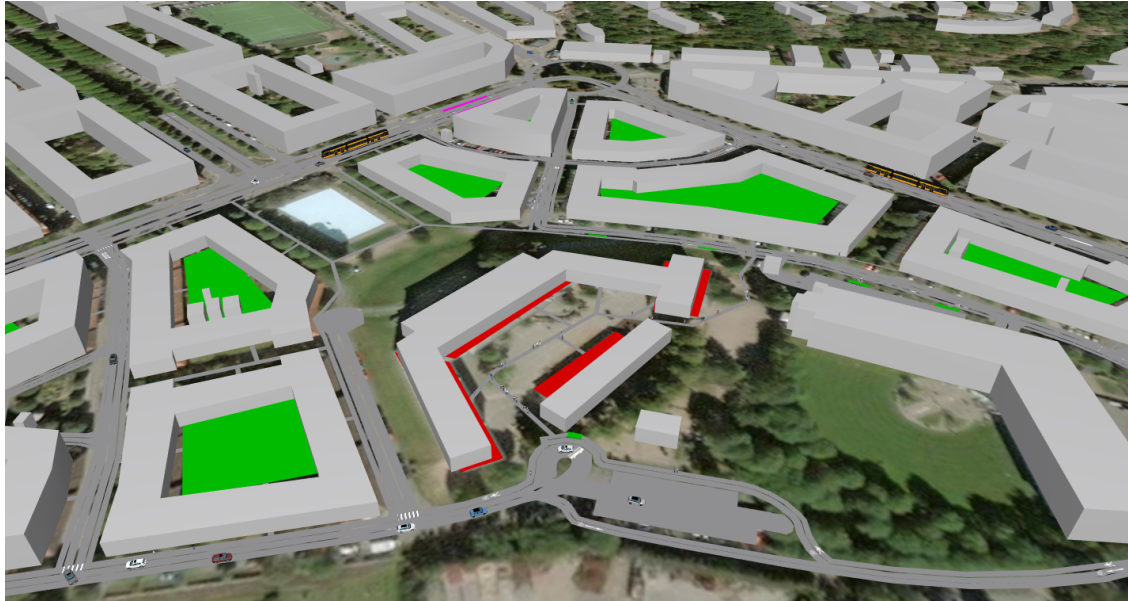




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Car-Free Zones Around Schools in Gothenburg

A literature- and simulation-based study for future implementation of car-free zones around schools

Master's thesis in the Master's Programme Infrastructure and Environmental Engineering

Daniel Engström

Alva Sonesson

DEPARTMENT OF ARCHITECTURE AND CIVIL ENGINEERING
DIVISION OF GEOLOGY AND GEOTECHNICS

CHALMERS UNIVERSITY OF TECHNOLOGY
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DANIEL ENGSTRÖM

ALVA SONESSON

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Institutionen för Arkitektur och Samhällsbyggnadsteknik
Chalmers Tekniska Högskola, 2026

Department of Architecture and Civil Engineering

Division of Geology and Geotechnics

Chalmers University of Technology

SE-412 96 Göteborg

Sweden

Telephone +46 31 772 1000

Cover: Image generated using the simulation software PTV Vissim, depicting Kungsladugårdsskolan and the surrounding environment.

Department of Architecture and Civil Engineering
Göteborg, Sweden, 2026

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ABSTRACT

This master's thesis reviews international implementations of car-free zones around schools and assesses how similar measures could be applied at four selected schools in Gothenburg. It examines which interventions have proven effective across different contexts and develops context-sensitive proposals for designing and implementing car-free zones under varying traffic conditions and urban contexts in Gothenburg.

The study combines a literature review, interviews, field observations, case studies, and traffic simulations. Experiences from Sweden and other countries are analysed to identify effective implementation strategies, common challenges, and key factors for successful implementation.

The literature review and interview indicate that car-free zones can improve traffic safety and promote active travel. However, their effectiveness depends on local conditions such as road network function, traffic volumes, alternative routes, and stakeholder acceptance. The findings highlight the need for context-specific design, clear regulations, physical measures to ensure compliance, and complementary safety measures.

Four schools in Gothenburg, representing different urban contexts, were selected as case studies. The proposed solutions included permanent road closures for Brunnsboskolan and Långmosseskolan, a time-restricted closure for Kungsladugårdsskolan, and alternative safety measures for Brottkärsskolan. In all cases, complementary safety measures such as improved crossings, speed reduction measures, and designated drop-off areas are proposed. For Kungsladugårdsskolan and Brunnsboskolan, traffic simulation models were developed in PTV Vissim to evaluate the impacts of the proposed measures on queue delays, travel times, and level of service (LOS). The most affected streets reached LOS B at Kungsladugårdsskolan and LOS C at Brunnsboskolan, with maximum queue delays of 14.90 and 17.39 s/vehicle, respectively. This indicates that the proposed measures can be implemented without major negative effects on the surrounding network.

Overall, the thesis provides practical recommendations for implementing car-free zones around schools in Gothenburg and contributes to a broader understanding of how such measures can be adapted to different urban environments.

Key words:

Car-free zones around schools, school streets, traffic safety, traffic simulation, active transport, urban planning, Gothenburg, PTV Vissim

Bilfria zoner runt skolor i Göteborg

En litteratur- och simuleringsbaserad studie för framtida implementering av bilfria zoner runt skolor

Examensarbete inom masterprogrammet Infrastruktur och miljö

DANIEL ENGSTRÖM

ALVA SONESSON

Institutionen för arkitektur och samhällsbyggnadsteknik

Avdelningen för Geologi och Geoteknik

Chalmers tekniska högskola

SAMMANFATTNING

Detta examensarbete granskar tidigare internationella implementeringar av bilfria zoner runt skolor och undersöker hur liknande åtgärder kan tillämpas vid fyra utvalda skolor i Göteborg. Studien analyserar vilka åtgärder som har visat sig effektiva i olika kontexter och utvecklar kontextanpassade förslag för hur bilfria zoner kan utformas och implementeras under varierande trafikförhållanden och i olika urbana miljöer i Göteborg.

Studien kombinerar litteraturstudie, intervjuer, fältobservationer, fallstudier och trafiksimuleringar. Erfarenheter från Sverige och andra länder analyseras för att identifiera effektiva implementeringsstrategier, återkommande utmaningar och nyckelfaktorer för framgångsrikt genomförande.

Litteraturstudien och intervjun visar att bilfria zoner kan förbättra trafiksäkerheten och främja aktiva färdssätt. Åtgärdernas effektivitet beror dock på lokala förutsättningar, såsom vägnätets funktion, trafikvolym, tillgång till alternativa färdvägar och acceptans hos berörda aktörer. Resultaten betonar behovet av kontextspecifik utformning, tydliga regelverk, fysiska åtgärder för efterlevnad samt kompletterande trafiksäkerhetsåtgärder.

Fyra skolor i Göteborg, som representerar olika urbana kontexter, valdes ut som fallstudier. De föreslagna lösningarna omfattar permanenta avstängningar för Brunnsboskolan och Långmosseskolan, en tidsbegränsad avstängning för Kungsladugårdsskolan samt alternativa trafiksäkerhetsåtgärder för Brottkärrsskolan. I samtliga fall föreslås kompletterande trafiksäkerhetsåtgärder såsom förbättrade övergångsställen, hastighetsdämpande åtgärder och särskilda avlämningszoner. För Kungsladugårdsskolan och Brunnsboskolan utvecklades trafiksimuleringsmodeller i PTV Vissim för att utvärdera åtgärdernas påverkan på köfördörjning, restid och servicenivå (LOS). De mest belastade gatorna uppnådde LOS B vid Kungsladugårdsskolan och LOS C vid Brunnsboskolan, med maximala köfördörjningar på 14.90 respektive 17.39 s/fordon. Simuleringsresultaten visar att de föreslagna åtgärderna kan implementeras utan betydande negativa effekter på det omgivande trafiknätet.

Sammanfattningsvis ger examensarbetet praktiska rekommendationer för implementering av bilfria zoner runt skolor i Göteborg och bidrar till en ökad förståelse för hur sådana åtgärder kan anpassas till olika urbana miljöer.

Nyckelord:

Bilfria zoner runt skolor, skolgator, trafiksäkerhet, trafiksimulering, aktiv mobilitet, stadsplanering, Göteborg, PTV Vissim

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Gothenburg, May 2026
Daniel Engström & Alva Sonesson

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1 Introduction

Creating safe and attractive environments around schools has become an important aspect of urban planning. Traffic conditions during school start and end times can create congestion, traffic safety concerns, and conflicts between road users, which may influence children's travel mode choice (Clarke, 2022; Köllinger, 2024). At the same time, increased active travel to school is associated with health, environmental, and social benefits (Brown et al., 2015; Schepers et al., 2015; World Health Organization [WHO], 2022). This chapter presents the background to the study, the aim and research questions that will be addressed, and defines the scope and limitations of the study.

1.1 Background

According to recent studies, regular physical activity contributes to both mental and physical health (Biddle & Asare, 2011; WHO, 2022). However, research conducted by the World Health Organization shows that 81% of children do not meet the recommended levels of physical activity (WHO, 2022). This pattern may partly be explained by a decline in children's active mobility, as fewer children walk or cycle to school today compared to previous years (Reimers et al., 2021). Insufficient physical activity is a severe problem and affects not only the individual but also their families, healthcare services and society as a whole. One effective and relatively simple change to increase daily physical activity is to encourage children to use active travel modes to school. Active travel, such as walking and cycling, represents an accessible and cost-effective way to integrate daily physical activity into children's routines. In addition, increased active transport also offers broader societal benefits, including reduced traffic congestion, lower emissions and improved environmental quality (Brown et al., 2015; Schepers et al., 2015).

One key reason why fewer children walk or cycle to school is traffic safety concerns. Millions of people die each year on the road, and road traffic injuries are the most common cause of fatal injuries among children and young adults aged 5–29 (Clarke, 2022). In addition, approximately 40% of road traffic accidents occur during school commuting hours, which highlights the increased risks associated with travel to and from school (Distefano et al., 2025). This has contributed to growing parental concerns regarding children's safety in traffic. As a result, many parents choose to drive their children to school instead of allowing them to travel independently by foot or bicycle (Forsberg et al., 2020).

When more parents drive their children to school, the traffic situation may be perceived to be even less safe, as more cars approach the school to drop off children (Köllinger, 2024). This can also lead to congestion, which negatively affects the surrounding area. To address this and improve traffic safety around schools, car-free zones can be implemented in which motorised vehicles are prohibited or restricted, either permanently or during peak travel times. This approach is often referred to as "school streets" and by creating a safer environment around schools, it can promote active and sustainable transport modes and make it easier for children to walk or cycle to school.

In recent years, the implementation of car-free zones around schools has increased significantly, from a handful of schools to well over 1,000 worldwide (Clarke, 2022). This has become an attractive strategy to improve children's traffic safety, promote health by

encouraging more active transport modes, and improve local environmental conditions by reducing air and noise pollution. The concept is most common in the United Kingdom, Belgium, France, and Italy, but many other countries have shown interest and are beginning to adopt similar measures. However, despite the growing interest, there is currently a lack of clear and consistent guidelines on how such measures should be designed and implemented effectively under different conditions, such as school location, surrounding urban context, and traffic characteristics.

The use of traffic simulation and modelling tools is well established in transport planning, but their application in the planning and evaluation of car-free zones appears to be limited. This further highlights a research gap, as such tools support a more systematic approach to analysing traffic impacts and developing implementation strategies.

In Gothenburg, safe routes to school and safe environments around schools are a priority, and the city's Urban Environment Administration has been assigned to prioritise work on securing safe school routes for children and implementing car-free zones around schools where the environment is perceived as unsafe (Göteborg Stad, n.d.). During the summer of 2025, the City of Gothenburg conducted a study investigating school travel modes among children in grades 0–9 (Göteborg Stad, 2025). The results show that during the summer months, 37% of children walk to school, 34% use public transport, 10% cycle, and 13% are driven by their parents. During the winter months, the share of parents who drive their children to school increases to 18%, and the share using public transport increases to 38%, while only 3% cycle to school.

A pilot project has been conducted in which different measures were implemented around Ånässkolan during 2024 and 2025 (Göteborg Stad, n.d.). The City of Gothenburg plans to continue its work on safe school routes and environments in 2026 and onwards. Investigating solutions for schools in the city and proposing concrete measures is therefore highly relevant and could provide valuable insights for the municipality.

1.2 Aim and research questions

The aim of this thesis is to investigate how car-free zones around schools have been implemented in other cities and countries, and how such zones can be implemented around four selected schools in Gothenburg. Previous implementations will be evaluated to identify which measures are effective in different contexts and to determine the main implementation challenges. In addition, the study will examine which measures can be applied to the selected schools in Gothenburg. The goal is to propose concrete, context-appropriate technical interventions to improve traffic safety and accessibility around the selected schools. To achieve this, the thesis addresses the following research questions:

- What implementation approaches and traffic measures have been used for car-free zones around schools in other cities and countries and what effects have been observed?
- How does the effectiveness of different measures vary depending on school location, surrounding urban context, and traffic conditions?
- How can car-free zone solutions be developed for four selected schools in Gothenburg based on the local traffic situation and urban context?

1.3 Scope and limitations

This thesis aims to analyse previous implementations of car-free zones around schools in Sweden and internationally, and subsequently to propose concrete solutions for how such zones can be implemented around four selected schools in Gothenburg. The case study is limited to a small number of schools with specific local conditions, which means that the results might not be applicable to all types of schools in Gothenburg. Four different types of schools have been selected based on urban context, the identified need for improved traffic safety, and the potential for increased active transportation. Two of these will be investigated in detail, including a comprehensive analysis and proposed design, while the other two are examined more briefly. This delimitation is intended to keep the project within the available time frame while still covering four different school contexts.

This study focuses on car-free zones in the immediate surroundings of schools. Broader perspectives, such as safe school routes covering larger areas, are not discussed in depth. The thesis primarily focuses on technical measures and on how the implementation stage of car-free zones can be carried out to achieve effective outcomes. Economic analyses and detailed cost estimations are outside the scope of this project.

Since this study will only propose measures, rather than implement them in practice, the focus is on technical solutions. Stakeholder groups such as the municipality, children, parents, school staff, and nearby residents are therefore not involved to the same extent as in a real-world implementation. Furthermore, behavioural campaigns to promote car-free zones and encourage a shift to active transport are not included.

2 Theoretical background

This chapter presents the theoretical background for the study. The concept of car-free zones around schools and school streets is introduced and relevant factors such as car dependency, children's travel behaviour, and traffic safety around schools are described. The chapter also briefly introduces common implementation methodologies and identifies knowledge gaps and research needs.

2.1 Car-free zones around schools and school streets

Car-free zones are a traffic management measure in which motorised traffic is prohibited or severely restricted within a defined area to prioritise pedestrians and cyclists. When a car-free zone is implemented around a school, it is commonly referred to as a "school street" (Köllinger, 2024). The first documented school street was implemented in Bolzano, Italy, as early as 1989, but the concept gained significant international attention only in recent years (Clarke, 2022). There are many different ways to design and implement car-free zones around schools. Restrictions on motorised traffic can be either permanent or temporary. A common solution is to apply time-restricted measures for approximately 30 minutes at the beginning and end of the school day, when traffic volumes are highest. Measures may also be physical, such as barriers or flower boxes, or regulatory, such as traffic signage and access restrictions (Köllinger, 2024).

The main objectives of implementing car-free zones around schools are to increase traffic safety for children, promote active transportation for health benefits, and improve environmental conditions in the surrounding area (Clarke, 2022). Reducing motorised vehicles in the area around schools aims to lower the risk of traffic-related accidents, improve local air quality, and reduce noise levels. In addition, safer and calmer streets aim to increase the attractiveness of active transportation, such as walking and cycling, thereby encouraging children's independent mobility and contributing to increased daily physical activity.

School streets are commonly implemented as pilot projects or trials before decisions are made about permanent implementation, modification, or removal of the measures (Clarke, 2022). This approach is straightforward, as measures can be implemented quickly and at relatively low cost. However, it also involves complex challenges. One major challenge is that many cities are car-dependent, so restricting private vehicles can generate opposition from affected residents and other local stakeholders. In addition, each school has unique local conditions and complexities to address, such as its location, the characteristics of the surrounding street network, traffic volumes, and existing travel patterns. Therefore, measures must be adapted to each specific context, making it difficult to develop a standardised framework applicable to all schools.

Although car-free zones around schools, often referred to as school streets, have received significant attention in recent years, the spread of the concept was limited for several decades after the first implementation (Clarke, 2022). By 2019, there were only examples of school streets in around eight countries. Interest in school streets then increased rapidly in response to COVID-19, and the number of school streets expanded significantly worldwide to over 1,250 documented implementations by 2022. This growth was also supported by EU-funded projects during the mid-2010s, through which experiences on sustainable school travel were exchanged and early examples,

such as Bolzano, were highlighted. Most school streets are located in Europe, but the concept has also been implemented in Canada, the United States, Australia, and New Zealand (Clarke, 2022).

Despite its relatively long history, the concept is still quite new in terms of formalisation, and the term “school streets” is used to describe a wide range of measures (Clarke, 2022). Although the concept is becoming increasingly formalised, there are still many definitions, and it varies across countries and contexts. For example, some definitions refer exclusively to school streets as a complete closure to vehicle traffic, whereas others include areas where vehicle traffic is restricted. Terminology also differs for essentially the same concept, especially across countries and languages—for example, “schoolstraat” in Belgium and the Netherlands, “strade car free” and “strade scholastiche” in Italy, “rues aux ecoles” in Paris, and “Safe Routes to School” in the United States. In Sweden, terms such as “bilfria zoner runt skolor”, “skolgator”, and “lekgator” are used (Stadsmiljöförvaltningen Göteborg Stad, 2025; Stockholms stad, 2025; Uppsala kommun, 2025). In this report, car-free zones and school streets are used to describe the same concept, while other terms can be used when referring to specific projects with different terminology.

For the purpose of this study, car-free zones around schools and school streets are defined as measures that prohibit or restrict motorised vehicle access in areas close to schools, with the aim of prioritising pedestrians and cyclists. A complete closure to motorised traffic is not required, as certain user groups, such as delivery vehicles, emergency services, local residents, and people with reduced mobility, may still need access. The definition adopted in this report therefore includes both absolute closures and restrictions on motorised traffic, implemented to improve traffic safety, promote active transportation, and enhance environmental conditions. These restrictions may be implemented as permanent or temporary measures, including time-restricted measures during specific periods of the day.

2.2 Car dependency

Road networks and urban planning have, for decades, primarily prioritised motorised vehicles (WHO, 2022). In 2022, the average number of passenger cars in Europe was 560 per 1,000 people, representing a 14.3% increase in car ownership between 2012 and 2022 (Eurostat, 2024). A key issue with high levels of motorised traffic is that road safety for pedestrians and cyclists remains a concern. Globally, roughly half of countries have national road-design standards that clearly separate motorised traffic from other active-transport users (WHO, 2022).

A complete shift away from a car-dependent system is complex, as it is shaped by political, economic, and cultural processes (Mouratidis, 2025). Car ownership offers advantages such as flexibility and comfort, which further reinforces the difficulty of shifting to other modes. Car-oriented planning also has important social and spatial consequences. Cities that prioritise car use often allocate large portions of public space to roads and parking, reducing access to shared and open spaces. Transport systems that depend heavily on private cars can also make it harder for people who cannot drive or afford a car to get around. This increases the risk of social exclusion and reinforces existing socioeconomic inequalities (Mouratidis, 2025).

