CHALMERS
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Public transport during COVID-19

How to take advantage of a pandemic

Master's thesis ACEX30

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Department of Architecture and Civil Engineering
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2021

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Thesis cover: Picture of the tram in Lund which was inaugurated during the COVID-19 pandemic, 12 December 2020.

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Abstract

As the COVID-19 pandemic hit the world in March 2020 many changes occurred, one of them being a severe travel reduction. This has affected public transport heavily as they have operated with the same supply as before the pandemic but with reduced passengers and thereby ticket income, which could lead to long-term consequences for the post-pandemic public transport if not remediated.

This master's thesis was carried out during the COVID-19 pandemic to investigate how public transport was affected during the pandemic's first year, and to create solutions on how the found positive effects can be maintained and the negative ones counteracted.

A literature study was carried out where the changes due to the COVID-19 pandemic were presented, i.e. travel changes for different modes of transport and societal changes. Interviews were held with the major regions' public transport authorities to gain knowledge about the different approaches on the pandemic. Traffic data was analysed to collect numbers of the change in travel numbers and travel distribution over the day.

Seven negative and three positive pandemic effects were found based on the research material. Furthermore four potential long-term effects were established, all negative. The long-term effects will be the most crucial ones to determine for the future planning of public transport but as they now only can be assumed, the documented pandemic effects are as important to give a relevant view of what has happened and to be an indication of what can be expected ahead.

Twelve solutions were produced, ten aimed towards public transport authorities and two towards authorities working on a local, regional and national level. The solutions need to be adjusted and combined by each authority implementing them to achieve the most efficient result possible.

Sammanfattning

När världen drabbades av COVID-19-pandemin i mars 2020 förändrades många människors liv till följd av restriktionerna som infördes i syfte att minska smittspridningen. En av konsekvenserna har varit en kraftig resandeminskning som har påverkat kollektivtrafiken kraftigt då kollektivtrafikmyndigheterna har kört med samma utbud som före pandemin men med färre passagerare och därmed minskade biljettintäkter. Detta riskerar att leda till långsiktiga konsekvenser för kollektivtrafikens utveckling efter pandemin om de inte åtgärdas.

Detta examensarbete genomfördes under COVID-19-pandemin för att undersöka hur kollektivtrafiken påverkats av pandemin under dess första år och för att ta fram lösningar för hur de funna positiva effekterna kan bibehållas och de negativa motverkas.

En litteraturstudie genomfördes där förändringarna av COVID-19-pandemin presenterades, till exempel resändringar för olika transportmedel och samhällsförändringar. Intervjuer hölls med storstadsregionernas regionala kollektivtrafifkmyndigheter för att få kunskap om de olika åtgärderna som gjorts under pandemin. Trafikdata analyserades för att samla in data för förändringen i antalet resande och resfördelning över dagen.

Sju negativa och tre positiva pandemiska effekter hittades baserat på arbetsmaterialet. Dessutom fastställdes fyra potentiella långsiktiga effekter, alla negativa. De långsiktiga effekterna anses vara de mest avgörande för den framtida kollektivtrafikplaneringen, men eftersom de i nuläget bara kan antas är de dokumenterade pandemiska effekterna lika viktiga för att ge en relevant bild av vad som har hänt och ge en fingervisning om vad som kan förväntas ske framöver.

Tolv lösningar togs fram, tio riktade till kollektivtrafikmyndigheterna och två till myndigheter som arbetar på lokal, regional och nationell nivå. De behöver justeras och kombineras av varje myndighet som genomför dem för att uppnå det mest effektiva resultatet.

Preface

This master's thesis report was written January-May 2021 via Chalmers University of Technology in cooperation with Trivector AB. As the author lives in Region Skåne nowadays, the work was mainly carried out in Lund and Malmö. The COVID-19 pandemic is still ongoing with vaccinations carried out at the time of writing.

This master's thesis finalizes my civil engineer studies specialised within the master's program Infrastructure and Environmental Engineering (MPIEE) at Chalmers, including courses within the specialisation of Transport and Roads at Lund Faculty of Engineering (LTH).

I want to express my deepest gratitude to my supervisors Ziling Zeng from Chalmers and Mats Améen from Trivector who both gave me a strong support with their knowledge and experience within the field of transportation and thesis construction. I also want to thank my examinor Xiaobo Qu for his help.

Furthermore I want to thank the employers at SL (Kristina Abelin, Mark Kesper, Ivana Ewerlöf and Hampus Larsson), Västtrafik (Leif Gjulem and Michael Stjernberg), Skånetrafiken (Carl Björklund) and Trivector (Emeli Adell) who have made the interviews and traffic data analysis in this report possible.

I finally want to thank my family and friends who have supported me through my education and patiently participated in endless infrastructure discussions. Thank you Jacob for helping me with Latex and the pictures of this report.

