4
Totalt	6703	53,3	6833	52,4	7136	53,4	5638	53,8	4836	55,3	6317	53,3	6655	52,3	44118	1951	42167	53,3	33644	1739	31905	52,9

A.14 Appendix 14

Table A.14: The given data from Aranäs for the point referred to as 'Lindälvsgata' in the report, with the total direction of travel.

Measuring point: Lindälvsgatan, Kungsbacka, South entrence Elof Lindälvs Gymnasium (70535). Direction of travel: Total. Speed limit: 30 km/h

	2021-11-16 (tue)		2021-11-17 (wed)		2021-11-18 (thu)		2021-11-19 (fri)		2021-11-20 (sat)		2021-11-21 (sun)		2021-11-22 (mon)		Total				Weekdays			
Hour	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Heavy	Light	Speed	Quantity	Heavy	Light	Speed
00:00-01:00	0	-	0	-	2	30,6	0	-	4	20,3	0	-	2	28,4	8	0	8	24,9	4	0	4	29,5
01:00-02:00	2	32	2	34,9	0	-	2	30,6	0	-	0	-	0	-	6	0	6	32,5	6	0	6	32,5
02:00-03:00	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	0	0				0	
03:00-04:00	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	0	0				0	
04:00-05:00	0	-	0	-	0	-	0	-	0	-	2	24,5	0	-	2	0	2	24,5			0	
05:00-06:00	0	-	0	-	0	-	2	40	0	-	0	-	0	-	2	0	2	40	2	0	2	40
06:00-07:00	6	23,7	7	25,6	7	25,2	4	27,3	0	-	0	-	9	20,7	33	8	25	24	33	8	25	24
07:00-08:00	19	22,1	21	23,1	16	21,3	18	22,9	1	20,5	0	-	16	21	91	4	87	22,1	90	3	87	22,1
08:00-09:00	11	19	11	17,5	11	19,5	6	15,6	0	-	0	-	18	19,6	57	4	53	18,6	57	4	53	18,6
09:00-10:00	4	16,6	3	20,8	5	20	7	16,9	1	17,3	0	-	2	20,7	22	2	20	18,5	21	2	19	18,5
10:00-11:00	7	18,6	7	20,6	2	23,6	4	24	2	18,4	1	17,3	4	19,6	27	6	21	20,4	24	6	18	20,7
11:00-12:00	2	19,1	8	23,1	3	21,5	2	25,9	1	21,2	2	19,8	4	17,3	22	11	11	21,3	19	10	9	21,5
12:00-13:00	3	16,1	3	20,2	3	24,4	3	19,6	0	-	1	14,8	5	19,7	18	8	10	19,7	17	8	9	20
13:00-14:00	4	20,5	1	21,6	2	20,2	6	28,3	1	36	1	22	5	13,3	20	1	19	21,9	18	1	17	21,1
14:00-15:00	7	21	0	-	4	14,8	5	32,3	2	26,5	1	28,4	5	16,7	24	2	22	22,2	21	2	19	21,5
15:00-16:00	2	21,5	4	26,8	1	21,6	0	-	0	-	3	18,7	2	22,7	12	2	10	22,8	9	2	7	24,1
16:00-17:00	0	-	1	22,7	1	23,4	4	26,9	1	18	0	-	5	12,7	12	0	12	19,6	11	0	11	19,7
17:00-18:00	0	-	3	17,2	1	10,4	2	25,9	1	18	0	-	2	12,4	9	0	9	17,4	8	0	8	17,3
18:00-19:00	0	-	5	17,4	0	-	0	-	0	-	0	-	0	-	5	0	5	17,4	5	0	5	17,4
19:00-20:00	1	35,3	3	26,4	1	17,6	1	21,6	0	-	0	-	7	16,8	13	2	11	20,9	13	2	11	20,9
20:00-21:00	0	-	0	-	0	-	1	21,6	0	-	0	-	1	16,2	2	0	2	18,9	2	0	2	18,9
21:00-22:00	0	-	4	27,7	0	-	0	-	2	31,7	0	-	0	-	6	0	6	29	4	0	4	27,7
22:00-23:00	0	-	0	-	0	-	0	-	1	36,7	0	-	0	-	1	0	1	36,7			0	
23:00-00:00	0	-	1	22,7	0	-	0	-	1	25,2	0	-	0	-	2	0	2	24	1	0	1	22,7
Total	68	21	84	22,4	59	21,2	67	24,1	18	23,7	11	20,7	87	18,8	394	50	344	21,5	365	48	317	21,4

A.15 Appendix 15

Table A.15: The given data from Aranäs for the point referred to as ‘Varlagård’ in the report, with the total direction of travel.