Urban density is a key factor influencing the choice of travel mode. In denser urban

areas, car mode shares are generally lower because distances between origins and destinations are shorter and alternative modes are more viable (Ton et al., 2020). Berrill et al. (2024) found that lower urban density and greater distance from the city centre are associated with increased car travel. In an example from Paris, living one kilometre farther from the city centre increased daily car travel by approximately 0.52 kilometres (Berrill et al., 2024).

2.3 Children's travel behaviour and traffic safety around schools

Over the last century, road networks and urban planning have prioritised motorised vehicles, often at the expense of pedestrians and cyclists, which has contributed to traffic accidents (WHO, 2022). Globally, 26% of all road deaths are among pedestrians and cyclists, and road-traffic injuries are among the leading causes of death for children, often during school commuting hours (Clarke, 2022). This has contributed to growing parental concerns about traffic safety and consequently, many parents choose to drive their children to school rather than allowing independent walking or cycling.

According to the World Health Organization, 81% of children do not meet the recommended minimum of one hour of daily physical activity (WHO, 2022). Insufficient physical activity has been associated with declining rates of children choosing active travel to school. An article published in the *International Journal of Environmental Research and Public Health* compared active transportation to and from school among children and adolescents across 49 countries (González et al., 2020). The results showed a global average of 47–53% using active transport to school. Countries were further grouped by socioeconomic level using the Human Development Index (HDI), which is an index that ranks countries based on education, life expectancy, and gross national income per capita. The findings revealed that countries with higher HDI had lower active travel among children, whereas countries with lower HDI had higher active travel (González et al., 2020).

In lower-HDI countries, higher levels of active travel are likely due to limited access to motorised vehicles, reflecting necessity rather than choice. In contrast, some higher-HDI countries reported lower average levels of active travel, which has been associated with longer distances and more car-oriented infrastructure. The study also highlights some high-HDI countries with relatively high levels of active travel, achieved through school siting policies, compact urban design, and traffic calming measures (González et al., 2020). Countries with well-functioning public transport systems may also influence walking and cycling, as active travel can be part of a multimodal commute at the start or end of a trip (WHO, 2022).

In 2025, the City of Gothenburg (Sweden) conducted a study of how children travel to school, considering factors such as location, sex, and season (Göteborg Stad, 2025). The results showed that 47% used an active travel mode in summer, compared with 39% in winter. In a Nordic context, seasonal conditions are particularly relevant, as reduced daylight during winter creates low-light environments that can reduce the detectability of pedestrians and affect perceived and actual safety (Ghari et al., 2024). In the Gothenburg study, the most common factors influencing the choice of travel mode were that the distance to school was too long and that children had access to free public transport. Other factors included low motivation to walk or cycle, a perceived unsafe

route to school, and limited time in the mornings and afternoons.

Overall, children's travel behaviour to and from school depends on several factors and varies between countries. Key determinants of whether children walk or cycle to school include traffic safety, distance to school, socioeconomic conditions, and road network design. This indicates that increasing active school travel requires safe traffic conditions and supportive planning to enable walking and cycling.

2.4 Methodologies for implementing car-free zones around schools

Before implementing car-free zones around schools, the traffic situation in the surrounding area is assessed to identify the most suitable sites for implementation. Factors typically considered include traffic volume, vehicle speed, and perceived safety outside the school (Clarke, 2022).

In the early planning stage, stakeholders, including parents, children, and local authorities, are usually involved to increase acceptance and ensure that local needs are considered. Clear information about the plan and the rules for implementation is then communicated to ensure that everyone is informed (Clarke, 2022).

Following these steps, a pilot project is often implemented. During the pilot period, the implemented measures are evaluated over a defined time frame, and feedback and opinions are collected. Pilot projects are beneficial because they can be implemented quickly and at relatively low cost. However, in some countries, such as France, ambitious environmental and emissions targets have led to many car-free zones being implemented permanently from the outset (Clarke, 2022).

Various regulatory tools may be used, for example time-limited access during morning drop-off and afternoon pick-up periods, along with signs to reinforce the rules (London Borough of Hackney, 2018). Physical measures, such as barriers and vegetation, may be used to prevent cars from driving on the street (Department for Transport & Active Travel England, 2024). Cameras may also be used to allow access only for residents and authorised vehicles and to prohibit unauthorised vehicles from entering (London Borough of Hackney, 2022).

Once implemented, continuous monitoring and evaluation are essential. This includes assessing user behaviour, traffic safety, public perception, and effects on surrounding streets (London Borough of Hackney, 2022). If substantial problems arise, changes to the design or regulation may be required.

2.5 Knowledge gaps and research needs

Car-free zones around schools are increasing worldwide and are seen as a promising solution for improving traffic safety and promoting active transportation for children (Clarke, 2022). However, significant knowledge gaps remain regarding how these measures can be implemented systematically and effectively across different contexts. Existing studies mainly present case examples, but general and transferable implementation frameworks are lacking. Legal frameworks have been introduced in some countries at both national and local levels, for example, in Italy, the UK, Belgium, and Austria (Köllinger, 2024). In Sweden, local and national guidelines and legislation remain limited, and there is a lack of standardised solutions and guidance on these measures

in technical manuals (Tyréns, 2026). Furthermore, only a few car-free zones around schools have been implemented in Sweden, resulting in limited experience and few domestic examples.

The City of Gothenburg implemented its first car-free zone around a school as a pilot project in 2024 (Göteborg Stad, n.d.). The city aims to continue prioritising safe routes to school and to implement additional car-free zones, but the work is still in the start-up phase, and clear guidance on effective implementation is lacking. The lack of national guidelines and legislation, standardised solutions, and inclusion of these relatively simple and temporary measures in technical manuals has made implementation more difficult and is a central barrier to broader development (Tyréns, 2026). This situation highlights the need for increased knowledge on how car-free zones can be implemented around schools in Gothenburg across different urban contexts. Further studies are needed to develop strategies and identify which solutions are most effective in different urban and traffic contexts.

Furthermore, a wide range of traffic and simulation tools is available and commonly used in transport planning, including GIS-based models and traffic-simulation software (e.g., PTV Vissim, MATSim, and SUMO) (Ejercito et al., 2017; Wang & Zhang, 2024). However, based on the existing literature, their application in the planning and evaluation of car-free zones around schools appears to be limited. Most studies focus on observational data, surveys, and qualitative assessments, with little use of modelling or simulation tools to analyse traffic impacts and evaluate design scenarios. This indicates a research gap, as traffic simulation and modelling tools could support a more systematic approach to implementing car-free zones around schools.

3 Methods

In this chapter, the methods used in this project are described. Initially, a literature review was conducted to establish the theoretical background and to gain insight into previous implementations in other countries and cities. The literature review was supplemented by an interview with employees at the municipality of Uppsala. Next, case study areas were selected. A list of schools was provided by the City of Gothenburg where traffic problems have been experienced, and one additional school was included following the literature review. These schools were evaluated based on site characteristics and field visits. Two schools were selected for a deeper investigation and traffic simulation in PTV Vissim, while two schools were chosen for a briefer analysis. Two models were developed, one for each school, and simulations were conducted. Finally, the results were analysed and solutions for each school were proposed. A flow chart presenting the project methods is shown in Figure 3.1.

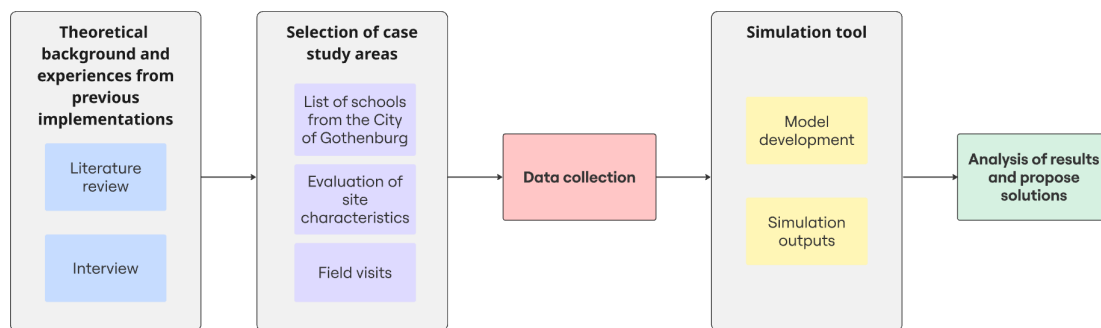


Figure 3.1: Flow chart presenting the project methods.

3.1 Literature review

A literature review was conducted in the initial stage of the project to develop knowledge and understanding of the subject and to examine previous implementations of car-free zones around schools in Sweden and other countries. The literature review formed the foundation for identifying implementation strategies, previously implemented measures and their effectiveness, and challenges and outcomes related to car-free zones around schools.

Three primary databases were used for the literature review: Google Scholar, ScienceDirect, and Chalmers Library. The search was conducted using keywords related to the topic, including “car-free zones”, “school streets”, “traffic safety”, “bilfria zoner runt skolor”, “active transportation”, and “car dependency”. In addition, relevant articles and studies were retrieved from citations in the selected articles.

Grey literature was also included, such as information from municipal websites describing their implementations of car-free zones and official documents from public authorities (e.g., the Urban Environment Administration in Gothenburg) that were not identified through the database search. Furthermore, some sources were identified with assistance from the project supervisors.

The sources included in the literature review are mainly up-to-date, with the majority published in the past few years. However, some older references are also included,

mainly describing the first implementations of school streets. The selected literature consists of a mixture of peer-reviewed scientific articles, information from municipalities' websites, and reports from public authorities. Additionally, one YouTube video published by the EU Urban Mobility Observatory, describing and showing the school streets in Bolzano, was included. This source was considered reliable due to the credibility of the publisher and because the information presented was supported by other sources.

3.2 Interview

A semi-structured group interview was conducted with three officials from the municipality of Uppsala. The participants were selected because they had all participated in the implementation and evaluation of school zones in Uppsala and therefore have substantial knowledge of the topic. The interview was conducted digitally on February 12, 2026, and lasted approximately one hour.

The interview followed a semi-structured format which means that the interview is characterised by neither being completely structured with only predetermined questions nor being an open conversation (Brinkmann & Kvale, 2015). Instead, it combines both approaches and allows for greater flexibility. The interview questions were prepared in advance, with the possibility of asking follow-up questions during the interview when clarification was needed or to gain deeper insights. The interview questions are presented in Appendix A.

In addition, short informal interviews were conducted during field visits and data collection, in which parents and school staff were asked how they perceived the traffic situation around the school. This was helpful for evaluating which schools should be included in the study and for gathering valuable information about current problems, which was later used to identify solutions tailored to the specific concerns of each school.

3.3 Site characterisation and case study selection

The primary case study areas were identified in collaboration with the City of Gothenburg, which suggested eight schools where traffic problems have been reported. In addition, one extra school was identified through a municipal report from Gothenburg presenting travel statistics. The report indicated that approximately one third of students are driven to school by car, despite 90% living within two kilometres from the school (Centerpartiet, 2025). Therefore, this school was included in the selection because a high share of students being driven to school may indicate traffic problems and, since most students live close to the school, there is substantial potential to shift to active transport. This makes the site particularly relevant for analysing the potential implementation of a school street or car-free zone.

Each school was evaluated in terms of location, total number of pupils, and the current traffic situation. The selection of case study areas was based on a structured assessment of several traffic-related factors. Using Google Maps and publicly available geospatial data, existing traffic conditions were examined, including speed calming interventions, speed limits outside the school, and pedestrian visibility near the school.

In addition, the surrounding street environment was analysed, including the presence of bicycle lanes and pedestrian crossings, proximity to public transport, and availability of

parking. All of these parameters were considered essential for understanding mobility patterns and potential safety challenges at each school.

After a thorough review of the schools and field visits, several schools were excluded as they were considered not feasible for this study. Following this systematic exclusion, four schools were selected for this project, and additional field visits were conducted to verify that site conditions were suitable for investigation and potential improvement.

The final schools chosen were Kungsladugårdsskolan, Brunnsboskolan, Långmosseskolan, and Brottkärrsskolan, representing four types of school contexts:

- A centrally located inner-city school (Kungsladugårdsskolan).
- A school situated in a more peripheral residential area outside the city centre (Brunnsboskolan).
- A school served by a single road with a dead end (Långmosseskolan).
- A school surrounded by two main roads, representing a context where a car-free zone might not be suitable (Brottkärrsskolan).

This variation in spatial and traffic contexts enables a comparative analysis of how the implementation of school streets and other traffic safety measures may differ. The study will investigate two schools, Kungsladugårdsskolan and Brunnsboskolan, in greater detail, including a more comprehensive analysis and traffic simulation. These schools were chosen for deeper analysis because they represent more complex traffic environments, where the proposed measures were expected to influence the surrounding traffic network to a greater extent. The two remaining schools will be analysed more briefly. This approach allows the study to represent four different types of schools while remaining within the project's time frame.

3.4 Data collection

Field visits were conducted around the schools to observe traffic flows, behaviours, and how people moved during the morning peak hour. The results from the data collection were used as inputs to the traffic simulation tool. Observed behaviours were also used to identify current problems and to represent the existing situation in the simulation model as accurately as possible. The school day started at 08:00 for both schools, so data collection was conducted between 07:30 and 08:10.

Data collection for Kungsladugårdsskolan was conducted on March 3. Traffic was observed at three locations, shown in Figure 3.2 below, to obtain a clear understanding of traffic movements during the morning peak hour. A camera was also used to observe vehicles on Lilla Fridhemsgatan and Godhemsgatan. Each observer used a manual tally counter to record traffic. Observations included the total number of vehicles, travel direction, and behaviours such as parking, drop-off, and turning manoeuvres. The specific attributes recorded varied by location depending on local conditions. For example, at site 3, the number of vehicles using the turning area was counted. The results and the attributes recorded at each location are presented in Appendix B.



Figure 3.2: Overview map of the locations for the data collection around Kungsladugårdsskolan. Modified based on map data from OpenStreetMap (n.d.).

Data collection for Brunnsboskolan was conducted on February 24. Traffic flow was counted at two locations, shown in Figure 3.3 below. At location 1, the observer counted traffic along Klassikergatan and also observed the traffic on Skaldegatan, the number of vehicles continuing on the road on the west side of the school towards the turning area, and any conflicts between pedestrians and vehicles at the crossings of Klassikergatan and Rimsmedsgatan. At location 2, the observer counted the total number of vehicles on Monologgatan and recorded pedestrian-vehicle conflicts, as well as traffic conditions and behaviours on Författaregatan.

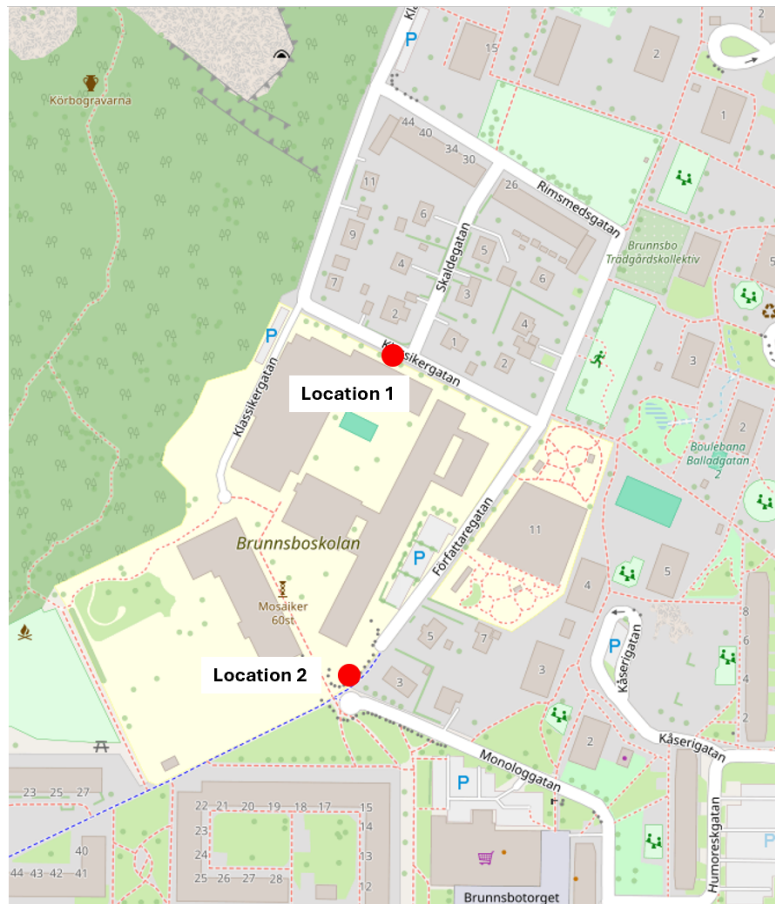


Figure 3.3: Overview map of the locations for the data collection around Brunnsvskolan. Modified based on map data from OpenStreetMap (n.d.).

3.5 Simulation tool

Traffic simulations for the two study areas were conducted using the multimodal traffic simulation software PTV Vissim (version 2026). PTV Vissim is a microscopic simulation software developed for modelling multimodal traffic operations (PTV Group, 2025). The program is behaviour-based and can simulate vehicle traffic, rail- and road-based public transport, cyclists, and pedestrians.

The first step was to develop a model for each school by setting up the school and its surrounding traffic network in the program. After the models were completed, the current situation and proposed solutions for implementing car-free zones around the schools were simulated and evaluated in terms of queue delay, travel time, and level of service on different links to determine the suitability of the proposed implementations.

3.5.1 Model development

Two models were developed, one for Kungsladugårdsskolan and one for Brunnsvskolan, using the same procedure in PTV Vissim. A Bing Maps basemap was used as a background image when drawing the traffic network. The model development was carried out in eight steps, as visualised in the flow chart in Figure 3.4 below.

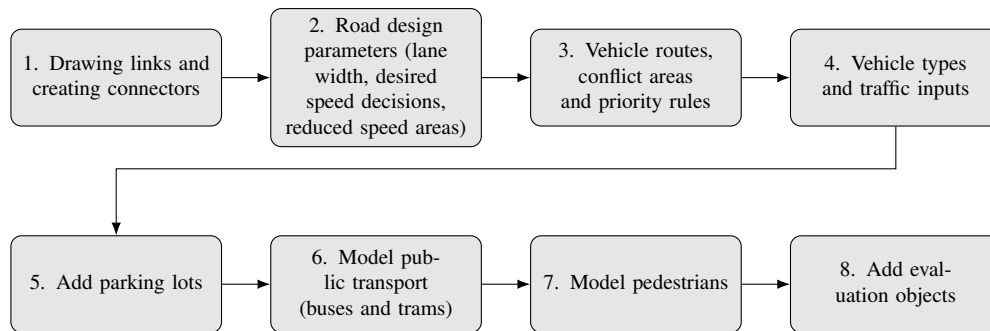


Figure 3.4: Flowchart showing the model development steps in PTV Vissim.

Step 1

In the first step, the road network was created by drawing links for each road with the correct number of lanes. Connectors were then added to connect all links where vehicle movements were possible. This included connections between different segments of a road (e.g., where the number of lanes changes) and turning movements at intersections. For some residential streets around the two schools, traffic is allowed in both directions. However, in practice there is only space for one vehicle at a time due to on-street parking. This could not be represented directly in PTV Vissim, as links cannot carry traffic in both directions. In these cases, one lane was drawn in each direction, but lane widths were reduced and parking lots were added along the street to approximate real-world conditions.