Measuring point: Varlagård, Kungsbacka, Borgmästaregatan North (70539). Direction of travel: Total. Speed limit: 30 km/h

	2021-11-16 (tue)		2021-11-17 (wed)		2021-11-18 (thu)		2021-11-19 (fri)		2021-11-20 (sat)		2021-11-21 (sun)		2021-11-22 (mon)		Total				Weekday			
Hour	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Heavy	Light	Speed	Quantity	Heavy	Light	Speed
00:00-01:00	0	-	0	-	0	-	0	-	1	20,9	2	10,6	1	14,8	4	0	4	14,2	1	0	1	14,8
01:00-02:00	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	0	0				0	
02:00-03:00	2	18,7	4	15,2	2	13,9	1	13,7	3	15,5	2	20,5	1	27,7	15	8	7	17	10	7	3	16,8
03:00-04:00	0	-	0	-	0	-	1	18,7	0	-	1	19,8	1	19,4	3	0	3	19,3	2	0	2	19,1
04:00-05:00	0	-	0	-	1	21,2	0	-	1	20,9	5	15,8	3	10,3	10	2	8	15,2	4	1	3	13,1
05:00-06:00	11	18,6	4	18,2	2	21,5	9	20,8	4	14,4	0	-	1	22	31	15	16	18,9	27	15	12	19,6
06:00-07:00	10	20,1	10	19,2	5	16,6	9	17,7	2	20,3	5	21,3	11	19,5	52	16	36	19,2	45	15	30	18,9
07:00-08:00	10	14	10	15,8	8	19,1	14	12,4	6	16,6	1	16,6	25	15	74	13	61	15,1	67	12	55	14,9
08:00-09:00	15	18,3	14	16,5	12	17,4	15	16,4	3	16,6	2	21,1	14	16	75	9	66	17	70	9	61	16,9
09:00-10:00	21	17,8	13	18,5	25	18,5	25	18,4	19	21,5	17	19	10	13,6	130	12	118	18,5	94	10	84	17,8
10:00-11:00	11	15,3	7	18,2	13	18,5	19	14,1	34	16,1	13	14,8	17	16,7	114	19	95	16	67	12	55	16,2
11:00-12:00	9	17,4	15	18,5	9	15,7	46	14,2	43	13,3	11	18,8	13	14,4	146	29	117	15	92	20	72	15,4
12:00-13:00	20	15,6	11	17,4	16	16,1	35	14,4	53	14,3	12	15	21	12,7	168	24	144	14,7	103	17	86	14,9
13:00-14:00	26	14,6	15	17,3	15	15,8	34	13,8	52	12,8	27	13,6	25	14,6	194	15	179	14,1	115	8	107	14,9
14:00-15:00	20	13,8	19	14,4	16	15,4	32	14	45	14	31	14,7	12	14	175	26	149	14,3	99	11	88	14,3
15:00-16:00	10	17,1	18	17,1	15	16,3	27	14,1	43	13,6	24	13,4	24	14	161	10	151	14,6	94	4	90	15,3
16:00-17:00	21	15,4	35	16,3	27	15,7	35	14,2	60	13,6	20	13,2	25	13	223	17	206	14,5	143	4	139	15
17:00-18:00	42	16,1	58	16,1	20	15,4	31	12,9	25	14,4	30	13,3	29	15,5	235	16	219	15	180	10	170	15,4
18:00-19:00	13	14,5	40	14,8	19	15,5	18	17,4	19	18,4	29	15,2	17	15,4	155	6	149	15,7	107	4	103	15,4
19:00-20:00	7	16,2	11	16,7	25	16,1	7	13,7	8	20,4	3	10,7	16	12,8	77	4	73	15,5	66	4	62	15,1
20:00-21:00	20	17,9	15	19,5	18	18,1	22	17,5	31	12,5	4	15,8	26	16,6	136	3	133	16,5	101	0	101	17,8
21:00-22:00	2	23,8	0	-	0	-	0	-	4	16,3	0	-	3	16,9	9	1	8	18,2	5	0	5	19,7
22:00-23:00	0	-	1	14,4	1	19,8	9	13,3	6	17,3	0	-	2	15,5	19	1	18	15,2	13	0	13	14,2
23:00-00:00	3	19,1	2	20,4	4	16,8	6	15,9	7	14,5	4	15,1	3	13,7	29	0	29	16	18	0	18	16,8
Totalt	273	16,3	302	16,6	253	16,6	395	14,9	469	14,6	243	14,9	300	14,9	2235	246	1989	15,5	1523	163	1360	15,8

A.16 Appendix 16

Table A.16: The given data from Aranäs for the point referred to as ‘Varlagård’ in the report, with the north direction of travel.

Measuring point: Varlagård, Kungsbacka, Borgmästaregatan North (70539). Direction of travel: North. Speed limit: 30 km/h