Step 2

In the second step, road design parameters were added for each link. Road widths were measured in AutoCAD and then assigned to each link in PTV Vissim. Desired speed decisions were added on links where the speed limit changed, for example when entering a residential area with a recommended speed of 30 km/h. Reduced speed areas were added in turns, intersections, speed humps, roundabouts, and turning areas where operating speeds were expected to be lower than the posted speed limit. Pavement markings for speed limits and speed humps were drawn.

Step 3

The third step of the model setup was to add vehicle routes, conflict areas, and priority rules. Vehicle routes were added in each intersection for all possible movements. If no vehicle route is defined, vehicles automatically choose the first available connector. For each vehicle route decision, the share of vehicles turning in each direction was specified. For roads where observed counts were not available, turning shares were estimated based on assumptions and the capacity of each road (e.g., higher flows were assumed on larger roads, with smaller shares turning into minor streets). Pavement markings for turning were drawn. Conflict areas and priority rules were added to define right-of-way at intersections. Field visits and Google Street View were used to verify priority rules in the study areas.

Step 4

In the fourth step, vehicle types and traffic inputs were included in the model. The predefined vehicle type settings were used for cars, light and heavy vehicles, buses, trams, cyclists, and pedestrians. The share of heavy vehicles was reduced, and permitted vehicle types were adjusted for some links (e.g., bicycle lanes and bus lanes). Bus lanes were marked with pavement markings. Traffic inputs were based on the observed peak 10-minute period during the morning peak hour, so that the simulation represented the highest-demand scenario and the greatest risk of traffic problems.

Step 5

In the next step, parking lots and parking lot areas were inserted in the models. For on-street parking, the parking lot tool was used, and a parking time distribution was added as an input. A shorter time distribution was chosen for spots where most vehicles were assumed to drop off passengers or park for a short time (e.g., to accompany a child into the school), while a longer time distribution was used for more long-term parking. A parking routing decision was also added to allow vehicles to use the parking areas, and the share of vehicles choosing to park was specified as an input. For larger parking areas, the parking lot area tool was used, which allowed many spaces to be added efficiently and enabled additional settings. Time distributions and parking routing decisions were also defined for these areas.

Step 6

The sixth step involved modelling public transport. First, public transport lines were added along the links where buses and trams operate. In some cases, links were shared between general traffic and public transport, while other links were blocked for all vehicle types except trams or buses. Departure times and frequencies were defined for each line according to the actual timetables. Public transport stops were added at their real locations and the length of the trams, along with the number of passengers boarding and alighting at each stop.

Step 7

Next, pedestrians were included in the model. Pedestrian areas were created and connected with links between the areas. For each link, the setting was changed to “is pedestrian area” to allow pedestrians to use the link. Pedestrian demand was implemented by defining pedestrian inputs for each area, and pedestrian routes were then created to represent where pedestrians could walk. The routes mainly originated in pedestrian areas near residential buildings and public transport stops and ended in areas within the school yard. Conflict areas were used at pedestrian crossings and at locations where pedestrians were frequently observed crossing the street to define priority rules between vehicles and pedestrians. Conflict areas were defined such that pedestrians had the right of way at marked pedestrian crossings, while vehicles had priority at unmarked crossings. Pavement markings were added at marked pedestrian crossings.

Step 8

In the final step before running the simulation, evaluation objects were added to measure queue delay, travel time, number of vehicles, and similar parameters. This was accomplished by placing evaluation objects on selected road links and configuring the appropriate parameters in the evaluation settings.

The evaluation objects included data collection points and vehicle travel time measurements. By analysing the results obtained from these points over the selected time period, vehicle inputs and routing were adjusted to better match the traffic conditions observed during the field study.

The placement of the evaluation objects is shown in Figure 3.5 for Kungsladugårdsskolan and in Figure 3.6 for Brunnsboskolan.

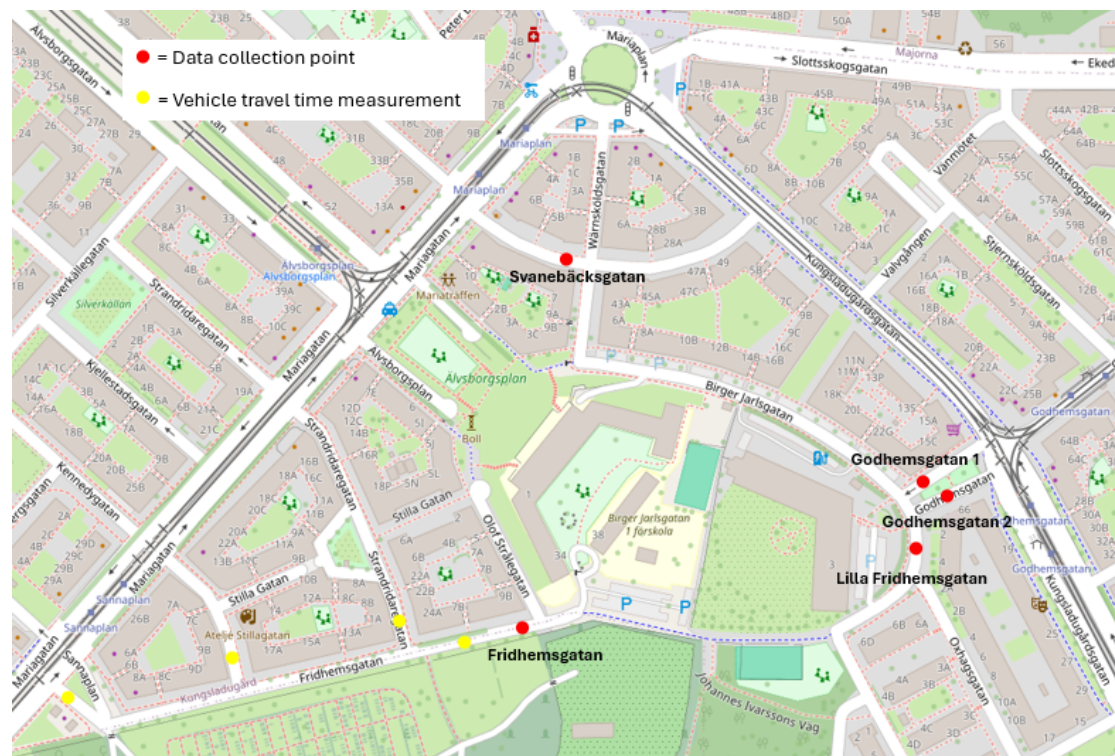


Figure 3.5: Overview map of the location of the evaluation objects around Kungsladugårdsskolan. Modified based on map data from OpenStreetMap (n.d.).



Figure 3.6: Overview map of the location of the evaluation objects around Brunnsboskolan. Modified based on map data from OpenStreetMap (n.d.).

3.5.2 Simulation settings and outputs

The simulation was run for 40 minutes to ensure a stable system and reliable results. However, the results analysed in this report are based on the 10-minute peak period between minutes 20 and 30 of the simulation. This approach was used to minimise the influence of the first and last ten minutes, during which the system may not have reached a steady state and errors may occur at the start and end of the simulation.

The vehicle inputs used for the full 40-minute simulation were based on the observed peak 10-minute period, since traffic conditions around schools are typically worst during the short period immediately before school starts. Although these inputs represent 10-minute peak conditions, they were applied throughout the entire simulation to represent a worst-case scenario and to allow the system time to stabilise.

Three scenarios were evaluated in the simulation with the model adjusted between the scenarios to correspond to the new traffic conditions. For example, the car-free zone

and other measures were added in scenarios 2 and 3, and vehicle routes were modified to better represent each scenario.

For the analysis, queue delay, travel time, and level of service were used as outputs. The equations used to calculate travel time and queue delay in PTV Vissim are presented in Section 3.5.3. Level of service criteria from the Highway Capacity Manual were used as reference values (Transportation Research Board, 2010). These values are shown in Table 3.1 below.

Table 3.1: Level of service criteria from the Highway Capacity Manual (Transportation Research Board, 2010).

Level of service	Queue delay [s/veh]
A	0–10
B	>10–15
C	>15–25
D	>25–35
E	>35–50
F	>50

3.5.3 Calculation of travel time and queue delay in PTV Vissim

In PTV Vissim, the travel time is defined as the time required for a vehicle to travel a specified section. It is calculated as

$$TT = t_{\text{exit}} - t_{\text{entry}}, \quad (3.1)$$

where t_{entry} is the time when the vehicle enters the section and t_{exit} is the time when it leaves the section (PTV Group, 2022).

Delay is defined as the difference between the actual travel time and the ideal travel time, i.e.

$$D = TT - TT_{\text{ideal}}, \quad (3.2)$$

where TT_{ideal} represents the travel time under ideal conditions without interactions with other vehicles.

Queue delay is defined as the time during which a vehicle is part of a queue. In this study, a vehicle is considered to be in a queue when its speed falls below 5 km/h and the queue ends when its speed exceeds 10 km/h again. The queue delay can therefore be expressed as

$$QD = \sum \Delta t, \quad (3.3)$$

where Δt represents the time steps during which the vehicle is in a queue.

4 Experiences of car-free zones around schools

A considerable proportion of child injuries occur in areas surrounding schools, which has led to child safety becoming a central concern for transport and public health authorities in many countries (Distefano et al., 2025). Implementing car-free zones around schools can reduce the risk of road traffic injuries while also contributing to improved health outcomes by limiting children's exposure to traffic-related air pollution. School street schemes have been implemented and evaluated in several countries and cities using a range of governance and enforcement models. These different approaches are examined in this chapter.

4.1 International experiences

This section describes how car-free zones around schools have been implemented in Italy, Belgium, the United Kingdom, and France. Examples of implementation strategies, positive outcomes, and challenges are shown.

4.1.1 Italy

Italy was the first country to introduce school streets, with the first schemes implemented in Bolzano as early as 1989 (Clarke, 2022). In 2012, the concept was introduced in Milan and subsequently spread to many cities across Italy.

Since 2020, the concept of school zones, including school streets, has been included in the Italian Highway Code (Distefano et al., 2025). These zones are defined as protected areas where pedestrians and the environment receive special protection. The legislation covers different types of implementation and includes initial attempts to map school zones.

In Italy, a range of solutions have been used to implement school streets. For example, in Rome there is a mix of temporary and permanent traffic closures, as well as a mix of full street closures and partially pedestrianised streets (Roma Servizi per la Mobilità, 2025).

In Bolzano, school streets follow the principle of temporarily closing streets to vehicles for 30 minutes at the start and end of the school day, supported by police and school guides (EU Urban Mobility Observatory, 2014). Although the concept is now considered successful, it initially faced substantial complaints from parents, teachers, and residents. In 2014, 80% of children in the city walked, cycled, or used the bus to travel to school, with walking accounting for 45%. By 2014, the number of accidents had halved, indicating that traffic safety for children improved significantly following the implementation of school streets.

In Catania, Sicily, two school streets were implemented in 2021 and 2022 and later evaluated to identify factors influencing success and barriers to implementation (Distefano et al., 2025). Both schools are located near a main commercial street with well-developed public transport. For the first school, the closest metro station is within a short distance, while the distance is somewhat longer for the second school. For both schools, the initial plan was to permanently close the street outside the school. This worked well for the first school, where the closed street was enhanced with flower boxes, tree planting, benches, and painted paths and games in front of the school build-

ing. The closure was also well received by residents, who could use the pedestrianised street when walking to and from the metro station.

Initially, all traffic outside the second school was prohibited, except for residents (Distefano et al., 2025). However, the scheme was not well received by local residents and, after numerous requests, the closure was reduced to half of the roadway, allowing vehicles to use the other half. No physical delimiters (e.g., flower boxes, trees, or benches) were installed, meaning there were no clear physical elements defining the school street. As a result, the intervention did not achieve adequate comfort or traffic safety, and the implementation objectives were not met.

The main lessons from this evaluation are that successful implementation of a school street requires consideration of multiple factors, including structural, relational, educational, and institutional conditions (Distefano et al., 2025). It is essential that measures are supported by residents and that implementation is based on collaboration between local municipalities, schools, and parents for the school street to be perceived as a positive intervention. Success does not depend on a single technical or functional factor; rather, it represents a complex challenge. Traffic closures should be combined with physical interventions such as delimiters, flower boxes, trees, and benches to achieve real impact and ensure compliance with vehicle restrictions (Distefano et al., 2025).

4.1.2 Belgium

The first school streets outside Italy were introduced in Ghent, Belgium, in 2012 (Sherekar, 2025). By the end of 2024, twelve school streets were in use across the city. The City of Ghent has worked with three different approaches. The most common approach is temporary street closures for cars, where a road is closed to vehicle traffic for 30 minutes twice a day at the start and end of the school day. This is managed by volunteers who place barriers (e.g., turning fences, trestles, and scissor gates) during closure periods and monitor traffic conditions. A drawback of this approach is that it depends on volunteers, and volunteer shortages are a recurring challenge (Sherekar, 2025).

The other two approaches are permanent street closures to car traffic or volunteer-based traffic management without a formal vehicle closure (Sherekar, 2025). Permanent closures have a larger impact on traffic patterns in the area and therefore require more planning, more comprehensive measures, and larger investments at the implementation stage. Volunteer-based traffic management without restrictions has a smaller effect on traffic safety than the other options, but it is easier to implement. However, it also depends on having enough volunteers. Overall, the City of Ghent has reported positive outcomes from school streets, particularly when combined with new bicycle lanes and bicycle streets. Approval ratings have increased over time, and active mobility is now the preferred mode for daily school trips (Sherekar, 2025).

School streets have also expanded across Belgium, with 171 registered school streets by early 2022 (Clarke, 2022). Since 2018, school streets have been formally included in the highway code, with regulations such as standard signage and implementation guidance.

In 2020, an evaluation of school streets implemented around primary schools in Flanders (February 2019 to April 2020) was conducted (Den Hond et al., 2020). The evaluation was based on seven parameters, namely mobility, air quality, noise, health, physical activity, perception, and well-being, and resulted in policy recommendations for upcom-

ing school street projects (De Ridder et al., 2020). The study showed positive effects on perceived traffic safety and air quality, mainly during periods when the road was closed. It therefore recommended longer closure periods, rather than restricting traffic only during drop-off and pick-up times. To achieve the best long-term outcomes, the evaluation also recommended making school streets as permanent as possible, rather than relying on temporary solutions. Where feasible, it also suggested expanding the geographic scope of the intervention to include more streets in the area, since traffic safety and environmental impacts are not limited to the streets closest to the school. The evaluation found that school streets have contributed to more sustainable and active mode choices for school trips (Den Hond et al., 2020).

4.1.3 United Kingdom

In the United Kingdom, the first school street was introduced in East Lothian, Scotland, in 2012 (Clarke, 2022). Since then, the number of school streets has expanded to more than 800, with London currently having the highest number. From 2019, London experienced a significant expansion from around 80 to more than 500 school streets by 2021, partly due to the pandemic. Reducing air pollution is a high priority for the Mayor of London, and school streets have been incorporated as a policy tool to improve the local environment and promote active travel (Greater London Authority, 2023).

A study compared NO₂ concentrations on school streets with time-limited vehicle restrictions with concentrations on a street with unrestricted vehicle access during the morning drop-off period in London. The results showed a 23% reduction in NO₂ on school streets, highlighting the effectiveness of time-limited traffic restrictions (Greater London Authority, 2021).

In the United Kingdom, experimental traffic regulation orders (ETROs) can be put in place to test schemes that can later be made permanent (Department for Transport & Active Travel England, 2024). Advantages of this approach include flexibility and adaptability, as well as opportunities for public engagement.

One London borough with a well-developed network of school streets is Hackney. Hackney provides an online map of all school streets in the area, including filters such as whether an area is a low-traffic neighbourhood (London Borough of Hackney, 2025). Sir Thomas Abney Primary School is located in a high-traffic neighbourhood. Its school street uses time-limited restrictions during drop-off and pick-up and is enforced through street signs preventing unauthorised motorised traffic, as well as number plate recognition cameras covering entrances and exits (London Borough of Hackney, 2022). This enforcement reduced traffic by up to 70% and had strong support from the school. However, cameras were often vandalised, which reduced compliance and trust in the enforcement. Another drawback was a slight increase in traffic on surrounding streets.

St John the Baptist School is located on Crondall Street in a low-traffic neighbourhood (London Borough of Hackney, 2018). The trial was launched in 2017 and used time-limited restrictions, with enforcement through signage and camera surveillance during restricted periods in the morning and afternoon drop-off and pick-up times. Monitoring during the trial showed that traffic decreased by 32%. A survey conducted during the experiment found that 80% of the respondents were in favour of the implementation, and road safety outside the school also improved. Overall, both school streets showed improvements in safety and reductions in traffic.

Other implementation approaches used in London include physical barriers combined with volunteer or steward supervision (Department for Transport & Active Travel England, 2024). This model is typically applied as a temporary or pilot solution and relies on volunteers to deploy barriers and manage access during restricted periods. Although barrier schemes are comparatively low-cost and flexible, their effectiveness depends on the availability and reliability of volunteers.

4.1.4 France

France has committed to becoming climate neutral by 2050, and the implementation of school streets supports this goal (European Parliamentary Research Service (EPRS), 2024). France is one of the leading countries in Europe in implementing the school street concept, with schemes in several cities (Clarke, 2022). Most of the implementations have taken place in Paris through the programme “rues aux écoles” (streets for schools). The aim of this initiative is to improve child safety, reduce air pollution, and promote active travel. Unlike in many countries where school streets are first introduced as temporary pilot projects, many schemes in Paris are permanent from the outset (Alkawas et al., 2024).

Paris has set a target to transform 300 school-adjacent streets by 2026, of which 100 are planned to be fully pedestrianised (Manhattan, 2024). The remaining streets involve varying degrees of traffic restriction and traffic calming measures. Key implementation measures include physically closing streets using barriers, as well as redesigning street layouts through surface modifications. These modifications include adding paving or stone treatments at street entrances and removing parking spaces, replacing them with benches, bicycle stands, and vegetation (Manhattan, 2024).

Examples of streets transformed through the “rues aux écoles” programme include Rue Eble, Rue de la Providence, and Rue Ferdinand-Flocon (Ville de Paris, 2025). Before-and-after illustrations provide insight into how conventional streets have been redesigned into school-focused environments. Common improvements include the removal of on-street parking and the reallocation of space to benches, vegetation, and pedestrian areas.

Overall, France illustrates that successful implementation of school streets relies on clear long-term goals and a combination of regulatory and physical measures. Paris has made several interventions permanent from the start, rather than primarily relying on pilot projects, which further reflects the city’s ambition to support climate-neutral development (Clarke, 2022). The transformations around schools have been supported by measures such as barriers, signage, the removal of parking spaces, and the addition of seating and vegetation.

4.2 Experiences in Sweden

There are also some examples of car-free zones implemented around schools in Sweden. This section describes Swedish examples and summarises lessons learned from the projects. In addition, three employees from the municipality of Uppsala were interviewed about their experiences with implementing car-free zones, and their responses are presented in the subsection on Uppsala.

4.2.1 Stockholm

The City of Stockholm implemented a temporary scheme of “lekgtator” (play streets), i.e., car-free zones around three different schools: Björngårdsskolan, Norra Ängby school, and the preschools Lofoten and Regnbågen (Stockholms stad, 2025). The criteria used to select these streets were:

- The street needed to have a speed limit lower than 50 km/h.
- The street could not be served by public transport.
- The school needed to have an entrance on the street.
- The street could not have a load-bearing delivery function.
- The street had to be public.
- The school had to have less than 20 m² of open space per student.
- The number of students at the school had to be more than 200.
- There should be no loading bay or garage along the relevant section.

The results indicated that the measures contributed to a safer and calmer environment for the children (Stockholms stad, 2025). However, of the three trial play streets, only Björngårdsskolan was made permanent. The implementation around Norra Ängby school received mixed responses from parents and local residents (Gustafsson, 2024). There were several instances of non-compliance with the street closures, which reduced the effectiveness of the implementation. School staff reported periods of traffic chaos, as parents who previously used the closed street instead drove via a nearby backstreet. This led to increased congestion and higher driving speeds, creating new traffic-safety risks (Gustafsson, 2024).

Stockholm also ran a trial in 2020 in which it implemented “framtidsgator” as an experiment to improve streets. This temporary solution selected streets that were less than 100 metres from schools and temporarily closed them to give children a place to play (Spacescape AB, 2022). Reflections and lessons learned from this trial showed that “framtidsgator” can make streets more active, but clear communication and early involvement of residents are important to limit conflicts and address safety concerns.

A study performed by the Origo Group examined local residents’ perceptions of the implementation and potential improvements. It showed that approximately 60% perceived the street as safe, but that it could still feel too close to vehicles (Origo Group, 2023).

4.2.2 Huddinge

In 2022, a new school was developed in Huddinge, and it was decided that it should be a car-free school (Huddinge Samhällsfastigheter, 2024). The school, Långsjöskolan, is designed for around 360 children, from preschool to third grade. The car-free zone includes a drop-off and pick-up parking area a few hundred metres from the school to reduce the number of cars close to the school. It also includes improved walking and cycling infrastructure, especially between the new parking area and the school, and traffic regulations on nearby streets to prevent drop-off and pick-up on these streets (Huddinge kommun, 2017). The plan for the car-free zone is that parents should use the newly developed parking area either for drop-off and pick-up, or to park and accompany their children to school, so that no additional traffic is added to the existing residential area as a result of the school development. The nearby streets Morkullevägen, Lövsångarvägen, and Ålyckevägen are regulated with a prohibition of stopping and parking between 07:00–09:00 and 15:00–17:00 on weekdays. This still allows residents in the area to drive to their home, but prohibits parents from stopping to drop off or pick up their children, or parking to accompany them to school (Huddinge kommun, 2024a, 2024b). Rödhakevägen is regulated by a prohibition of through traffic (Huddinge kommun, 2022). The new traffic situation is shown in Figure 4.1 below.

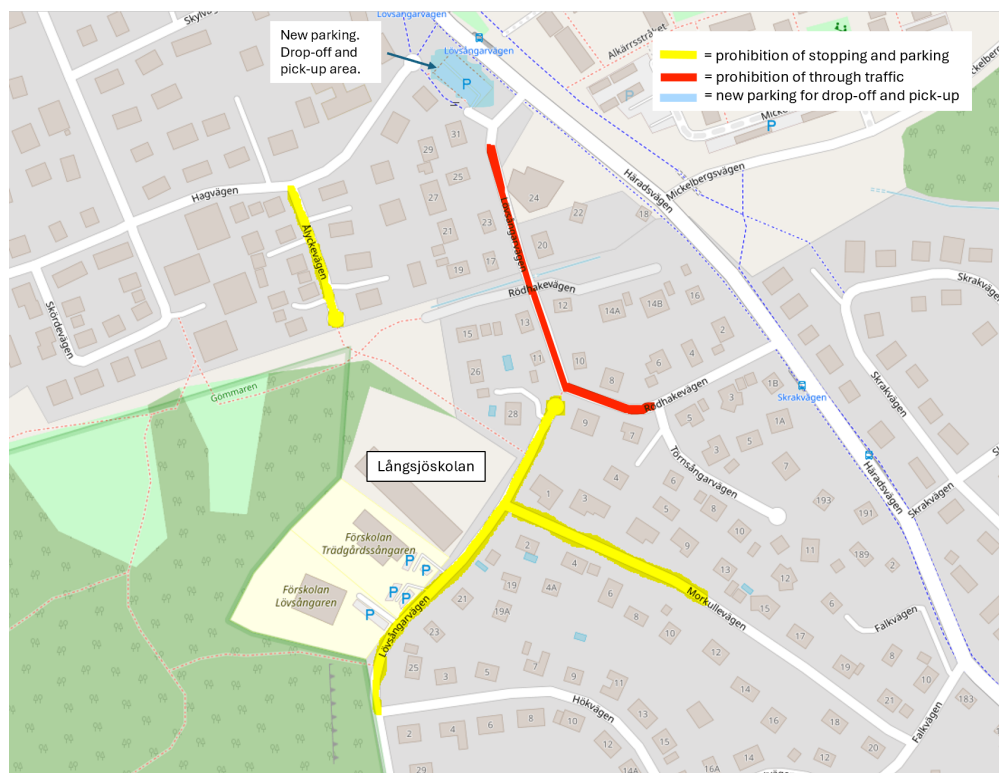


Figure 4.1: New traffic solution after implementation of a car-free zone around Långsjöskolan. Modified based on map data from OpenStreetMap (n.d.).

However, the new traffic situation has received substantial criticism from parents, local residents, and staff at nearby preschools (Holmström, 2024; Krook, 2024). Traffic volumes in the surrounding residential areas have increased significantly, as many parents do not use the designated drop-off and pick-up area but instead drive on the nearby streets to drop off and pick up children closer to the school, despite traffic restrictions

that are often not respected. This has created a less safe traffic environment and traffic chaos during peak hours, with higher traffic volumes than the streets were designed for. Reported issues include congestion, cars driving well above the speed limit, and vehicles frequently stopping, turning around, and reversing in inappropriate places, including near preschools and wherever space is available. In addition, cars drive onto sidewalks and block driveways and loading areas at the school (Krook, 2024).

4.2.3 Uppsala

The City of Uppsala launched its first three school zone projects in 2025 with the aims of improving children's traffic safety and promoting sustainable transport (Uppsala kommun, 2025). The main goal is to implement zones around schools that are entirely car-free. However, this is not possible everywhere and in such cases, car traffic should instead be reduced as much as possible. Three different types of schools were selected as pilot projects: one rural school, one urban school, and one school in a newly developed area. These schools were chosen because travel behaviour surveys showed potential for improvement, concerns were expressed about traffic safety, and there was engagement from parents and the school (Officials at Uppsala municipality, personal communication, February 12, 2026).

School staff, children, and parents have been involved in developing the school zones through child dialogues and surveys (Uppsala kommun, 2025). To promote sustainable transport, these groups will also be offered campaigns and trial activities after implementation.

Funbo skola is the rural school chosen for the school zone project (Uppsala kommun, 2025). Most children live too far from the school to walk or cycle, and the majority are entitled to school transport. However, only approximately 50% use school transport, and many are instead driven to school by their parents, which creates traffic problems during drop-off and pick-up hours (Officials at Uppsala municipality, personal communication, February 12, 2026). A challenge for this school is that the municipality does not own the roads in the area. Instead, most roads are state-owned, and one road is privately owned with several individual property owners. In collaboration with the individual property owners, a car-free zone has been implemented on the private road between Funbo Church and the school, with exceptions for deliveries and a few residents in the area. In addition to signage, school staff place and remove temporary barriers during the morning peak hour to further strengthen the vehicle restriction. Other implemented measures include improvements to the bus stop to create a more pleasant environment, improved lighting between the bus stop and the school, pavement markings to guide pedestrians and cyclists, flower boxes, improved bicycle parking facilities, and school staff who accompany children to and from the bus stop (Uppsala kommun, 2025). Campaigns such as information about bus routes and timetables, guidance on how to behave on the bus, and a "Walk and Cycle to School" campaign targeting children have also been introduced. Other campaigns include an offer for parents to receive a free bus card for 30 days, a nudge platform with guidance on sustainable transport to school, and the opportunity to book bicycles to work with traffic safety in theory and practice (Uppsala kommun, 2025).

The school street was evaluated after implementation through parent surveys, dialogues with children, and surveys focusing on the perceived effect of each individual measure (Officials at Uppsala municipality, personal communication, February 12, 2026). Using

a hand-raising survey, the share of children using active transport to school increased by approximately 10 % compared to the previous year in Funbo. The results were largely positive, with many younger children appreciating the painted footsteps indicating where to walk, as well as the upgrade of the bus stop near the school. However, an unintended consequence of the bus stop improvement was that significantly more children began using the bus, which led to overcrowding and other potential safety concerns. Uppsala identified this as an area for further development and noted that it could be improved through better collaboration with the education administration. Overall, the safety of the school street in Funbo was perceived as improved compared to previous years.

The second school is Rosendals skola (Uppsala kommun, 2025). In this case, a completely car-free zone was not considered suitable, since the school is located along a transport route and investigations showed that closing the street to all vehicle traffic could lead to a less safe traffic situation. The consequence of closing that street is traffic displacement to nearby streets with mixed traffic conditions and less developed walking and cycling infrastructure, which are also used by many children on their way to school (Officials at Uppsala municipality, personal communication, February 12, 2026). Instead, other measures were implemented to reduce vehicle speeds and improve traffic safety. Examples include raised pedestrian crossings, flower boxes and pavement markings to inform about entry into a school zone, painted footsteps to guide children to and from the bus, improved lighting, and improved connections between existing walking and cycling paths and the school's bicycle parking (Uppsala kommun, 2025). In addition, new drop-off and pick-up parking areas a short distance from the school were created and clearly marked with signage to reduce traffic in front of the school. Similar to Funbo skola, campaigns targeting children and parents have also been introduced, including the "Walk and Cycle to School" campaign and an offer for parents to receive a free bus card for 30 days (Uppsala kommun, 2025).

Rosendals skola is located in an area where residents generally prefer to limit car traffic, and the implementation was therefore largely received positively. The evaluation was conducted through dialogue sessions with the children, a survey assessing children's opinions on each individual measure, and a parent survey (Officials at Uppsala municipality, personal communication, February 12, 2026). Many children appreciated the physical measures, such as the flower boxes, while older pupils highlighted improvements to the pick-up and drop-off zones. The overall traffic safety in the area improved. However, a credible evaluation and comparison of any increase in the share of children using active transport could not be conducted, as the previous year's survey was distributed to only one class.

The implementation of a school zone around Domarringen skola has been delayed due to other construction projects, but it is expected to be implemented in the autumn 2026 (Uppsala kommun, 2025).

The City of Uppsala has not used simulation or modelling tools to implement school zones (Officials at Uppsala municipality, personal communication, February 12, 2026). Instead, qualitative analyses have been conducted. However, such tools are considered to have the potential to be useful for schools with higher traffic flows or in the early stages of developing new schools. Simulating different scenarios in the planning stage can help identify potential weaknesses or problems, allowing planners to adjust and

improve designs before construction begins. Other lessons from the projects include that collaboration between many different departments, as well as the school, parents, and children, is necessary, and that a municipal network for knowledge sharing would be useful, especially since clear guidelines are lacking and measures need to be adapted to different contexts.

4.2.4 Göteborg

In August 2024, the first car-free zone around a school was implemented at Ånässkolan as a pilot project (Ljungblad & Rosendahl, 2025). The project was initiated because the city's Urban Environment Administration had been tasked with prioritising safe school routes for children and implementing car-free zones around schools where the environment is not perceived as safe. This was part of fulfilling the United Nations Convention on the Rights of the Child, which has been law in Sweden since 2020.

Ånässkolan was selected as a pilot project because the environment around the school was not perceived as safe and was therefore considered to have the potential to improve traffic safety through a car-free zone and to influence children's travel behaviour to and from school (Stadsmiljöförvaltningen Göteborg Stad, 2025). Different solutions were investigated, including two different extents of a car-free zone. A larger car-free zone, including streets in all directions of the school, was considered best for improving children's traffic safety and promoting active transport, but it was also considered to have a too large impact on residents in the area. Instead, a smaller car-free zone was implemented in front of the school. This solution ensured that residents in the surrounding area were not excessively affected and that essential vehicles, such as goods deliveries, waste collection, and assisted transport for people with reduced mobility, could still access the school via Falkgatan.

The car-free zone was furnished with seating and plants to promote the new vehicle restrictions and create a safe and pleasant environment (Stadsmiljöförvaltningen Göteborg Stad, 2025). Another measure implemented was that the southern part of Övre Ol-skroksgatan was converted into a one-way street allowing southbound traffic. Cycling is still permitted in both directions. Two new pedestrian passages were also implemented close to the school to create a safer route. The new traffic solution is visualised in Figure 4.2 below.

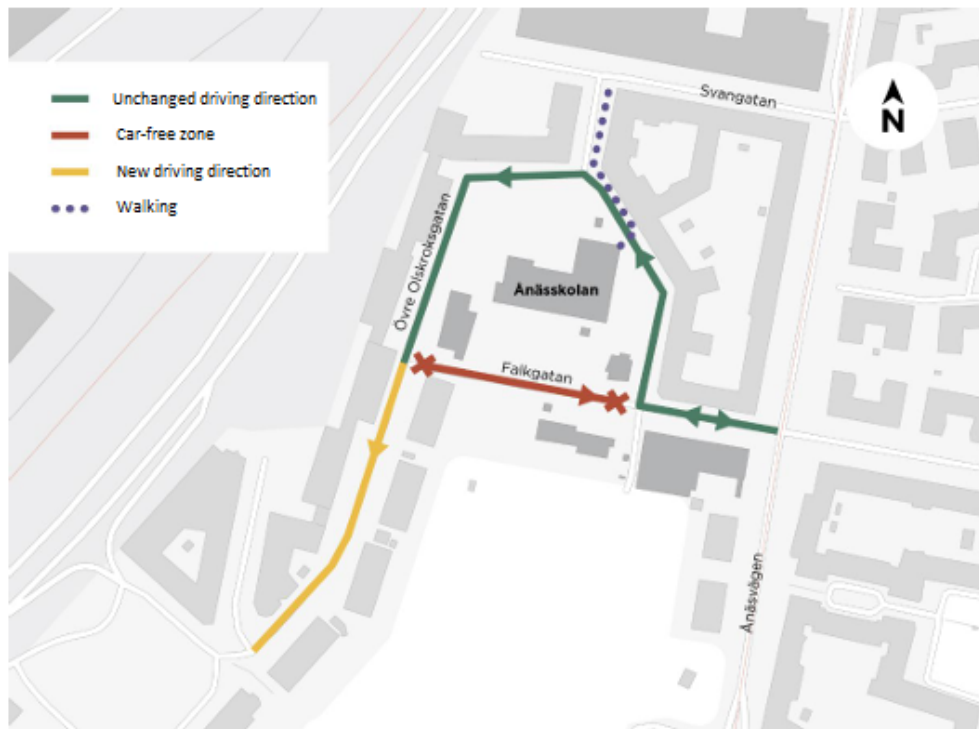


Figure 4.2: New traffic solution after implementation of a car-free zone around Ånässkolan. Modified based on picture from Stadsmiljöförvaltningen Göteborg Stad (2025).

The car-free zone was evaluated two months after implementation (Stadsmiljöförvaltningen Göteborg Stad, 2025). Results showed that motorised traffic around the school on school days had decreased by 50%. No substantial changes in travel behaviour were observed within the first two months. However, a small increase in walking and cycling was observed, and fewer parents drove their children to school. Most parents were positive about the car-free zone, and the share of parents who felt unsafe due to vehicles decreased from 62% to 37%. However, residents in the area were more negative about the changed traffic situation.

A major challenge after implementation was compliance with the traffic regulations. Approximately 35% of vehicles drove in the wrong direction on Övre Olskroksgatan, and more than 75% of the vehicles in the car-free zone (Stadsmiljöförvaltningen Göteborg Stad, 2025). This is difficult to address, as the street cannot be fully closed for vehicles due to the need to maintain access for permitted vehicles, such as emergency vehicles and goods deliveries, while still ensuring that other road users comply with the restrictions.

Another lesson from the project is that a single, geographically confined measure has a limited influence on travel behaviour if other parts of the route to school are perceived as unsafe (Stadsmiljöförvaltningen Göteborg Stad, 2025). Where possible, measures should be implemented across a larger geographic area, but this is more challenging, as it affects traffic flows and a greater number of local residents.

5 Case study areas

The selected case study areas are located in Gothenburg and have varying characteristics in terms of road network structure, traffic safety conditions, spatial context, and accessibility to public transport. This chapter presents the selected study sites: Kungsladugårdsskolan, Brunnsboskolan, Långmosseskolan, and Brottkärrsskolan. In-depth information and an overview map for each of the selected schools are provided. An overview map of the entire area is presented in Figure 5.1 below, illustrating the geographical distribution of these schools within Gothenburg.



Figure 5.1: Overview map of the four selected schools. Modified based on map data from OpenStreetMap (n.d.).

5.1 Kungsladugårdsskolan

Kungsladugårdsskolan serves students from preschool to sixth grade and accommodates approximately 600 students and 110 employees (Göteborgs Stad, 2026b). The school is located in Kungsladugård, Majorna, in a relatively central part of Gothenburg. The surrounding area is primarily residential and consists mainly of apartment buildings. Several public transport stops are located nearby, with the closest approximately 300 metres from the school. The majority of the students live close to the school, yet a

significant number of parents still drive their children to school (Centerpartiet, 2025). Figure 5.2 below shows the location of the school and the surrounding road network.

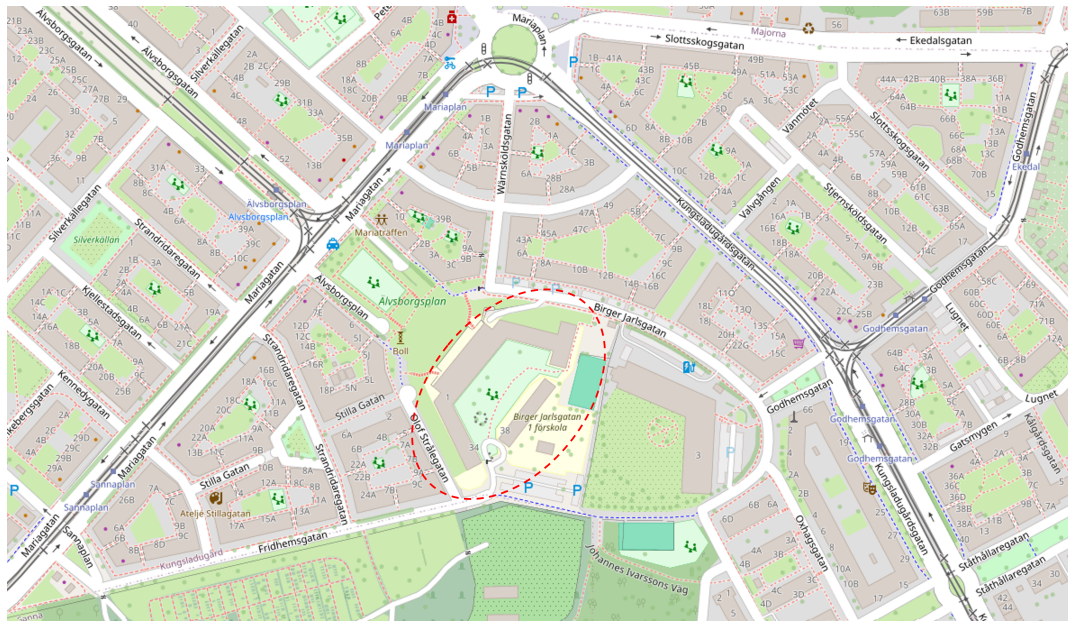


Figure 5.2: The current road network at Kungsladugårdsskolan. The school area is highlighted by the red dashed outline. Map data from OpenStreetMap (n.d.)