	2021-11-16 (tue)		2021-11-17 (wed)		2021-11-18 (thu)		2021-11-19 (fri)		2021-11-20 (sat)		2021-11-21 (sun)		2021-11-22 (mon)		Total				Weekday			
Hour	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Heavy	Light	Speed	Quantity	Heavy	Light	Speed
00:00-01:00	0	-	0	-	0	-	0	-	1	20,9	0	-	1	14,8	2	0	2	17,9	1	0	1	14,8
01:00-02:00	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	0	0				0	
02:00-03:00	1	18	2	15,7	1	11,2	0	-	1	23,8	2	20,5	0	-	7	4	3	17,9	4	3	1	15,1
03:00-04:00	0	-	0	-	0	-	0	-	0	-	0	-	1	19,4	1	0	1	19,4	1	0	1	19,4
04:00-05:00	0	-	0	-	1	21,2	0	-	0	-	2	16,2	1	11,2	4	2	2	16,2	2	1	1	16,2
05:00-06:00	3	16,4	3	18,7	2	21,5	5	20,7	2	17,3	0	-	1	22	16	4	12	19,3	14	4	10	19,6
06:00-07:00	10	20,1	7	21,2	4	16,5	7	17	2	20,3	4	22,3	8	20,7	42	10	32	19,8	36	9	27	19,5
07:00-08:00	8	14,9	9	15,9	7	19,1	9	13,4	4	19,2	1	16,6	14	16,7	52	8	44	16,2	47	7	40	16
08:00-09:00	11	18,2	8	17,6	9	16,7	14	16,8	3	16,6	2	21,1	8	19,3	55	7	48	17,7	50	7	43	17,6
09:00-10:00	16	18	10	19	20	19,4	18	18,7	18	21,9	14	20	5	15,2	101	8	93	19,3	69	6	63	18,5
10:00-11:00	7	16	4	20,3	9	19,8	8	15,9	24	17,4	6	17,9	10	18,3	68	11	57	17,8	38	5	33	17,9
11:00-12:00	7	17,4	12	18,4	7	16,4	22	17,2	25	14,7	9	19,8	13	14,4	95	21	74	16,5	61	12	49	16,8
12:00-13:00	9	16,8	7	18	7	18,5	16	14,7	34	16,4	9	16,3	12	15	94	10	84	16,2	51	3	48	16,1
13:00-14:00	10	17,9	8	18	5	18,5	7	18,1	19	13,7	13	15,7	19	15,9	81	9	72	16,1	49	4	45	17,2
14:00-15:00	10	13,2	11	14,2	9	16	12	17,5	16	16,5	12	17,4	10	13,6	80	18	62	15,6	52	4	48	15
15:00-16:00	7	19,3	7	17,7	5	17,8	10	16,2	11	20,2	15	14,2	10	15	65	7	58	16,8	39	1	38	16,9
16:00-17:00	11	17,3	19	17,7	13	17	9	14,6	10	15	2	20,9	5	12,9	69	8	61	16,4	57	2	55	16,5
17:00-18:00	12	14,4	25	17,2	6	15,3	1	20,2	17	13,8	14	12,5	12	17,2	87	10	77	15,3	56	4	52	16,4
18:00-19:00	2	13,1	12	12,2	6	16,5	6	14,3	1	20,9	1	20,9	0	-	28	4	24	14,3	26	2	24	13,8
19:00-20:00	0	-	1	14,4	4	16,7	1	17,6	0	-	0	-	1	18,4	7	2	5	16,7	7	2	5	16,7
20:00-21:00	1	16,9	1	19,4	2	19,8	4	13,5	8	16,3	3	13,8	1	14,4	20	3	17	15,8	9	0	9	16
21:00-22:00	0	-	0	-	0	-	0	-	4	16,3	0	-	1	19,8	5	1	4	17	1	0	1	19,8
22:00-23:00	0	-	0	-	0	-	4	12,4	1	20,9	0	-	0	-	5	1	4	14,1	4	0	4	12,4
23:00-00:00	1	21,6	1	17,3	1	13	0	-	0	-	0	-	1	19,8	4	0	4	17,9	4	0	4	17,9
Total	126	16,9	147	17,2	118	17,7	153	16,4	201	16,7	109	16,9	134	16,2	988	148	840	16,8	678	76	602	16,9

A.17 Appendix 17

Table A.17: The given data from Aranäs for the point referred to as ‘Varlagård’ in the report, with the south direction of travel.

Measuring point: Varlagård, Kungsbacka, Borgmästaregatan North (70539). Direction of travel: South. Speed limit: 30 km/h