The school can be accessed from two directions: Birger Jarlsgatan on the north side and Fridhemsgatan on the south side. Both are local residential streets designed for relatively low traffic volumes, with a recommended speed limit of 30 km/h.

Birger Jarlsgatan, located on the north side of the school (see Figure 5.2), functions as an important access street for pedestrians from nearby residential areas, as well as for those arriving by public transport at Mariaplan or Godhemsgatan. The street primarily serves residents, with residential parking on the north side of the road and on-street parking along the south side either for residents or time-restricted to two hours. There is also a parking facility on the south side of the eastern section of Birger Jarlsgatan, intended for a nearby housing area, but it is frequently used by parents as a turning space and drop-off area.

Traffic is permitted in both directions. However, the large number of parked cars reduces the effective road width to a single lane in many sections. As a result, vehicles often need to pull aside to allow oncoming traffic to pass (see Figure 5.3). This combination of narrow carriageway conditions, reduced visibility due to parked vehicles, and frequent manoeuvres during the morning peak (e.g., drop-off, parking, turning, and reversing) creates an unsafe and problematic traffic environment. During the field visit, a near-collision was observed when a car reversed out of a parking space with limited visibility due to other parked vehicles.



(a) Western part of Birger Jarlsgatan



(b) Eastern part of Birger Jarlsgatan

Figure 5.3: Pictures of Birger Jarlsgatan.

There are no dedicated bicycle lanes along Birger Jarlsgatan, forcing cyclists to share the road with vehicles. Narrow pedestrian paths are located on both sides of the road, but the street lacks marked pedestrian crossings, contributing to both perceived and actual safety concerns. Speed humps were not observed, which may contribute to higher vehicle speeds. Informal conversations with two parents during the field visit indicated that the traffic situation is perceived as unsafe for their children due to the high number of vehicles and frequent manoeuvres.

The number of vehicles and their behaviour were observed during the morning peak hour. Parents were observed either parking and accompanying their child to the school entrance or dropping children off along the road. Most vehicles parked along the street, while others used the residential parking on the north side or the nearby parking area serving a neighbouring housing area. Some vehicles were also observed using the 30-minute parking spaces on Godhemsgatan.

For drop-off, all these parking areas were used, and some vehicles also stopped in the middle of the roadway, blocking traffic. After dropping off the child, some drivers continued in the same direction, while others turned around and exited the same way as they arrived.

Traffic was observed at two locations along Birger Jarlsgatan (see Figure 3.2), and the results are shown in Table 5.1 below.

Table 5.1: Observed vehicles on the north side of the school on Birger Jarlsgatan during the morning of March 3.

	07:30–07:40	07:40–07:50	07:50–08:00	08:00–08:10
Location 1				
Observed vehicles east	6	14	9	11
Observed vehicles west	4	2	4	3
Location 2				
Observed vehicles east	7	12	8	11
Observed vehicles west	10	6	5	2

Fridhemsgatan is located on the south side of the school and continues towards a parking facility close to the school, where the street ends (see Figure 5.2). Adjacent to the parking facility, there is a dedicated turning area and drop-off zone for taxis and school transport. On-street parking is also permitted along Fridhemsgatan, which often reduces the effective road width to a single lane and restricts traffic flow due to the high number of parked vehicles (see Figure 5.4). During the field visit, a minor collision between a moving vehicle and a parked car was observed when a driver attempted to pull aside to allow oncoming traffic to pass.



(a) Fridhemsgatan and Olof Strålegatan



(b) Fridhemsgatan

Figure 5.4: Pictures of Fridhemsgatan.

During the morning peak period, 50 vehicles were observed arriving via Fridhemsgatan. Most vehicles continued to the school entrance and used the designated taxi space for drop-off and turning, increasing traffic activity close to the entrance. The parking area directly adjacent to the school entrance was also frequently used for both parking and drop-off.

Just before reaching the school, vehicles can turn left onto Olof Strålegatan. This street is primarily intended for residents, but several drivers were observed using it to turn around. In some cases, vehicles used the intersection between Fridhemsgatan and Olof Strålegatan to turn around, in the same section where children using the pedestrian path cross the street. The intersection lacks a marked pedestrian crossing, which reduces safety for children crossing and continuing along the pedestrian path. These manoeuvres create direct conflicts between motor vehicles and pedestrians in an area heavily used by children, negatively affecting traffic safety.

Another identified issue is the lack of designated parking spaces for persons with disabilities. During the field visit, a conflict situation was observed when a parent stopped at the entrance to the parking facility to unload a wheelchair for their child, and vehicles behind attempted to pass in an unsafe manner.

Cycling conditions are also limited. There is one combined pedestrian and cycle path connecting Lilla Fridhemsgatan and Fridhemsgatan, but the surrounding streets lack

dedicated cycling infrastructure, requiring cyclists to share the roadway with motor vehicles. As a result, several parents were observed accompanying their children by bicycle along the street. In addition, the combined pedestrian and cycle path terminates at the parking entrance and close to the turning area, creating conflicts when children walking and cycling must cross the vehicle road to access the school area. A conversation with one parent also highlighted concerns about their child's safety, particularly around the parking area near the school.

The observed number of vehicles on Fridhemsgatan on the south side of the school is shown in Table 5.2 below.

Table 5.2: Observed vehicles on the south side of the school on Fridhemsgatan during the morning of March 3.

	07:30–07:40	07:40–07:50	07:50–08:00	08:00–08:10
Observed vehicles	13	15	14	8

5.2 Brunnsboskolan

Brunnsboskolan is located in Brunnsbo, Hisingen, and has approximately 700 students from preschool to ninth grade and 120 employees (Göteborgs Stad, 2025a). The school is located in a suburban, primarily residential area just north of the city centre. Figure 5.5 below shows the location of the school and the surrounding road network.

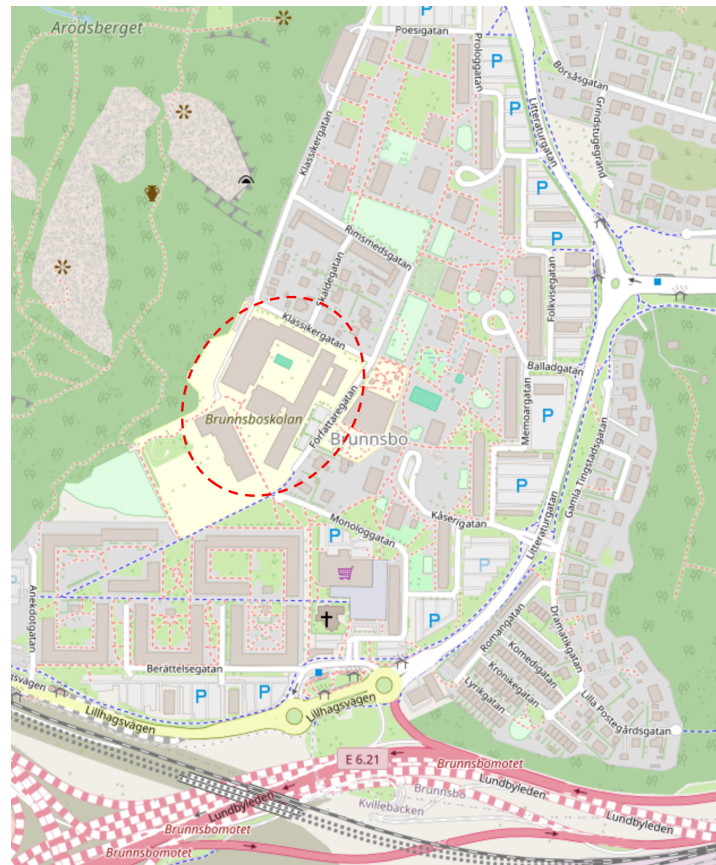


Figure 5.5: The current road network at Brunnsboskolan. The school area is highlighted by the red dashed outline. Map data from OpenStreetMap (n.d.).

The school can be accessed from several directions. There are two pedestrian entrances from Klassikergatan on the north side of the school. In addition, a road runs along the western side of the school, with permit parking and a turning area where children can be dropped off and picked up.

Klassikergatan, Rimsmedsgatan, and Skaldegatan, on the north side of the school, are local residential streets designed for relatively low traffic volumes, with a recommended speed limit of 30 km/h. Sidewalks along these routes are narrow, and although there are some speed humps, there are no marked pedestrian crossings. In addition, there are no dedicated bicycle lanes, meaning cyclists share the roadway with motor vehicles.

All observed vehicles entered the area via Klassikergatan, and approximately half continued towards the road on the western side of the school to access the parking and turning area. No pedestrians were observed on this segment, and therefore no vehicle-pedestrian conflicts were recorded. The remaining vehicles primarily stopped outside one of the two school entrances to drop children off, while others parked along the street

and accompanied the child to the school entrance. A few vehicles continued along Klassikergatan and turned right onto Författaregatan.

Traffic conditions along Klassikergatan pose several safety concerns. Narrow sidewalks provide limited separation between vehicles and pedestrians, and there are no marked pedestrian crossings. As a result, children and parents were observed crossing the street at many different locations. Visibility is also restricted for pedestrians and cyclists approaching from Skaldegatan who need to cross Klassikergatan, as hedges limit sight-lines at the intersection. In addition, some vehicles were observed driving relatively fast and using Skaldegatan and the sidewalks to turn around, further increasing safety risks (see Figure 5.6).



(a) Klassikergatan



(b) Klassikergatan and Skaldegatan

Figure 5.6: Pictures of Klassikergatan.

When parents park along the street to accompany their child to school, parked vehicles occupy a large part of the roadway, making it difficult for other vehicles to pass. In some cases, drivers used the sidewalk to create enough space to pass. During the field visit, one parent reported that the situation feels unsafe due to the high number of cars and the relatively high speeds. However, the parent considered it acceptable as long as they accompanied their child to school. The parent also noted that the sidewalks are perceived as too narrow and that marked pedestrian crossings are desired.

The observed number of vehicles on Klassikergatan on the north side of the school is shown in Table 5.3 below.

Table 5.3: Observed vehicles on the north side of the school on Klassikergatan during the morning of February 24.

	07:30–07:40	07:40–07:50	07:50–08:00	08:00–08:10
Observed vehicles	6	7	27	8

There is also an entrance on the south side of the school. This entrance can be reached

via Författaregatan or Monologgatan, both of which are dead-end residential streets with a recommended speed limit of 30 km/h. Författaregatan leads to three parking areas on the east side of the school and ends in a small turning area. Monologgatan also ends in a turning area close to the school entrance, where taxis and school transport can drop children off.

On Författaregatan, on the east side of the school, no safety conflicts were observed between vehicles and pedestrians. The street has a wide shared pedestrian and bicycle path that continues all the way to the southern school entrance, allowing pedestrians and cyclists to access the school without having to cross the street (see Figure 5.7).



(a) Författaregatan and shared path



(b) Parking at Författaregatan

Figure 5.7: Pictures of Författaregatan.

However, several safety challenges were identified along Monologgatan. The street has only narrow pedestrian paths and no dedicated bicycle infrastructure. During the field visit, many vehicles were observed using the street for drop-off. In addition, several vehicles were observed partially driving onto the pedestrian path in the turning area, further increasing safety risks (see Figure 5.8).



Figure 5.8: Picture of Monologgatan.

The turning area at the end of the street was frequently used but is too small, which caused cars to reverse onto the pedestrian path when turning around. The most used pedestrian path is directly adjacent to the turning area, creating conflicts between turning vehicles and children walking to school.

During the morning period between 07:30 and 08:10, school staff were present to meet children arriving by school transport. However, staff only waited for a specific child to arrive and then left to accompany the child to school, rather than supervising all arriving children. As a result, the safety issues remained. It was also observed that a school transport vehicle arriving from Författaregatan used the combined pedestrian and bicycle path to reach Monologgatan, creating conflicts with pedestrians and cyclists.

Several pedestrian paths connect the surrounding residential areas to the southern entrance. Observations indicated that many pedestrians used the path from the public transport stop at Brunnsbotorget.

The observed number of vehicles on Monologgatan on the south side of the school is shown in Table 5.4 below.

Table 5.4: Observed vehicles on the south side of the school on Monologgatan during the morning of February 24.

	07:30–07:40	07:40–07:50	07:50–08:00	08:00–08:10
Observed vehicles	3	6	18	8

5.3 Långmosseskolan

Långmosseskolan houses approximately 150 students from preschool to third grade and 40 employees (Göteborgs Stad, 2025b). The school is located in Angered, north of the city centre, in a residential area consisting mainly of multi-family housing. Figure 5.9 below shows the location of the school and the surrounding road network.

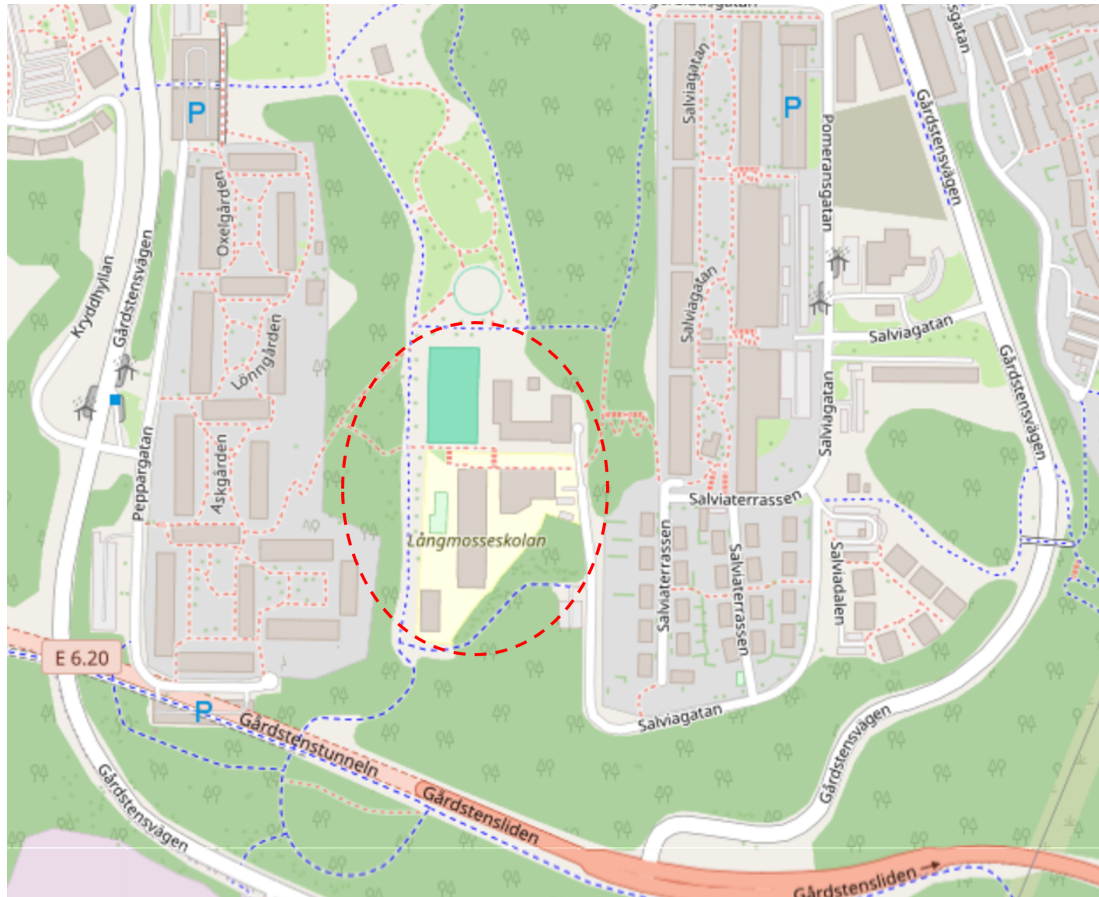


Figure 5.9: The current road network at Långmosseskolan. The school area is highlighted by the red dashed outline. Map data from OpenStreetMap (n.d.).

The surrounding road network mainly consists of local streets with limited through traffic. One road leads directly to the school and it is a dead-end street that terminates outside the school entrance. The recommended speed limit is 30 km/h, and speed humps have been installed to ensure low vehicle speeds. Several pedestrian and cycling paths also connect the surrounding housing areas to the school. A small number of permit-only parking spaces are located outside the school, and an additional parking area is located approximately 100 metres away. The closest public transport access consists of two bus stops located about 600 metres from the school.

5.4 Brottkärrsskolan

Brottkärrsskolan is located in Nya Hovås, south of the city centre, and has approximately 290 students from preschool to sixth grade (Göteborgs Stad, 2026a). The surrounding area is primarily residential, with a mixture of detached houses and apartment buildings. Figure 5.10 below shows the location of the school and the surrounding road network.



Figure 5.10: The current road network at Brottkärrsskolan. The school area is highlighted by the red dashed outline. Map data from OpenStreetMap (n.d.).

Two larger roads, Brottkärrsvägen and Klåvavägen, which connect the area to Hovås and Brottkärr are located directly east and south of the school. These roads carry through traffic and have higher traffic volumes than the surrounding residential streets. The speed limit is 50 km/h, and speed humps have been implemented outside the school to reduce vehicle speeds. Both streets are also used by public transport buses, and two bus stops are located close to the school. A parking area is located on the school premises, where permit parking is available and where vehicles can drop off and pick up children. The major roads have separate pedestrian and cycling paths.

6 Proposed measures and simulation results

This chapter presents the proposed measures for the four selected schools based on site-specific conditions such as traffic patterns, urban context, and observed safety issues. For the two main case study areas, Kungsladugårdsskolan and Brunnbskolan, the proposed solutions are further evaluated using traffic simulation in PTV Vissim.

6.1 Proposed measures for the selected case study areas

This section outlines the proposed measures for the four selected case study areas. The interventions are based on the literature review, interviews, and field observations.

6.1.1 Kungsladugårdsskolan

Based on field observations and simulations in PTV Vissim for Kungsladugårdsskolan, it can be concluded that conflicts exist between children and vehicles. Currently, there are two vehicular access routes to Kungsladugårdsskolan: via Fridhemsgatan in the southwest and via Birger Jarlsgatan in the north.

For Birger Jarlsgatan, the proposed measure is to temporarily close the road to incoming traffic on weekday mornings between 07:30 and 08:15. This could be implemented using an automated barrier that allows vehicles to leave the area while restricting vehicles attempting to enter. Access through the barrier would remain possible for emergency services and essential deliveries using a key. Although Birger Jarlsgatan currently provides residential parking, field observations indicated that most morning traffic consisted of parents dropping off children, while resident parking movements were very limited during this period. An automated barrier is considered a flexible and practical solution, as it still allows vehicles to enter and exit when needed and limits the restriction to a short time window. Fixed measures such as planters or other obstacles would reduce this flexibility and are therefore less suitable, especially for temporary closures where physical measures should only be present for a short period of the day. Signage at both ends of the street should clearly indicate the temporary morning access restrictions.

When Birger Jarlsgatan is closed during the morning peak, a dedicated drop-off zone is proposed at the end of Godhemsgatan (see Figure 6.2), together with the use of the existing 30-minute parking spaces along Godhemsgatan. These measures ensure that children do not need to cross a vehicular roadway and reduce potential conflicts between children and vehicles. To further improve safety even when Birger Jarlsgatan is open to traffic, it is also suggested to expand the pedestrian path along the road.

On the southern side of the school, at Fridhemsgatan, the potential for a full road closure is limited due to its functional role in providing access to residential parking, designated staff parking, and routes used by school transport services. The proposal is therefore to improve safety for pedestrians and cyclists along this road with other types of measures. One measure is to add a raised, tapered pedestrian crossing on Olof Strålegatan, see Figure 6.1. This intervention is expected to reduce vehicle speeds and discourage the use of this area as a turning point, while providing a safer crossing for children. Raised pedestrian crossings are also proposed in the intersections with the other connecting streets to Fridhemsgatan. The existing speed hump on Fridhemsgatan, near the intersection with Strandridaregatan, will be retained.



Figure 6.1: Proposed design of raised, tapered crossing on Olof Strålegatan. Picture modified using AI tool for conceptual visualisation.

Fridhemsgatan currently lacks dedicated cycling infrastructure, requiring cyclists to share the carriageway with motor vehicles, which contributes to an unsafe traffic environment. To improve safety for cyclists, it is proposed to widen the existing pedestrian path to accommodate a combined pedestrian and bicycle facility.

At the end of Fridhemsgatan, there is a staff parking area that experiences a high traffic volume during the morning peak. On the southern side of this parking area, a dedicated pedestrian and bicycle path currently ends at the parking entrance, creating conflict points between pedestrians and vehicles. To address this issue, it is proposed to reroute the pedestrian and bicycle path along the outer edge of the parking area (right-hand side) and connect it directly to the school entrance (see Figure 6.2). This would eliminate the previous conflict points by preventing pedestrians from crossing or moving through the vehicular roadway. The new shared path should also be clearly marked with pavement markings to further indicate that it is intended for pedestrians and cyclists.

The final proposed solution is shown in Figure 6.2 below.

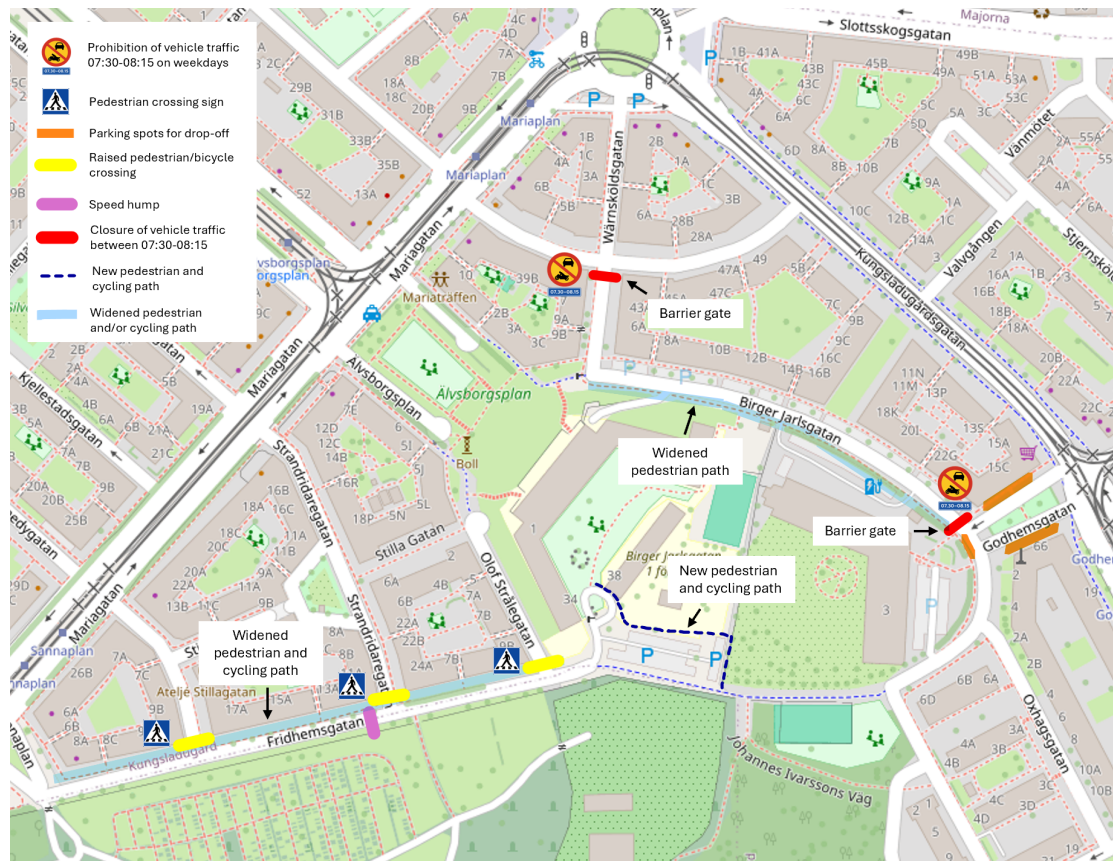


Figure 6.2: Proposed traffic solution for Kungsladugårdsskolan for the implementation of a car-free zone. Modified based on map data from OpenStreetMap (n.d.).

6.1.2 Brunnsboskolan

Brunnsboskolan can be accessed from the north via Klassikergatan and Författaregatan, and from the southeast via Monologgatan. Traffic-related issues were observed on both sides of the school. Based on the observed traffic conditions and the knowledge gained from the literature review, interviews, and field observations, a car-free zone is proposed, together with additional measures to improve traffic safety for children travelling to the school.

On the north side, the proposal is to permanently close the section of Klassikergatan that runs along the school to motorised vehicles (see Figure 6.3). This segment is frequently used by children to access the school, as two school entrances are located along the street, while it only serves one household with a driveway along this segment. More suitable alternatives for drop-off and parking are available, with fewer conflicts between pedestrians and vehicles. Therefore, closing this segment of Klassikergatan is not expected to have a significant negative impact on accessibility for nearby residents, traffic flow in the area, or the possibility of dropping off or parking close to the school, while substantially improving safety for children walking to school.

The main drop-off option should be to redirect vehicles to the turning area on the western side of the school, where no conflicts between children and vehicles were observed, since the street leading to the turning area is not used by pedestrians. For parking, drivers should be referred to the parking spaces on Författaregatan, which can still be reached via Rimsmedsgatan when Klassikergatan is closed. At the intersection of

Rimsmedsgatan, Författaregatan, and Klassikergatan, many children arriving from residential areas located north and northeast of the school cross the street to access the school entrances. Therefore, a raised pedestrian crossing is proposed to enable safer crossings and provide safer access to the car-free zone. Two speed humps are currently located along Rimsmedsgatan, one close to the intersection with Skaldegatan and one 50 m north of the proposed pedestrian crossing. These will be retained to ensure low vehicle speeds.

The car-free zone should be physically enforced using flower boxes and concrete barriers at the intersections of Skaldegatan and Klassikergatan, and Rimsmedsgatan and Författaregatan. At the western entrance to the car-free zone, a barrier gate should be installed to provide physical enforcement while allowing access for authorised vehicles (e.g., emergency vehicles) and for the one household with a driveway on the closed street, if relocating the driveway to Skaldegatan is not feasible. In addition, appropriate signage prohibiting motor vehicle traffic should be implemented, together with pavement markings, such as “SKOLA” and footsteps, to clearly define the car-free zone and create a more pedestrian-friendly environment.

When the segment of Klassikergatan is closed, there is a risk that vehicles will use Skaldegatan to drop off children close to the entrances instead. To prevent this, signage stating that Skaldegatan is a dead-end street without a turning area should be installed at the intersection with Rimsmedsgatan. This measure aims to discourage drivers from entering this street that is primarily intended for residents.

Monologgatan, on the southeast side of the school, will remain open to vehicle traffic, but several safety improvements are proposed. During the field visit, conflicts between pedestrians and vehicles around the turning area at the end of Monologgatan were observed. To address this, it is proposed to separate the pedestrian path from the turning area with a fence. This would prevent vehicles from using the pedestrian path for parking or turning manoeuvres, while guiding children to use the designated pedestrian path instead of crossing through the turning area. Furthermore, the alignment of the pedestrian path could be slightly adjusted so that the shortest route does not involve crossing the turning area, thereby reducing the risk of pedestrians taking shortcuts across it. School staff were observed waiting at the turning area to meet children using school transport, and could also help guide other arriving children while waiting.

In addition, one vehicle was observed driving on the combined pedestrian and cycle path between Författaregatan and Monologgatan. This behaviour can be prevented by installing fences between the combined pedestrian and cycle path and the adjacent vehicle streets, restricting vehicle access to the path. As this path is heavily used by children and is not intended for motorised vehicles, preventing such behaviour is important for traffic safety.

Finally, a speed hump is proposed along Monologgatan, approximately 50 m before the turning area, to reduce vehicle speeds. The environment should also be enhanced with flower boxes and footsteps on the pavement, as implemented in Uppsala, to provide guidance and create a more pleasant environment for children (Uppsala kommun, 2025).

The final proposed solution is shown in Figure 6.3 below.

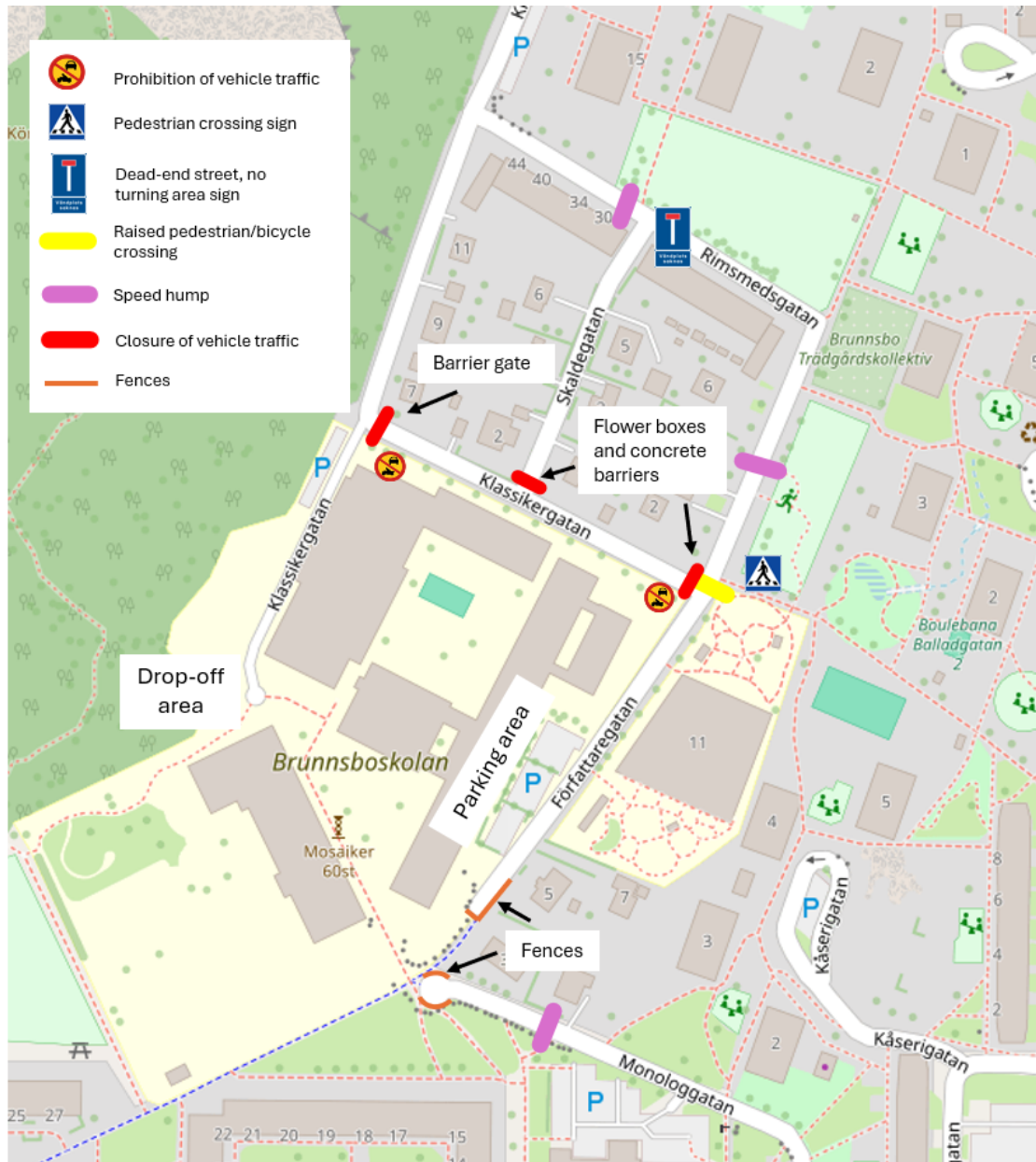


Figure 6.3: Proposed traffic solution for Brunnsboskolan for the implementation of a car-free zone. Modified based on map data from OpenStreetMap (n.d.).

6.1.3 Långmosseskolan

Långmosseskolan is located in a relatively rural area on the outskirts of Gothenburg. It is currently accessed by a single vehicular road, Salviagatan, which leads directly to the main entrance. The surrounding area is characterised by several pedestrian and cycling paths connecting nearby residential areas to the school.

To improve traffic safety and reduce potential conflicts between vehicles and children, it is proposed to close the final segment of Salviagatan to vehicle traffic, with the exception of deliveries and individuals with reduced mobility who require access. This solution would limit unnecessary vehicle access in close proximity to the school entrance while preserving essential functionality. Access beyond the closure point should be controlled by a barrier gate system that only allows entry for authorised users, emer-

agency services, and necessary delivery vehicles. For those with permission, a key to open the barrier can be provided. Given that Salviagatan functions as a dead-end street and does not serve as a critical link in the main traffic network, this measure is expected to have minimal impact on overall traffic flow in the area. The main impact is that it will no longer be possible to park or drop off directly outside the school entrance. Instead, users will need to walk the final 100 m.

The proposed car-free zone is shown in Figures 6.4 and 6.5 below. The yellow arrows indicate the existing pedestrian and bicycle paths connecting the surrounding residential areas to the school. By closing Salviagatan to vehicle traffic at the location marked in red, children will be able to access the school area from all directions without interacting with vehicles. This is expected to improve traffic safety and promote active transportation.

In addition, the number of parking spaces in the school area could be reduced, since only the limited number of vehicles with access would park there. The area could instead be redesigned to create more space for the children.

For children and school staff arriving by car, the existing parking area located 100 m from the school can be used for both parking and drop-off. However, the success of this proposal depends on ensuring that this parking facility is adequately designed and dimensioned to meet the new demand, so that it does not become congested and cause additional problems. It is therefore proposed to expand the parking area to accommodate the increased demand when parking spaces within the school area cannot be used.

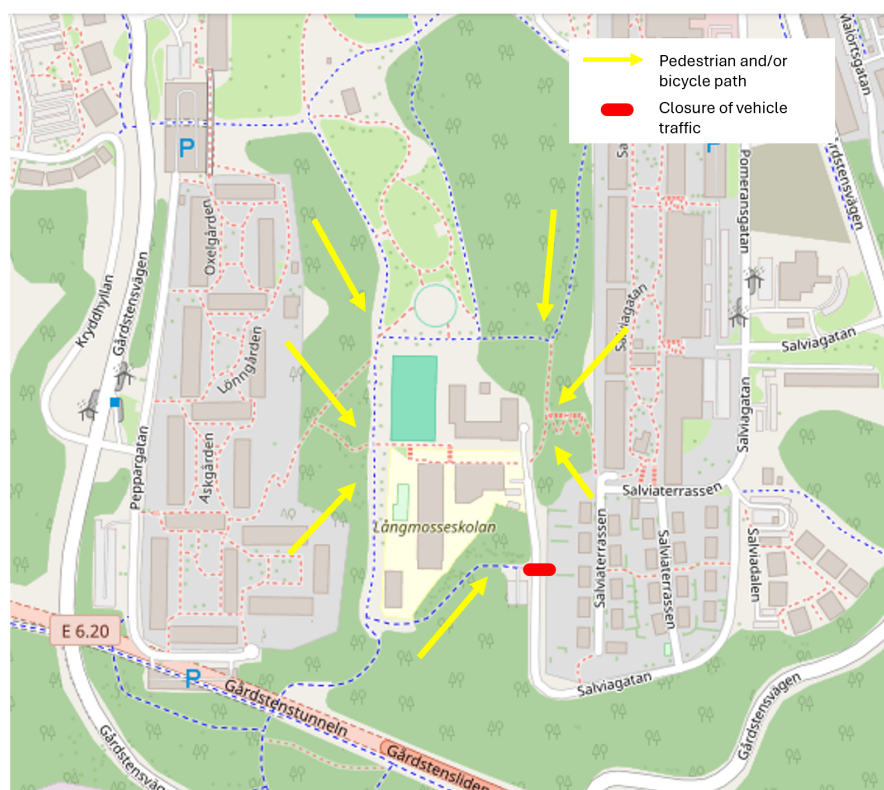


Figure 6.4: Proposed traffic solution for Långmosseskolan for the implementation of a car-free zone. Modified based on map data from OpenStreetMap (n.d.).

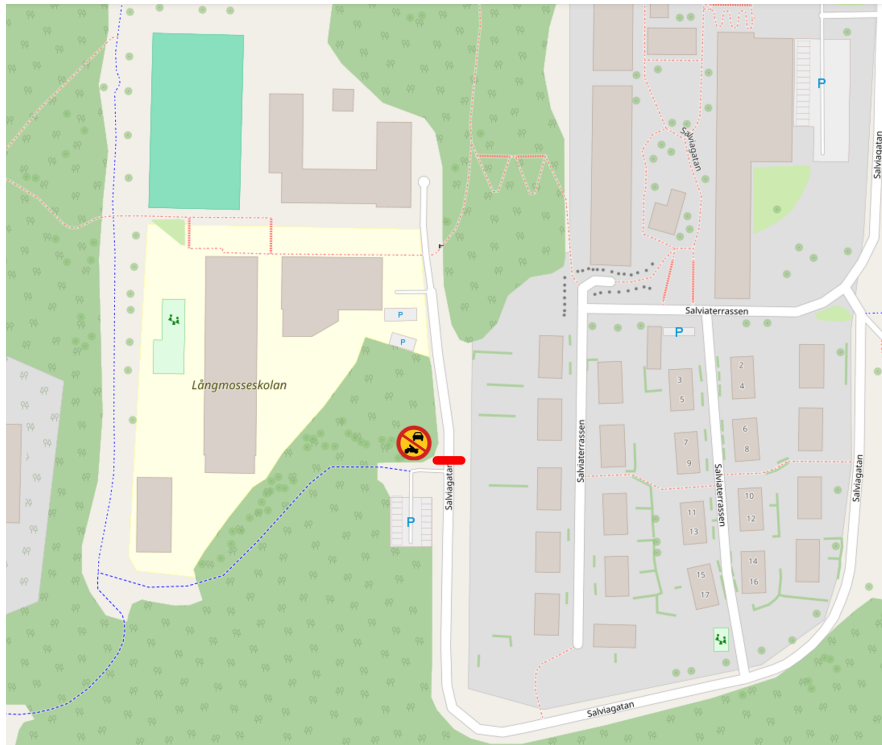


Figure 6.5: Proposed traffic solution for Långmosseskolan for the implementation of a car-free zone. Modified based on map data from OpenStreetMap (n.d.).