	2021-11-16 (tue)		2021-11-17 (wed)		2021-11-18 (thu)		2021-11-19 (fri)		2021-11-20 (sat)		2021-11-21 (sun)		2021-11-22 (mon)		Total				Weekday			
Hour	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Heavy	Light	Speed	Quantity	Heavy	Light	Speed
00:00-01:00	0	-	0	-	0	-	0	-	0	-	2	10,6	0	-	2	0	2	10,6				
01:00-02:00	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	0	0					
02:00-03:00	1	19,4	2	14,8	1	16,6	1	13,7	2	11,3	0	-	1	27,7	8	4	4	16,2	6	4	2	17,8
03:00-04:00	0	-	0	-	0	-	1	18,7	0	-	1	19,8	0	-	2	0	2	19,3	1	0	1	18,7
04:00-05:00	0	-	0	-	0	-	0	-	1	20,9	3	15,5	2	9,9	6	0	6	14,5	2	0	2	9,9
05:00-06:00	8	19,4	1	16,6	0	-	4	21	2	11,5	0	-	0	-	15	11	4	18,6	13	11	2	19,7
06:00-07:00	0	-	3	14,3	1	17,3	2	20,2	0	-	1	17,3	3	16,2	10	6	4	16,6	9	6	3	16,6
07:00-08:00	2	10,5	1	14,4	1	19,1	5	10,6	2	11,3	0	-	11	12,9	22	5	17	12,4	20	5	15	12,5
08:00-09:00	4	18,6	6	15,1	3	19,7	1	11,9	0	-	0	-	6	11,6	20	2	18	15,3	20	2	18	15,3
09:00-10:00	5	17,2	3	16,9	5	14,6	7	17,7	1	14,8	3	14,3	5	12	29	4	25	15,6	25	4	21	15,8
10:00-11:00	4	14,2	3	15,4	4	15,7	11	12,7	10	12,8	7	12,1	7	14,3	46	8	38	13,4	29	7	22	14
11:00-12:00	2	17,3	3	18,7	2	13,1	24	11,5	18	11,4	2	14,4	0	-	51	8	43	12,3	31	8	23	12,6
12:00-13:00	11	14,7	4	16,5	9	14,3	19	14,2	19	10,5	3	11,2	9	9,6	74	14	60	12,8	52	14	38	13,7
13:00-14:00	16	12,5	7	16,5	10	14,4	27	12,7	33	12,3	14	11,6	6	10,4	113	6	107	12,7	66	4	62	13,1
14:00-15:00	10	14,4	8	14,6	7	14,6	20	11,9	29	12,7	19	13	2	15,7	95	8	87	13,1	47	7	40	13,5
15:00-16:00	3	11,9	11	16,8	10	15,6	17	12,9	32	11,3	9	12	14	13,3	96	3	93	13	55	3	52	14,2
16:00-17:00	10	13,4	16	14,7	14	14,6	26	14,1	50	13,3	18	12,3	20	13,1	154	9	145	13,6	86	2	84	14
17:00-18:00	30	16,8	33	15,3	14	15,5	30	12,7	8	15,7	16	14,1	17	14,3	148	6	142	14,9	124	6	118	14,9
18:00-19:00	11	14,7	28	15,9	13	15	12	18,9	18	18,3	28	15	17	15,4	127	2	125	16,1	81	2	79	15,9
19:00-20:00	7	16,2	10	16,9	21	16	6	13,1	8	20,4	3	10,7	15	12,4	70	2	68	15,4	59	2	57	15
20:00-21:00	19	18	14	19,5	16	17,9	18	18,4	23	11,2	1	21,6	25	16,7	116	0	116	16,6	92	0	92	17,9
21:00-22:00	2	23,8	0	-	0	-	0	-	0	-	0	-	2	15,5	4	0	4	19,7	4	0	4	19,7
22:00-23:00	0	-	1	14,4	1	19,8	5	14	5	16,6	0	-	2	15,5	14	0	14	15,6	9	0	9	15
23:00-00:00	2	17,8	1	23,4	3	18,1	6	15,9	7	14,5	4	15,1	2	10,6	25	0	25	15,7	14	0	14	16,4
Total	147	15,8	155	16,1	135	15,7	242	14	268	13,1	134	13,4	166	13,8	1247	98	1149	14,4	845	87	758	14,9

A.18 Appendix 18

Table A.18: The given data from Aranäs for the point referred to as ‘Varlagård’ in the report, with the total direction of travel.

Measuring point: Varlagård, Kungsbacka, Varlavägen East (70538). Direction of travel: Total. Speed limit: 40 km/h

	2021-11-16 (tue)		2021-11-17 (wed)		2021-11-18 (thu)		2021-11-19 (fri)		2021-11-20 (sat)		2021-11-21 (sun)		2021-11-22 (mon)		Total				Weekday			
Hour	Quantity	Hastighet	Quantity	Hastighet	Quantity	Hastighet	Quantity	Hastighet	Quantity	Hastighet	Quantity	Hastighet	Quantity	Hastighet	Quantity	Heavy	Light	Hastighet	Quantity	Heavy	Light	Speed
00:00-01:00	2	23,6	5	27,1	7	24,4	2	20,9	23	24,7	11	27,1	2	25,4	52	0	52	25,3	18	0	18	24,8
01:00-02:00	1	29,2	0	-	4	28,7	1	29,9	14	25,1	4	25,2	0	-	24	0	24	26,1	6	0	6	29
02:00-03:00	1	27	0	-	0	-	0	-	3	27,5	0	-	0	-	4	0	4	27,4	1	0	1	27
03:00-04:00	0	-	0	-	1	22,3	0	-	0	-	2	27,2	0	-	3	0	3	25,5	1	0	1	22,3
04:00-05:00	1	18,7	0	-	0	-	1	21,6	2	29,5	6	28	0	-	10	0	10	26,7	2	0	2	20,2
05:00-06:00	2	21,8	3	30,8	2	32,1	2	20,9	1	13,7	0	-	1	19,1	11	2	9	25	10	1	9	26,1
06:00-07:00	28	25,9	14	26,4	20	24,9	22	25,5	4	27,6	2	25,7	29	25,6	119	23	96	25,7	113	21	92	25,6
07:00-08:00	49	25,6	62	24,9	58	23,4	39	24,6	7	25,9	4	28,6	54	22,7	273	30	243	24,3	262	27	235	24,2
08:00-09:00	129	24,4	130	25	135	23,5	119	23,7	24	24,9	16	23,4	119	24,1	672	18	654	24,1	632	17	615	24,1
09:00-10:00	211	22	191	23,8	217	22,8	237	22,6	126	23,6	96	23,3	198	23,5	1276	29	1247	23	1054	29	1025	22,9
10:00-11:00	470	21,8	391	22,6	432	22	538	22,4	520	22,3	380	23,1	453	22,1	3184	98	3086	22,3	2284	79	2205	22,2
11:00-12:00	632	21,7	586	22,2	634	22	770	21,7	746	21,5	628	21,9	665	21,7	4661	149	4512	21,8	3287	110	3177	21,9
12:00-13:00	653	21,7	659	22,6	681	21,8	791	21,2	971	20,2	768	22	692	21,9	5215	193	5022	21,5	3476	131	3345	21,8
13:00-14:00	619	21,6	618	22	653	22,4	830	22,5	1012	19,8	865	21,9	649	22,1	5246	214	5032	21,6	3369	120	3249	22,1
14:00-15:00	567	21,8	565	22,2	630	21,6	820	22,2	1006	20,4	815	21,8	663	21,7	5066	93	4973	21,6	3245	64	3181	21,9
15:00-16:00	605	22,2	653	21,9	643	21,9	772	22,2	829	21,8	820	21,2	619	22	4941	143	4798	21,9	3292	75	3217	22
16:00-17:00	655	22,4	680	22,1	659	22,2	753	21,8	573	22	755	21,7	726	22,3	4801	156	4645	22,1	3473	131	3342	22,1
17:00-18:00	661	22,4	687	21,7	626	22,3	642	22,9	505	22,5	512	22,6	651	22,1	4284	101	4183	22,3	3267	97	3170	22,3
18:00-19:00	446	22,8	505	22,2	501	22,7	417	22,9	198	23,3	198	23	506	22,4	2771	58	2713	22,7	2375	55	2320	22,6
19:00-20:00	271	23,1	366	23	338	23,3	261	23,1	95	23,7	77	23,2	289	23,2	1697	47	1650	23,2	1525	45	1480	23,1
20:00-21:00	160	23,3	137	23,6	189	23,3	151	23,8	98	24,8	100	23,9	111	23,3	946	9	937	23,6	748	9	739	23,4
21:00-22:00	52	24,4	50	24,4	73	24	110	24,2	49	25,3	39	23,9	47	25,3	420	11	409	24,4	332	11	321	24,4
22:00-23:00	35	23,1	56	23,5	29	25,9	89	25,2	76	22,8	23	23,1	30	24	338	9	329	24	239	6	233	24,4
23:00-00:00	6	24,9	18	26,6	19	23,6	84	23,2	41	24,5	8	24	8	24	184	1	183	24	135	0	135	23,8
Total	6256	22,2	6376	22,4	6551	22,3	7451	22,3	6923	21,4	6129	22,1	6512	22,2	46198	1384	44814	22,1	33146	1028	32118	22,3