6.1.4 Brottkärrsskolan

Based on the findings from the literature and previous implementations, Brottkärrsskolan, as well as other schools in a similar urban context, is assessed as unsuitable for the implementation of a car-free zone around the school. Instead, measures focusing on speed reduction and improved traffic safety are proposed. The two streets surrounding the school carry through traffic to Hovås and Brottkärr and are important links in the local road network. In addition, the surrounding network does not provide suitable options for redirecting traffic if these streets are closed. Therefore, restricting vehicle traffic on these streets would likely have an unreasonably large negative impact on traffic flow in the area.

However, traffic safety around the school can still be improved by ensuring reduced vehicle speeds and enhancing conditions for walking and cycling. Speed can be managed through a lower speed limit, speed cameras, and speed humps. Well-developed pedestrian and cycling infrastructure, separated from motorised vehicles, is also important. This includes safe crossing facilities such as raised pedestrian crossings or signalised intersections where pedestrians and cyclists interact with motorised traffic.

For Brottkärrsskolan, the proposed traffic solution is shown in Figure 6.6 below. The speed limit on the road in front of the school is proposed to be reduced to 30 km/h in both directions. To support compliance with the lower speed, raised pedestrian and bicycle crossings, as well as one speed hump, are proposed. The raised crossings contribute to reduced speeds and improve safety for pedestrians and cyclists, and are therefore preferred over regular crossings. If the speed limit is not sufficiently respected, a speed camera could be considered in the future as a complementary measure.



Figure 6.6: Proposed traffic solution for Brottkärrsskolan to reduce the speed and increase traffic safety. Modified based on map data from OpenStreetMap (n.d.).

6.2 Simulation-based evaluation of selected case study areas

This section presents the simulation-based evaluation of the proposed measures for Kungsladugårdsskolan and Brunnsboskolan. These two case study areas were selected for further assessment in order to examine the potential effects of the proposed interventions.

Three scenarios have been analysed in the simulation. No behaviour change is assumed in the simulation and the number of vehicles is the same before and after implementation of the proposed measures. The scenarios are as follows:

1. Scenario 1: Baseline scenario representing the current traffic situation.
2. Scenario 2: Implementation of the proposed car-free zone and additional measures.
3. Scenario 3: Traffic redistribution scenario in which all vehicles previously using the closed street segment are reassigned to streets on the opposite side of the school (Fridhemsgatan and Monologgatan).

The corresponding level of service (LOS) is then determined according to the queue-delay thresholds presented earlier in Table 3.1.

6.2.1 Kungsladugårdsskolan

To evaluate the potential impacts of the proposed changes to the road network surrounding the school, three separate simulation scenarios were developed. These scenarios were analysed through visual inspection within the simulation environment and by estimating the level of service (LOS) based on queue delay. The first scenario used the existing traffic situation and the current infrastructure and, therefore, serves as the reference case.

In the second scenario, Birger Jarlsgatan was closed to traffic, and the system was assessed without any reduction in traffic demand. Vehicles that previously used this route were reassigned to alternative streets near Birger Jarlsgatan, primarily Godhemsgatan. Additional curbside drop-off spaces were introduced at the end of Godhemsgatan to function as drop-off zones. In this scenario, traffic volumes increased on streets near Birger Jarlsgatan, including both directions of Godhemsgatan and Svanebäcksgatan. Visual inspection of the simulation indicated that no queues or other major issues occurred, and that the system handled the change well. The main issue observed was that vehicles stopping in the new drop-off zone caused following vehicles to wait their turn to drop off.

In the third scenario, potential traffic displacement was assessed by reallocating vehicles that previously used the closed segment of Birger Jarlsgatan to Fridhemsgatan. This scenario was used to evaluate whether the street could accommodate substantial displacement if vehicles that previously used Birger Jarlsgatan shift to Fridhemsgatan on the other side of the school to remain access close to the school entrance. The queue delay on Fridhemsgatan increased from 6.08 in the reference scenario to 14.90, which is expected given that more vehicles need to stop and wait for parking. Fridhemsgatan, which is the street affected in this scenario, experienced an increase in the level of service from A to B. However, this is still considered acceptable (Transportation Research Board, 2010). Overall, the results indicate that Fridhemsgatan can accommodate the additional traffic without major negative impacts on the surrounding road network.

As shown in Figure 6.7, queue delays remain generally low across all evaluated scenarios. For each street, the most critical scenario was selected to represent a worst-case condition. For the streets around Birger Jarlsgatan, Scenario 2 was used, while Scenario 3 was most critical for Fridhemsgatan. The most affected streets are Fridhemsgatan, Svanebäcksgatan, and the southwest direction of Godhemsgatan (Godhemsgatan 1), which increased to level of service B. Lilla Fridhemsgatan and the northeast direction of Godhemsgatan (Godhemsgatan 2) continue to operate at level of service A. The level of service for each location is shown in Table 6.1. The criteria for level of service are shown in Table 3.1, and the measurement locations are shown in Figure 3.5. Overall, these results indicate that, even with increased traffic and changes in street use, the road network can accommodate demand without severe operational problems. The simulation therefore supports that the proposed car-free zone measures and additional traffic-safety interventions can be implemented without substantial negative impacts on the traffic system.

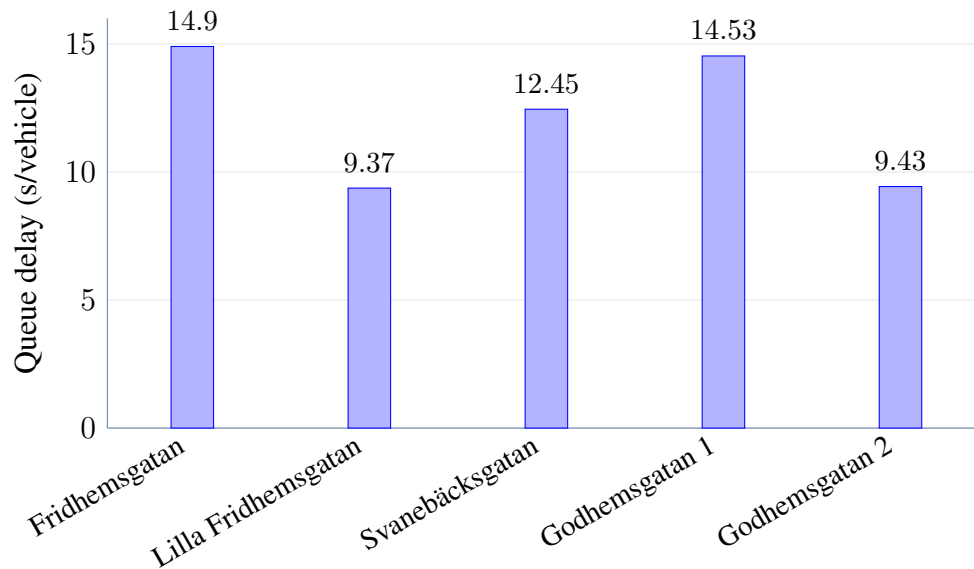


Figure 6.7: Queue delay at five locations around Kungsladugårdsskolan. The result for the worst-case scenario is used for each location, which is scenario 3 for Fridhemsgatan and scenario 2 for the other streets. A map of the measurement locations is shown in Figure 3.5 in chapter 3.

Table 6.1: Level of service for the five locations around Kungsladugårdsskolan according to the criteria from the Highway Capacity Manual (Transportation Research Board, 2010). The criteria for level of service are shown in Table 3.1 in chapter 3.

Location	Level of service
Fridhemsgatan	B
Lilla Fridhemsgatan	A
Svanebäcksgatan	B
Godhemsgatan 1	B
Godhemsgatan 2	A

6.2.2 Brunnsboskolan

Three simulation scenarios were modelled to evaluate the suitability and impacts of the proposed measures. The first scenario represents the current traffic situation and serves as a baseline for comparison. In the second scenario, the proposed car-free zone was implemented together with additional safety measures, which were incorporated into the model as accurately as possible. The third scenario was designed to assess traffic displacement, assuming that all vehicles that previously used the closed segment of Klassikergatan for drop-off and parking instead use the turning area on Monologgatan. Although a car-free zone is expected to encourage a shift from car to active transport for school trips, the simulation scenarios test system performance under the assumption of no behaviour change, with the same number of vehicles as before implementation.

The simulation results indicate that the proposed measures can be implemented without significantly reducing overall traffic system performance. In Scenario 2, where the car-free zone and additional measures were implemented, the system continued to function

well. Vehicle volumes increased on nearby streets, primarily on Författaregatan and on Klassikergatan towards the drop-off area, but these streets had sufficient capacity to accommodate the additional demand.

No substantial queues were observed, except for short delays caused by vehicles briefly stopping for passenger drop-off, which required following vehicles to wait. However, such delays are largely unavoidable in school environments where many drop-offs occur over a short period and in this scenario, they did not have a major effect on overall traffic flow.

For Monologgatan, Scenario 3 was analysed as a worst-case assumption in which all vehicles that previously used the closed segment of Klassikergatan instead use Monologgatan. The simulation shows a clear increase in traffic volume, leading to queues in the turning area where vehicles wait their turn to drop off. Consequently, the measured travel time from the start of Monologgatan to downstream of the turning area increased by approximately 25%. However, the queue delay indicates that the system still operates at level of service C, which is still considered acceptable (Transportation Research Board, 2010). Overall, the simulation suggests that the system can accommodate a full redistribution of traffic to Monologgatan without substantial negative impacts.

As shown in Figure 6.8, queue delay remains low even after implementation of the car-free zone. Under the worst-case condition on Monologgatan, queue delay increases and the level of service changes to C (Table 6.2). In contrast, queue delay on Författaregatan, Klassikergatan, and Skaldegatan remains low, and these streets continue to operate at level of service A (Table 6.2), even when the segment of Klassikergatan in front of the school is closed. These results support that the proposed car-free zone and accompanying traffic-safety measures are unlikely to cause major adverse impacts on traffic conditions in the area, and that the system would continue to operate effectively.

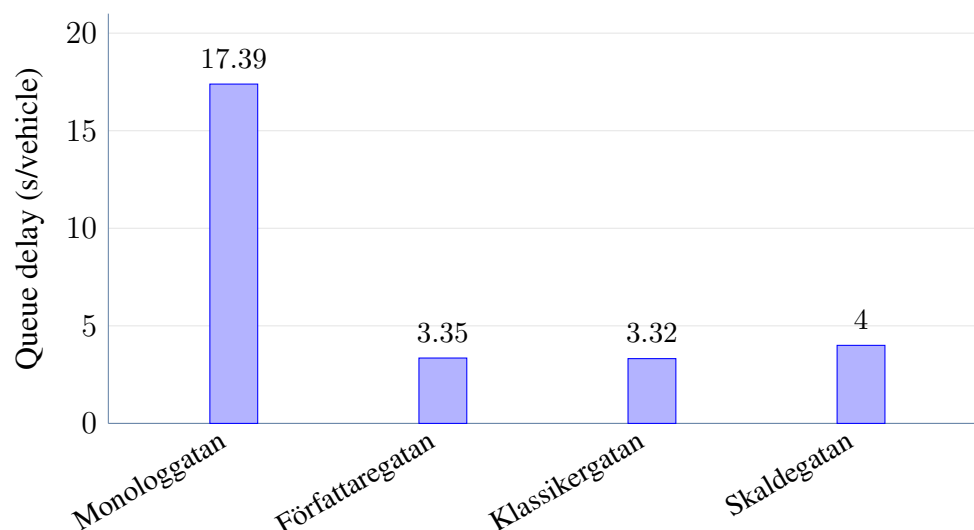


Figure 6.8: Queue delay at four locations around Brunnsboskolan. The result for the worst-case scenario is used for each location, which is scenario 3 for Monologgatan and scenario 2 for the other streets. A map of the measurement locations is shown in Figure 3.6 in Chapter 3.

Table 6.2: Level of service for the four locations around Brunnbskolan according to the criteria from the Highway Capacity Manual (Transportation Research Board, 2010). The criteria for level of service are shown in Table 3.1 in chapter 3.

Location	Level of service
Monologgatan	C
Författaregatan	A
Klassikergatan	A
Skaldegatan	A

7 Discussion

In this chapter, the results and related methods are discussed. The aim is to interpret the findings, identify challenges and opportunities, and highlight factors that may influence the effectiveness of car-free zones around schools.

7.1 Key findings from previous implementations

Previous implementations of car-free zones in other countries and cities have provided valuable insights into which measures work in practice across different contexts, which factors are critical for successful implementation, and which challenges may arise. The main findings are summarised in the section below.

7.1.1 Effects of car-free zones around schools

This study has identified several positive outcomes of implementing car-free zones around schools. Evidence across studies shows that car-free zones can significantly reduce traffic volumes, often by 50% to 70% (Göteborg Stad, 2025; London Borough of Hackney, 2022). These reductions contribute to calmer, less congested street environments, which in turn improve both perceived and actual safety for children (EU Urban Mobility Observatory, 2014; Stadsmiljöförvaltningen Göteborg Stad, 2025). Several studies have also reported substantial reductions in traffic-related accidents near schools (EU Urban Mobility Observatory, 2014).

However, reducing traffic on one street can lead to traffic displacement to surrounding streets. Several previous cases reported increased traffic volumes and reduced traffic safety on adjacent roads after implementation (Gustafsson, 2024; Holmström, 2024; London Borough of Hackney, 2025). This highlights the importance of evaluating impacts at the whole network level, rather than focusing only on individual streets, when introducing car-free zones.

In addition to safety improvements, car-free zones can improve local environmental conditions. Reductions in traffic volumes have been associated with lower concentrations of traffic-related air pollutants, such as NO₂ (Greater London Authority, 2021). For example, a case in London found that time-limited restrictions during the morning and afternoon were associated with a 23% reduction in NO₂ (Greater London Authority, 2021).

Furthermore, travel choices can shift towards more active modes when these are prioritised. Short-term evaluations in Belgium and Sweden have shown an increased use of active transport (Den Hond et al., 2020; Stadsmiljöförvaltningen Göteborg Stad, 2025; Officials at Uppsala municipality, personal communication, February 12, 2026), and a long-term evaluation in Italy reported that 45% of children walked to school, reinforcing the evidence of increased active travel (EU Urban Mobility Observatory, 2014).

7.1.2 Contextual factors and traffic conditions influencing effectiveness

Evidence from international and Swedish case studies indicates that a range of contextual factors, including social, political, spatial, environmental, and infrastructural conditions, shape implementation (Department for Transport & Active Travel England, 2024; EU Urban Mobility Observatory, 2014; Greater London Authority, 2023; London Borough of Hackney, 2022; Manhattan, 2024; Sherekar, 2025).

The local urban context strongly influences the effectiveness of car-free zones. In particular, the function of a street within the wider traffic network is critical. Local streets with low traffic volumes and limited through traffic are generally more suitable for closures, as this tends to minimise disruption to the network. In contrast, streets that serve as important links are more challenging to restrict, as closures may lead to unintended consequences such as increased congestion and new safety concerns (London Borough of Hackney, 2022). It is therefore necessary to assess the road function (e.g., primary versus local route, and the extent of through traffic) and the number of people affected.

The availability of alternative routes to which traffic can be redirected is also important. Car-free zones are often more feasible and publicly accepted where traffic can be re-routed without major consequences. Conversely, in areas with limited alternatives, closures may produce negative impacts, such as congestion or reduced safety on surrounding streets.

The urban structure surrounding schools further shapes feasibility and outcomes. Schools located in central areas often benefit from more developed walking, cycling, and public transport infrastructure, which supports a shift away from the car. In contrast, schools in more peripheral or rural areas often involve longer travel distances and fewer transport alternatives, which can limit the potential for active travel (Uppsala kommun, 2025). The availability of public transport also influences how children travel to school. Frequent and reliable services can enable multi-modal trips in which walking or cycling forms part of the overall journey (WHO, 2022). In Sweden, policies that provide free public transport cards for children in cities such as Uppsala and Gothenburg may further affect travel behaviour (Göteborg Stad, 2025; Uppsala kommun, 2025).

Weather and seasonality are additional contextual factors. Conditions such as reduced daylight during winter months and snow can affect travel mode choice (Ghari et al., 2024). For example, a study in Gothenburg reported an 8% increase in active transport during the summer months (Göteborg Stad, 2025).

Finally, implementation may differ between newly developed and existing areas. In newly planned school areas, car-free zones can be integrated from the outset, whereas implementation in established urban environments is often more complex, as it requires adapting existing infrastructure and traffic patterns.

7.1.3 Legal framework and guidelines

The study indicates that differences in legal frameworks and guidelines strongly influence the implementation of car-free zones. In some countries, the concept is included in national legislation and supported by standardised guidelines, such as standard signage and implementation guidance (Clarke, 2022; Distefano et al., 2025). Such formalisation can simplify implementation and support broader expansion.

In contrast, Sweden lacks national legislation and guidelines, as well as standardised solutions and implementation guidance, which creates challenges for implementation (Tyréns, 2026). Municipalities must therefore develop project-specific solutions for each site, which slows down implementation processes and makes broader implementation more challenging. This may partly explain why the concept has not yet been implemented on a larger scale in Sweden compared to other countries. To support future implementations, Sweden would benefit from a standardised national framework covering regulations, implementation strategies, and signage.

Camera-based systems to monitor and restrict vehicle access during specific time periods are used, for example, in the United Kingdom (Clarke, 2022). However, implementing similar solutions in Sweden is more challenging due to stricter regulations, and surveillance in public spaces must comply with the General Data Protection Regulation (GDPR) (Swedish Authority for Privacy Protection (IMY), 2025). While Sweden's regulations may provide strong protection of individual privacy, they may also limit the use of effective enforcement measures. This creates a dilemma between privacy protection and improved traffic safety, and Sweden's stricter regulatory framework may hinder the adoption of solutions that have proven effective in other countries.

In addition, road ownership can further complicate implementation. The authority to close a street depends on whether the road is municipally, state, or privately owned, and additional permits may be required, which can delay or hinder implementation (Officials at Uppsala municipality, personal communication, February 12, 2026). Moreover, legal procedures and stakeholder coordination can prolong the process even when the municipality owns the street.

7.1.4 Implementation strategies and challenges

Several implementation strategies influence the success of car-free zones around schools. A common approach is to begin with pilot or trial projects before deciding on permanent implementation, allowing feasibility to be tested, outcomes to be evaluated, feedback to be gathered, and measures to be adjusted before they become permanent (Clarke, 2022; Ljungblad & Rosendahl, 2025). In contrast, some countries have implemented permanent measures directly, which may have a stronger effect on behaviour change because people perceive the new traffic arrangement as lasting (Clarke, 2022).

Another major distinction concerns whether measures are permanent or temporary, with time-restricted regulations at the start and end of the school day being the most common temporary approach (Köllinger, 2024). Research suggests that permanent measures have a stronger effect on perceived safety and air quality, and yield better long-term outcomes (De Ridder et al., 2020). However, temporary solutions can be politically and practically easier to implement and may have a more limited impact on other groups, such as nearby residents (Clarke, 2022).

For temporary closures, measures such as movable barriers or volunteer-led control are common, as they are relatively easy to implement and require lower investment. However, these measures often rely on sustained involvement from volunteers and staff, which can be difficult to maintain over time. A more adaptable option is automated barriers, which can provide both control and flexibility by restricting vehicle entry during specified time periods while still allowing vehicles to exit the area. However, such systems may involve higher costs and technical complexity.