A.19 Appendix 19

Table A.19: The given data from Aranäs for the point referred to as ‘Varlagård’ in the report, with the west direction of travel.

Measuring point: Varlagård, Kungsbacka, Varlavägen East (70538). Direction of travel: West. Speed limit: 40 km/h

	2021-11-16 (tue)		2021-11-17 (wed)		2021-11-18 (thu)		2021-11-19 (fri)		2021-11-20 (sat)		2021-11-21 (sun)		2021-11-22 (mon)		Total				Weekday			
Hour	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Heavy	Light	Speed	Quantity	Heavy	Light	Speed
00:00-01:00	2	23,6	2	23,6	4	22,2	2	20,9	12	21,5	6	24,4	1	19,1	29	0	29	22,4	11	0	11	22,2
01:00-02:00	0	-	0	-	2	28,1	0	-	10	26	2	25,7	0	-	14	0	14	26,3	2	0	2	28,1
02:00-03:00	1	27	0	-	0	-	0	-	1	24,5	0	-	0	-	2	0	2	25,8	1	0	1	27
03:00-04:00	0	-	0	-	0	-	0	-	0	-	1	29,5	0	-	1	0	1	29,5			0	
04:00-05:00	0	-	0	-	0	-	0	-	1	28,4	3	27,4	0	-	4	0	4	27,7			0	
05:00-06:00	0	-	1	32	0	-	0	-	0	-	0	-	1	19,1	2	0	2	25,6	2	0	2	25,6
06:00-07:00	5	23,9	2	24,1	5	24,2	6	23,5	2	26,3	0	-	7	25,6	27	8	19	24,5	25	6	19	24,4
07:00-08:00	8	25,9	11	23,8	12	22,7	9	23,8	3	26,9	2	25,4	15	19,9	60	14	46	23,1	55	12	43	22,8
08:00-09:00	22	22,5	29	23,5	36	22,3	25	22,2	10	23,3	6	24,1	22	22,5	150	8	142	22,7	134	7	127	22,6
09:00-10:00	67	21,6	49	24,1	66	23	63	22,3	29	23,9	24	22,2	56	22,7	354	13	341	22,7	301	13	288	22,7
10:00-11:00	163	21,6	154	22,1	166	21,5	190	22,2	191	22,6	134	23,1	168	21,7	1166	33	1133	22,1	841	26	815	21,8
11:00-12:00	304	21,5	241	22,4	248	21,9	366	21,8	297	22	287	22	293	21,6	2036	60	1976	21,9	1452	52	1400	21,8
12:00-13:00	340	21,8	328	22,6	351	21,2	439	21,7	477	22,2	401	21,8	361	21,5	2697	88	2609	21,8	1819	87	1732	21,7
13:00-14:00	311	21,1	330	22	349	22,2	491	22,6	538	21,8	456	22	342	21,8	2817	67	2750	22	1823	66	1757	22
14:00-15:00	289	21,5	292	22	323	21,6	434	21,3	740	20,6	413	21,6	359	21,2	2850	34	2816	21,3	1697	22	1675	21,5
15:00-16:00	301	21,5	332	21,9	340	21,5	393	21,4	578	22,2	497	21,3	373	21,6	2814	46	2768	21,7	1739	34	1705	21,6
16:00-17:00	306	22,2	338	22,1	320	22,4	429	21,2	363	22,1	484	21,6	385	21,7	2625	88	2537	21,9	1778	65	1713	21,9
17:00-18:00	367	22,2	351	21,7	356	22,5	374	22,2	306	23,1	309	22	345	22	2408	47	2361	22,2	1793	44	1749	22,1
18:00-19:00	278	22,3	305	21,7	297	22,8	249	22,3	140	23,3	128	22,5	321	22,4	1718	35	1683	22,4	1450	33	1417	22,3
19:00-20:00	187	22,5	265	22,6	226	23,1	173	22,6	53	23,1	43	21,6	187	22,7	1134	28	1106	22,7	1038	27	1011	22,7
20:00-21:00	122	22,8	106	23,3	130	23	106	23,6	60	24,6	75	23,8	80	23	679	6	673	23,3	544	6	538	23,1
21:00-22:00	26	23,5	32	24	45	23,6	60	24,5	26	25,4	22	23,9	26	25,1	237	6	231	24,3	189	6	183	24,2
22:00-23:00	20	23,5	28	22,8	16	26,1	41	25	43	22,5	15	22,4	16	23,1	179	4	175	23,6	121	3	118	24,1
23:00-00:00	4	24	15	26,3	12	23,3	56	23,4	29	24,7	5	23,9	5	22,6	126	1	125	24	92	0	92	23,8
Total	3123	21,9	3211	22,2	3304	22,2	3906	22	3909	22,1	3313	21,9	3363	21,9	24129	586	23543	22	16907	509	16398	22

A.20 Appendix 20

Table A.20: The given data from Aranäs for the point referred to as ‘Varlagård’ in the report, with the east direction of travel.

Measuring point: Varlagård, Kungsbacka, Varlavägen East (70538). Direction of travel: East. Speed limit: 40 km/h

	2021-11-16 (tue)		2021-11-17 (wed)		2021-11-18 (thu)		2021-11-19 (fri)		2021-11-20 (sat)		2021-11-21 (sun)		2021-11-22 (mon)		Total				Weekday			
Hour	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Heavy	Light	Speed	Quantity	Heavy	Light	Speed
00:00-01:00	0	-	3	29,5	3	27,4	0	-	11	28,2	5	30,4	1	31,7	23	0	23	28,9	7	0	7	28,9
01:00-02:00	1	29,2	0	-	2	29,2	1	29,9	4	22,7	2	24,7	0	-	10	0	10	25,8	4	0	4	29,4
02:00-03:00	0	-	0	-	0	-	0	-	2	29	0	-	0	-	2	0	2	29			0	
03:00-04:00	0	-	0	-	1	22,3	0	-	0	-	1	24,8	0	-	2	0	2	23,6	1	0	1	22,3
04:00-05:00	1	18,7	0	-	0	-	1	21,6	1	30,6	3	28,6	0	-	6	0	6	26,1	2	0	2	20,2
05:00-06:00	2	21,8	2	30,2	2	32,1	2	20,9	1	13,7	0	-	0	-	9	2	7	24,8	8	1	7	26,2
06:00-07:00	23	26,3	12	26,7	15	25,1	16	26,3	2	28,8	2	25,7	22	25,6	92	15	77	26	88	15	73	26
07:00-08:00	41	25,6	51	25,1	46	23,6	30	24,8	4	25,2	2	31,7	39	23,8	213	16	197	24,7	207	15	192	24,6
08:00-09:00	107	24,8	101	25,4	99	24	94	24,1	14	26	10	22,9	97	24,4	522	10	512	24,6	498	10	488	24,6
09:00-10:00	144	22,2	142	23,6	151	22,7	174	22,7	97	23,5	72	23,7	142	23,8	922	16	906	23,1	753	16	737	23
10:00-11:00	307	21,9	237	22,8	266	22,3	348	22,6	329	22,1	246	23,1	285	22,3	2018	65	1953	22,4	1443	53	1390	22,3
11:00-12:00	328	21,9	345	22	386	22,1	404	21,6	449	21,1	341	21,8	372	21,8	2625	89	2536	21,8	1835	58	1777	21,9
12:00-13:00	313	21,6	331	22,6	330	22,4	352	20,5	494	18,3	367	22,3	331	22,3	2518	105	2413	21,2	1657	44	1613	21,9
13:00-14:00	308	22,1	288	21,9	304	22,5	339	22,3	474	17,5	409	21,9	307	22,4	2429	147	2282	21,3	1546	54	1492	22,2
14:00-15:00	278	22	273	22,5	307	21,5	386	23,2	266	19,8	402	21,9	304	22,2	2216	59	2157	21,9	1548	42	1506	22,3
15:00-16:00	304	22,8	321	21,8	303	22,4	379	23,1	251	20,9	323	21,2	246	22,5	2127	97	2030	22,1	1553	41	1512	22,5
16:00-17:00	349	22,5	342	22	339	22	324	22,6	210	21,8	271	21,9	341	22,9	2176	68	2108	22,3	1695	66	1629	22,4
17:00-18:00	294	22,7	336	21,7	270	22	268	23,8	199	21,7	203	23,5	306	22,1	1876	54	1822	22,5	1474	53	1421	22,4
18:00-19:00	168	23,8	200	23	204	22,6	168	23,8	58	23,3	70	23,7	185	22,3	1053	23	1030	23,1	925	22	903	23
19:00-20:00	84	24,6	101	24,1	112	23,7	88	23,9	42	24,6	34	25,2	102	24,3	563	19	544	24,2	487	18	469	24,1
20:00-21:00	38	24,8	31	24,6	59	23,8	45	24,4	38	25,2	25	24,1	31	24	267	3	264	24,4	204	3	201	24,3
21:00-22:00	26	25,3	18	25	28	24,6	50	23,8	23	25,2	17	23,8	21	25,5	183	5	178	24,6	143	5	138	24,6
22:00-23:00	15	22,6	28	24,3	13	25,7	48	25,3	33	23,3	8	24,5	14	25	159	5	154	24,4	118	3	115	24,8
23:00-00:00	2	26,6	3	27,8	7	24	28	22,9	12	24,1	3	24,2	3	26,4	58	0	58	23,9	43	0	43	23,8
Total	3133	22,6	3165	22,6	3247	22,4	3545	22,7	3014	20,5	2816	22,3	3149	22,6	22069	798	21271	22,3	16239	519	15720	22,6