In terms of spatial scope, it may be preferable to expand the car-free zone to include several streets in the surrounding area rather than only the street immediately adjacent to the school (De Ridder et al., 2020; Stadsmiljöförvaltningen Göteborg Stad, 2025). If other parts of the school route remain unsafe, restricting a single street in front of the school may have limited effect. However, broader schemes can be more difficult to implement, as they have greater impacts on traffic flow and local residents.

Several studies highlight that signage and regulations alone are insufficient, as compliance is often low (Distefano et al., 2025; Gustafsson, 2024; Holmström, 2024; Krook, 2024; Stadsmiljöförvaltningen Göteborg Stad, 2025). Non-compliance can further undermine perceived safety when vehicles enter streets that pedestrians expect to be car-free. To achieve better outcomes, signage and regulations should be complemented by additional measures, such as physical barriers, camera enforcement, or street redesign. However, such measures can be more complex to implement due to higher costs, legal constraints on camera surveillance, resistance from residents, and practical challenges associated with time-restricted barriers and the need to maintain access for certain vehicles. Compliance is crucial to whether a car-free zone is perceived as positive and effective. Without sufficient compliance, the intended safety benefits may not be achieved and, in some cases, conditions may become even more unpredictable.

Stakeholder involvement is also an important implementation strategy. Engaging parents, children, school staff, and nearby residents in the planning process can improve understanding of the intervention, increase acceptance, and support a shift towards active transport modes (Distefano et al., 2025; Uppsala kommun, 2025). Resistance from residents or parents is a recurring challenge in many implementations, which further highlights the need for meaningful engagement (Distefano et al., 2025; Gustafsson, 2024; Holmström, 2024; Krook, 2024; Stadsmiljöförvaltningen Göteborg Stad, 2025). Higher acceptance and lower resistance may also be achieved by standardised signage and regulations, which can increase awareness and understanding of the concept.

A further challenge concerns the trade-off between maximising safety benefits through a fully car-free zone supported by physical barriers and maintaining necessary access for certain groups, such as emergency vehicles, deliveries, residents, and people with reduced mobility. Several cases demonstrate that the need to allow exemptions from vehicle restrictions can complicate the implementation of enforcement measures (Distefano et al., 2025; Stadsmiljöförvaltningen Göteborg Stad, 2025).

7.2 Evaluation of proposed solutions of car-free zones around schools in Gothenburg

When developing proposals for car-free zones around schools, several factors must be considered, and the local urban context is crucial for determining which measures are feasible and appropriate. For the four selected schools in this study, the proposed solutions have been developed and adapted to the specific conditions at each location.

For Brunnbsboskolan and Långmosseskolan, a permanent traffic closure has been proposed for one street directly in front of the school entrances. A key similarity between these contexts is that neither street provides access to a substantial number of residential driveways or parking facilities. As a result, closing these streets is expected to have only a limited impact on residents.

In the case of Långmosseskolan, the street functions as a dead-end road, meaning that the closure does not affect through traffic. This is an additional advantage when implementing car-free zones. For schools in contexts similar to Långmosseskolan, a complete closure of traffic is particularly suitable, as it does not disrupt the wider traffic network or substantially impact residents.

For Brunnbsboskolan, although the street is not a dead end, alternative routes are available. Traffic can be redirected to Rimsmedsgatan while maintaining access for residents, as well as to the preschool and parking areas along Författaregatan. There is still no through traffic on these streets because Författaregatan is a dead-end street, which further supports the feasibility of a closure. This suggests that a permanent vehicle restriction can be feasible provided that suitable alternative routes are available.

In contrast, for Kungsladugårdsskolan, a permanent closure is not proposed. Instead, the street on the north side of the school is proposed to be closed temporarily to vehicle traffic. The street serves a large number of residents who rely on it for access to parking and their properties, and a permanent closure would therefore have a more substantial impact on local residents. A permanent closure is also less likely to be accepted when many people are affected. Instead, a time-restricted closure is proposed during the morning peak (07:30–08:15), as it improves safety during the most critical period, when most children travel to school, while minimising disruption for residents.

Nevertheless, some residents may still object to restricted access during the morning peak. Implementing traffic restrictions without affecting any group is difficult, and some inconvenience is often unavoidable. However, since no residents were observed entering the area during this time period in any of the field visits, the practical impact is assessed as limited. The measure is therefore considered justified given the expected improvement in traffic safety for children arriving on foot or by bicycle.

A common characteristic across all three cases is the limited amount of through traffic. This is a key factor for the suitability of a car-free zone, as it allows traffic restrictions to be implemented without causing major disruption to the wider road network. In addition, most traffic outside the schools consists of parents driving their children to school, which is precisely the type of traffic that car-free zones aim to reduce, and instead encouraging a shift towards active transport modes.

In contrast, the conditions around Brottkärsskolan include a high level of through traffic and a lack of suitable alternative routes. Brottkärsskolan therefore illustrates a context in which a car-free zone is unlikely to be feasible and may instead have substantial

negative impacts on the overall traffic system. This case underscores that car-free zones are not appropriate in all urban contexts, and that a thorough assessment of the road network is essential prior to implementation.

An additional consideration when implementing car-free zones is the need to provide suitable alternatives for parking and drop-off when the former locations are no longer accessible to motor vehicles. Although the aim is to reduce the number of school trips made by car and encourage a shift towards active transport modes, some car trips to school are likely to remain. Designated parking and drop-off areas are therefore important to avoid conflicts and unsafe conditions elsewhere, for example when vehicles stop in inappropriate locations. Accordingly, rather than removing all parking and drop-off opportunities around Kungsladugårdsskolan, Brunnsboskolan, and Långmosseskolan, the proposed solutions include both existing and new locations where interactions between vehicles and pedestrians are more limited. Car-free zones should thus not only restrict traffic, but also carefully manage where remaining vehicle traffic is redirected, in this case by planning for drop-off and parking in more appropriate locations.

The literature review and interview findings also highlight the importance of physical measures to support traffic regulations and ensure compliance. Across the three case studies where traffic closures were proposed, different physical measures were selected depending on local conditions. Around Brunnsboskolan, flower boxes and concrete barriers were proposed in locations where vehicle access was considered unnecessary. At one access point, a barrier gate is proposed to maintain access for one household and for emergency vehicles. At Långmosseskolan, access must be maintained for goods deliveries, emergency vehicles, and individuals with reduced mobility, as this is the only road providing access to the school. Therefore, a barrier gate was selected.

For time-restricted measures, such as at Kungsladugårdsskolan, implementing physical measures is more challenging because the restriction applies only for a short time period. An automated barrier gate was proposed to enable closure during the morning peak while keeping the road open at other times. In some international cases, temporary closures are managed by volunteers who place barriers manually (Department for Transport & Active Travel England, 2024; Sherekar, 2025). However, relying on volunteer availability is undesirable for long-term operation and therefore, this solution is not preferred. Overall, although physical measures can be challenging when access must be maintained for certain groups, this study strongly recommends their use to support compliance.

In locations or on streets where traffic closures are not applicable, the focus should instead be on improving safety through other measures. This can be achieved by ensuring low vehicle speeds, providing safe pedestrian crossings, improving walking and cycling infrastructure, and strengthening separation between vehicles and pedestrians. The measures proposed in this study across all case areas include speed humps and raised pedestrian crossings, both of which can substantially reduce vehicle speeds in areas where children are present. Raised pedestrian crossings are particularly effective, as they provide clearly defined and highly visible crossing points while physically enforcing vehicles to slow down. This is especially important in school environments, where children may have a limited ability to assess traffic risks.

In addition to speed reduction, minimising direct interaction between vehicles and pedestrians or cyclists is essential. Observations indicate that vehicles use pedestrian

paths for turning manoeuvres and drop-off, particularly in the turning area on Monologatan. To address this, fences are proposed to clearly separate pedestrian paths from the carriageway. Furthermore, the pedestrian and cycling infrastructure is proposed to be widened and, in some cases, re-routed to prioritise these user groups and limit interactions with vehicles. At Kungsladugårdsskolan, conflicts were observed where the pedestrian and cycling path terminated in a turning area, requiring users to cross vehicle movements to access the school. By re-routing this path, users get direct access to the school and interactions with vehicles are eliminated. Reducing the number of conflicts and interactions between user groups contributes to a safer traffic environment.

Substantial safety improvements can be achieved through a combination of these measures, even where traffic cannot be prohibited. These measures are therefore important complements to car-free zones and may, in some cases, represent the most appropriate approach given local conditions, such as around Brottkärsskolan.

In addition, the literature review and interview findings indicate that design measures and visual elements, such as pavement markings in the form of footsteps and the use of flower boxes, can create a more attractive and pedestrian-friendly environment. Such measures are appreciated by children and can encourage walking instead of car use (Officials at Uppsala municipality, personal communication, February 12, 2026). These relatively simple and cost-effective interventions have been successful in previous implementations and are therefore relevant to include across all case areas.

Clear and standardised signage is also proposed at all locations to communicate the measures and support compliance. Developing standardised signage in Sweden and integrating it into national frameworks could further improve understanding and acceptance of the concept. Standardised signage that road users recognise is considered an important factor for regulatory compliance and for facilitating wider implementation across cities.

In summary, many factors must be considered, and measures need to be adapted to local conditions. The four schools in this study provide concrete examples of solutions for different urban contexts, and illustrate where particular measures are likely to be suitable. The simulation results for two of the schools further indicate that these measures can be implemented without significant negative impacts on the traffic system, even when assuming no behavioural change. Although effectiveness is strongly dependent on site-specific factors, the proposed solutions have the potential to be transferred to other locations and urban contexts. While it may not be possible to replicate a previous implementation directly, the growing body of examples of car-free zones around schools shows that elements from different implementations can be combined to fit conditions at a new location. This can also inform guidance on which measures are appropriate in different contexts. Overall, car-free zones around schools should not be applied as a standardised solution, but rather as a context-sensitive approach in which knowledge from previous implementations is adapted and combined to suit local conditions.

7.3 Limitations

This chapter presents the limitations of the study. These include limitations related to the simulation tool and model, as well as limitations of the overall project. The study is subject to, for example, simplifications required by the software, assumptions made during the analysis, and constraints in the data collection. Following the limitations of the simulation tool and model, the suitability of using simulation to model car-free zones around schools is discussed.

7.3.1 Limitations of the project

Data collection was conducted to obtain input data for the simulation. Traffic was counted manually on a single occasion. This limits the reliability and representativeness of the data, as counting errors may occur and traffic conditions may vary between days. However, these data were used only as inputs to the simulation model, which itself includes several assumptions and simplifications. Therefore, minor differences in traffic volumes are unlikely to substantially affect the results.

The literature review indicates that involving key stakeholders, such as children, parents, school staff, and nearby residents, is important for successful implementation. This was not included in this thesis due to the scope and time constraints of the project, and because the study examines potential implementation solutions in a theoretical manner rather than supporting an imminent real-world intervention, which made active stakeholder involvement more difficult.

Finally, the proposed solutions for each school are based on the authors' knowledge gained from the literature review, interviews, field visits, and the simulations, and should not be interpreted as definitive or as the only suitable solutions. Rather, they represent suggested approaches for implementing car-free zones in different urban contexts and highlight factors that should be considered. As each school and location is unique, the local urban context must be taken into account when planning car-free zones around schools.

7.3.2 Limitations of the simulation model

The aim of using the simulation tool was to represent real-world conditions as accurately as possible. However, this was not fully achievable due to limitations of the simulation software, and some simplifications and assumptions were therefore necessary.

On several residential streets around both schools, on-street parking reduces the effective road width such that only one vehicle can pass at a time, requiring vehicles travelling in opposite directions to share the same lane. This could not be modelled accurately in PTV Vissim, as the software does not allow two-way traffic on the same link. Therefore, separate links were implemented for each direction, and on-street parking was modelled on one of the links.

In addition, the main contributor to chaotic traffic conditions around schools is often not high traffic volumes, but driving behaviour, for example, stopping for drop-off in inappropriate locations, turning manoeuvres, and encroaching onto pedestrian space, in combination with high numbers of pedestrians and cyclists. Such behaviours are difficult to represent accurately in the simulation. To partially account for these effects,

short-duration on-street parking events were added to simulate drop-off scenarios.

For each intersection, vehicle routes were defined and route-choice shares were assigned. However, traffic counts were not conducted for the entire simulated area, and assumptions were therefore required for route-choice distributions. For streets where traffic counts were available, vehicle inputs were adjusted to match observed volumes. Pedestrian and cyclist volumes were not counted and were therefore also assumed. Finally, external factors, such as weather conditions and their influence on travel behaviour, were not considered.

7.3.3 Suitability of using simulation tools for modelling car-free zones around schools

Following the discussion of the simulation model limitations, the suitability and reliability of using simulation to model car-free zones around schools can be assessed. As highlighted in the previous section, there are several challenges in accurately capturing real-world conditions, particularly driving behaviours such as drop-off activity and turning manoeuvres. These limitations mean that the simulation cannot be considered a fully realistic representation of real-world conditions.

Nevertheless, simulation tools can still provide valuable support for implementation by enabling traffic flow analyses and assessing the impacts of different measures. The results should, however, be interpreted with caution and complemented with professional judgement and experience. Simulation tools may be particularly useful when planning new developments, to provide insights into how different designs affect traffic flow, and in areas with higher traffic volumes, as also noted by officials at Uppsala municipality (personal communication, February 12, 2026).

With further development to better capture driving behaviours around schools, simulation models have the potential to become a powerful tool to support more efficient and effective implementation of car-free zones.

7.4 Further research

Future research on the implementation of car-free zones around schools in Sweden, including Gothenburg, could examine how signage and regulatory frameworks can be developed to simplify and standardise implementation. Many municipalities are interested in adopting the concept, but the lack of clear guidance makes implementation more difficult. Specific signage could also improve clarity for road users and contribute to broader understanding and acceptance of these measures.

Future research could also explore how implementation knowledge can be shared more effectively between municipalities. Although car-free zones must be adapted to the local urban context, there are substantial benefits to sharing experiences and lessons learned. For example, the feasibility of a national platform where municipalities publish information about their projects, similar to the online map developed by the London Borough of Hackney, could be investigated (London Borough of Hackney, 2025).

Finally, further work is needed on simulation tools that are better able to capture the driving behaviours observed around schools. Current tools have limitations in modelling behaviours such as turning manoeuvres and stops for drop-off, indicating a need for improved approaches to model car-free zones around schools more accurately.

8 Conclusion

This thesis has examined how car-free zones around schools have been implemented in different contexts, which measures tend to work best, and how such measures could be implemented around four selected schools in Gothenburg. The findings indicate that car-free zones can reduce car trips, improve traffic safety and environmental conditions, and encourage a shift towards active transport modes.

The study also shows that several implementation strategies have been used, including temporary and permanent measures, as well as regulatory and physical interventions. In addition, major differences between countries were identified in how the concept is supported through legal frameworks and standardised guidelines, including signage.

A key takeaway is that there is no standardised solution for implementing car-free zones around schools. Effectiveness instead depends on contextual factors, such as the function of the surrounding road network, the availability of alternative routes, and the surrounding urban structure. For example, traffic closures are most suitable on local streets with low traffic volumes and limited through traffic, where impacts on overall traffic flow are small. Successful implementations are adapted to local conditions and supported by physical measures, rather than relying on signage and regulations alone.

The main challenges identified in this study include traffic displacement, low compliance with regulations, and resistance from stakeholder groups. Traffic displacement may reduce safety on adjacent streets, highlighting the importance of considering the surrounding network when implementing car-free zones. Low compliance is often observed when measures rely on signage alone, limiting the effectiveness of implementation. Physical measures to support regulations are therefore recommended. Resistance from stakeholders, such as residents and parents, can also arise where access is restricted or benefits are not well understood. Relevant stakeholders should therefore be involved in the planning process.

Different solutions adapted to local urban contexts were proposed for the four case study areas. For Brunnsboskolan and Långmosseskolan, permanent street closures were considered suitable, while a time-restricted closure during the morning peak was proposed for Kungsladugårdsskolan. In contrast, Brottkärrsskolan illustrates a context in which traffic closure is not suitable due to high levels of through traffic and a lack of suitable alternative routes. Instead, alternative safety measures are proposed. Across all cases, traffic closures are supported by physical interventions and complementary safety measures, including speed reduction, safer crossings, separation between user groups, and improved walking and cycling infrastructure. The simulation results for Kungsladugårdsskolan and Brunnsboskolan indicate that the proposed measures can be implemented without significant negative impacts on the surrounding traffic system, even under the assumption of no changes in travel behaviour. The most affected streets reached LOS B at Kungsladugårdsskolan and LOS C at Brunnsboskolan, with maximum queue delays of 14.90 and 17.39 s/vehicle, respectively.

Overall, the findings demonstrate that car-free zones around schools have strong potential to improve traffic safety and promote active transport in Gothenburg. However, successful implementation requires careful adaptation to local conditions and the use of complementary measures to improve safety and ensure compliance with regulations.

9 References

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Appendix A

Interview questions Uppsala municipality

The following questions were prepared in advance and asked during the semi-structured interview with officials from Uppsala municipality. The interview was conducted in Swedish and the questions have been translated to English.

1. Could you please describe your role at the municipality and what your work involves?
2. How did you select the schools (Funbo, Rosendals and Domarringen skola)?
3. Did you use any simulation modelling before implementing the school street?
4. Did you do any evaluation afterwards? What were the results, positive or negative?
5. What types of data were available for the evaluation, and were there any important data gaps?
6. If it was successfully implemented, what were the most important factors for it to be successful?
7. Did the traffic safety increase?
8. Did the active transportation increase?
9. What were the main lessons, and what difficulties did you run into?
10. What would you do differently if you did it again?
11. What were the differences between the different types of schools?
12. How did residents in the area respond to the restrictions?
13. Do people follow and respect the restrictions and signage?
14. Looking back, do you think simulation or modelling could have been useful in the planning or evaluation phase? If so, how?

Appendix B

Data collection Kungsladugårdsskolan

Location 1:

Table B.1: Observed vehicles and behaviours at location 1 during the morning of March 3.

	07:30–07:40	07:40–07:50	07:50–08:00	08:00–08:10
Observed vehicles east	5	8	7	4
Observed vehicles west	4	1	4	1
Drop-off	3	3	1	1
Parking	4	2	4	1
Turning around	0	0	0	1
Leaving parking east	1	6	2	7
Leaving parking west	0	1	0	2

Location 2:

Table B.2: Observed vehicles and behaviours at location 2 during the morning of March 3.

	07:30–07:40	07:40–07:50	07:50–08:00	08:00–08:10
Observed vehicles east	7	12	8	11
Observed vehicles west	10	6	5	2
Driving into the parking	4	4	3	1
Drop-off	4	1	2	1
Parking	2	1	3	0
Turning around	1	3	1	2
Godhemsgatan	3	3	2	2
Lilla Fridhemsgatan	6	6	6	4

Location 3:

Table B.3: Observed vehicles and behaviours at location 3 during the morning of March 3.

	07:30–07:40	07:40–07:50	07:50–08:00	08:00–08:10
Observed vehicles	13	15	14	8
Parking along the road	3	2	2	3
Turning in the crossing	1	2	0	1
Olof Strålegatan	3	2	2	0
Taxi turning area	6	8	5	6
Parking	4	3	5	0