A.21 Appendix 21

Table A.21: The given data from Aranäs for the point referred to as 'Varlagård' in the report, with the total direction of travel.

Measuring point: Varlagård, Westbound, Kungsbacka, Varlavägen East (70537). Direction of travel: Total. Speed limit: 40 km/h

	2021-11-16 (tue)		2021-11-17 (wed)		2021-11-18 (thu)		2021-11-19 (fri)		2021-11-20 (sat)		2021-11-21 (sun)		2021-11-22 (mon)		Total				Weekday			
Hour	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Heavy	Light	Speed	Quantity	Heavy	Light	Speed
00:00-01:00	0	-	0	-	3	31	1	38,9	4	32,6	4	32	2	34,2	14	0	14	32,8	6	0	6	33,4
01:00-02:00	1	30,2	2	27,9	0	-	1	28,4	2	28,1	0	-	0	-	6	2	4	28,4	4	2	2	28,6
02:00-03:00	1	42,8	1	45,7	1	34,6	0	-	3	37,4	1	35,6	0	-	7	4	3	38,7	3	3	0	41
03:00-04:00	0	-	0	-	0	-	0	-	0	-	0	-	2	36,7	2	0	2	36,7	2	0	2	36,7
04:00-05:00	1	30,6	0	-	1	34,2	0	-	0	-	3	25,7	0	-	5	1	4	28,4	2	0	2	32,4
05:00-06:00	4	29,1	2	36,4	3	36,9	2	26,3	2	33,7	0	-	0	-	13	4	9	32,3	11	3	8	32,1
06:00-07:00	9	32,1	7	29,4	8	29,1	11	30,2	3	29,5	1	28,1	13	36,7	52	20	32	31,8	48	18	30	32
07:00-08:00	54	31,3	66	30,1	41	30,6	44	30,6	26	33,2	9	28,2	76	36,5	316	32	284	32,2	281	31	250	32,2
08:00-09:00	106	29,2	112	29,5	72	30,7	124	30,1	42	31,3	27	29,7	152	36,5	635	46	589	31,5	566	40	526	31,6
09:00-10:00	121	29,5	93	30,2	78	31	118	30	66	31,5	66	30,1	124	36,6	666	44	622	31,4	534	39	495	31,6
10:00-11:00	158	28,6	155	29,1	128	30,1	173	29,3	138	30,6	110	31	151	36,7	1013	51	962	30,7	765	44	721	30,7
11:00-12:00	208	29	276	27,9	197	28,9	300	29,1	285	29,5	155	30,6	219	34,1	1640	70	1570	29,8	1200	59	1141	29,7
12:00-13:00	256	28,8	300	28,7	220	29,6	341	29,5	471	28,8	251	29,9	227	28,7	2066	37	2029	29,1	1344	30	1314	29,1
13:00-14:00	232	27,9	297	28,6	251	29,2	337	29,8	458	28,7	293	29,1	236	29,1	2104	70	2034	28,9	1353	60	1293	29
14:00-15:00	251	28,4	272	29,5	229	28,7	347	28,8	521	28,3	314	28,9	204	28,7	2138	70	2068	28,7	1303	56	1247	28,8
15:00-16:00	292	29,2	283	29,4	234	29,7	401	28,4	501	28,2	295	28,8	280	29	2286	65	2221	28,8	1490	53	1437	29,1
16:00-17:00	304	29,1	312	29,5	294	29,4	415	28,8	429	28	328	28,4	280	28,9	2362	50	2312	28,8	1605	41	1564	29,1
17:00-18:00	304	30,3	293	29,6	326	29,3	360	29,6	380	29,7	237	29,4	262	29,4	2162	41	2121	29,6	1545	38	1507	29,6
18:00-19:00	251	29,9	260	30,4	233	30,2	283	30,1	207	29,5	145	30,4	231	29,8	1610	21	1589	30	1258	21	1237	30,1
19:00-20:00	183	31	159	30,9	164	30,3	146	30,1	91	29,7	70	30,7	158	30,1	971	16	955	30,4	810	15	795	30,5
20:00-21:00	137	31,3	134	31,4	120	30,1	118	31	60	30,6	54	30,4	167	29,4	790	12	778	30,6	676	10	666	30,6
21:00-22:00	56	32,9	71	33,5	79	33,3	100	30,7	44	30,6	47	31,9	66	32,1	463	6	457	32,2	372	6	366	32,4
22:00-23:00	62	32,3	42	31,8	49	32,7	78	34,6	50	31,6	28	32	47	31,1	356	5	351	32,5	278	5	273	32,7
23:00-00:00	11	32,8	14	33,3	7	32	38	32,1	18	30,6	9	35	9	34,5	106	1	105	32,5	79	1	78	32,7
Total	3002	29,5	3151	29,6	2738	29,8	3738	29,6	3801	29	2447	29,5	2906	31	21783	668	21115	29,7	15535	575	14960	29,9

A.22 Appendix 22

Table A.22: The given data from Aranäs for the point referred to as 'Varlagård' in the report, with the total direction of travel.

Measuring point: Varlagård, Eastbound, Kungsbacka, Varlavägen East (70536). Direction of travel: Total. Speed limit: 40 km/h

	2021-11-16 (tue)		2021-11-17 (wed)		2021-11-18 (thu)		2021-11-19 (fri)		2021-11-20 (sat)		2021-11-21 (sun)		2021-11-22 (mon)		Total				Weekday			
Hour	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Speed	Quantity	Heavy	Light	Speed	Quantity	Heavy	Light	Speed
00:00-01:00	1	29,9	0	-	0	-	1	24,8	6	25,7	1	29,2	1	33,5	10	0	10	27,2	3	0	3	29,4
01:00-02:00	1	29,5	0	-	0	-	0	-	2	37,4	0	-	0	-	3	0	3	34,8	1	0	1	29,5
02:00-03:00	1	36,4	1	37,4	1	33,5	0	-	2	40	1	31,7	0	-	6	4	2	36,5	3	3	0	35,8
03:00-04:00	0	-	0	-	0	-	0	-	0	-	0	-	2	33,3	2	1	1	33,3	2	1	1	33,3
04:00-05:00	5	30,4	1	11,5	0	-	1	31,7	1	29,9	4	28,6	1	32	13	1	12	28,6	8	0	8	28,4
05:00-06:00	16	31,6	15	31	22	31	22	30,9	11	34,1	3	31	20	31,1	109	11	98	31,4	95	10	85	31,1
06:00-07:00	43	29	38	29,8	51	30,8	42	29,2	16	29,3	8	28,5	46	28,4	244	42	202	29,4	220	39	181	29,5
07:00-08:00	111	29,4	131	30,1	90	30,2	104	29,9	46	31,3	24	30,8	120	28,7	626	42	584	29,8	556	39	517	29,6
08:00-09:00	199	27,7	203	28,2	130	29,1	203	28,8	71	29,9	56	29,8	175	28,4	1037	77	960	28,6	910	71	839	28,4
09:00-10:00	232	27,8	211	28,7	178	29,3	231	28,7	162	30,6	129	30,7	182	28,4	1325	62	1263	29	1034	55	979	28,5
10:00-11:00	245	28,8	315	28,1	186	28,1	313	28,6	348	29	172	30,3	203	29	1782	62	1720	28,8	1262	54	1208	28,5
11:00-12:00	260	27,7	340	27,4	284	29,4	370	28,6	414	28,3	278	29,2	248	29,4	2194	62	2132	28,5	1502	53	1449	28,5
12:00-13:00	289	28,2	315	28,5	270	29	339	29,3	547	27,8	371	30	243	28,6	2374	50	2324	28,7	1456	45	1411	28,7
13:00-14:00	242	28,4	226	29	221	28,4	340	29,3	531	28,2	320	29,6	214	29,5	2094	53	2041	28,8	1243	50	1193	28,9
14:00-15:00	260	27,7	266	28,5	229	28,1	341	28,9	484	27,4	304	29	196	29,4	2080	44	2036	28,3	1292	39	1253	28,5
15:00-16:00	246	28,4	260	28,8	247	28,7	387	27,9	386	26,9	260	28,8	220	28,4	2006	38	1968	28,1	1360	35	1325	28,4
16:00-17:00	289	27,9	270	28,4	311	28,2	375	28,5	299	27,1	215	28,3	291	28,4	2050	23	2027	28,1	1536	22	1514	28,3
17:00-18:00	275	28,6	266	28,3	276	28,6	303	28,3	204	28,2	151	29,4	283	27,5	1758	25	1733	28,4	1403	24	1379	28,3
18:00-19:00	193	28,8	172	29,2	207	29,3	224	28,8	83	28,6	70	29	184	27,8	1133	19	1114	28,8	980	18	962	28,8
19:00-20:00	106	29,8	128	29,5	107	28,4	107	28,6	66	29,6	61	30,9	109	29,3	684	8	676	29,3	557	8	549	29,1
20:00-21:00	82	29,7	59	29,6	67	30,9	82	29,8	42	30	43	31	85	28,9	460	5	455	29,9	375	3	372	29,7
21:00-22:00	36	30,7	47	30,3	47	31,2	52	29,2	55	28,6	34	30,2	40	29	311	2	309	29,8	222	2	220	30,1
22:00-23:00	38	31,9	33	31,3	24	31,2	59	31,8	38	30,3	18	31,1	35	30,5	245	3	242	31,2	189	3	186	31,4
23:00-00:00	0	-	1	30,6	0	-	10	30,3	4	32,6	1	26,6	0	-	16	1	15	30,7	11	1	10	30,3
Total	3170	28,4	3298	28,6	2948	28,9	3906	28,8	3818	28,2	2524	29,5	2898	28,7	22562	635	21927	28,7	16220	575	15645	28,7

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