In these special times of the COVID-19 pandemic, I have been especially grateful for the possibility to gain knowledge from two great universities and two interesting, developing regions remotely. I am also grateful for the possibility to sit at the libraries of LTH and Malmö University when everything else has been closed down.

Lastly, for better or worse, this report would never have been written if the COVID-19 pandemic had not occurred.

Aida Skåreby Kalaaji, Malmö, June 2021

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1
Introduction

This report will present how public transport in Sweden has been affected by the COVID-19 virus in 2020 and how this knowledge can be used to develop an improved public transport system after the COVID-19 pandemic. Firstly the background of the report will be presented with aim, objectives, demarcations and general method. Secondly the introductory work of this report will be presented, the literature study, to investigate some of the objectives related to transport and society. Thereafter interviews with representatives from the three major public transport authorities will be presented and analysed to see how the authorities have handled the pandemic situation where physical contact should be avoided. Followed by that is the presentation of traffic data investigating how the pandemic has affected public transport in travel numbers. After that the pandemic effects will be presented based on the so far produced material. Then potential solutions on how to maintain the positive effects and counteract the negative ones will be presented. Lastly, a discussion and conclusion will finish the report.

1.1 Background

To introduce this report the background will be presented followed by aim, objectives, demarcations and general method.

1.1.1 The Coronavirus Outbreak

2020 will be remembered as the year when the COVID-19 pandemic hit the world. The Coronavirus, leading to the disease of COVID-19, had in January 2021 claimed two million victims globally and 10 000 in Sweden (Johns Hopkins University and Medicine, 2021) making it one of the main death causes in Sweden during 2020 (Socialstyrelsen, 2020-2021). The virus itself might not even stand for the major impact as laws and restrictions to avoid the spread of the virus have limited the average citizen's life drastically. Closed borders and workplaces have led to unemployment and remote work, and canceled events and activities have greatly limited the access of social and cultural occasions. The COVID-19 pandemic will surely have permanent effects on the post-pandemic society, but at the time of writing those effects are yet unknown and can only be speculated about.

1.1.2 COVID-19 and the impact on public transport

One consequence of the COVID-19 restrictions has been an immense decrease in travel. Although travel has decreased overall, the travel by public transport has

done so significantly. In April-May 2020, compared to 2019, overall travel decreased with 36% while public transport travel decreased with 68% (Svensk Kollektivtrafik, 2020a-b). For June-August the decrease was 14% respectively 66%. A consequence of this has been a loss of income and thereby worsened traffic economy for the public transport authorities. At the same time there are demands to operate traffic as usual and reduce congestion, which means that production costs hardly can be reduced. Different public transport authorities have handled the problem differently with possibly different outcomes. Inevitably the COVID-19 pandemic has also brought positive effects on the traffic system; biking has increased and the overall travel reduction might indicate that a share of unnecessary travel has been avoided when people are able to work from home. Public transport is a measure and not a goal itself to achieve fundamental values of society. These values include accessibility, freedom of choice, economic growth, traffic safety, environmental factors and health (Svensk Kollektivtrafik, 2018) - in other words well-functioning cities. It is therefore crucial to ensure the maintenance and development of public transport as a societal function even after the COVID-19 pandemic has passed.

1.2 Aim

This master's thesis aims to result in recommendations on how the positive effects the COVID-19 pandemic has had on public transport can be maintained and further developed after the pandemic, and how the negative effects can be counteracted. To fulfill this the COVID-19 pandemic's effect on traveling, public transport as well as other conventional traffic modes such as car, bike and pedestrian traffic will be investigated. The COVID-19 pandemic's effect on societal behavior will also be investigated to analyse if the pandemic itself or another phenomenon like remote work is the main factor affecting the travel. This work will furthermore investigate how the public transport authorities of the three major regions of Sweden (Stockholm, Västra Götaland and Skåne) have handled the COVID-19 pandemic and relate this to the actual travel difference for each region to see if there is any correlation.

1.3 Objectives

- How has the introduction of the COVID-19 pandemic affected the travel of different modes of transport in Sweden?
- What other significant changes has the COVID-19 pandemic brought to the Swedish society? Do they have a connection to the travel changes?
- How have the public transport authorities of the three major regions in Sweden handled the COVID-19 pandemic?
- How has travel with public transport changed in the major regions during the COVID-19 pandemic? Is there a connection between this development and how the public transport authorities have handled the COVID-19 pandemic?
- Has the hourly travel distribution with public transport become more even during the COVID-19 pandemic?
- What were the positive effects on public transport during the COVID-19 pandemic? How can these be further maintained after the pandemic?

- What were the negative effects on public transport during the COVID-19 pandemic? How can they be counteracted after the pandemic?

1.4 Demarcations

- The COVID-19 pandemic might be referred to as simply the pandemic. This work will focus on the period of March-December 2020 compared to 2019.
- Although the COVID-19 pandemic has affected public transport globally, this work will focus on Sweden. The literature will focus on Swedish data and the final recommendations will be aimed at the Swedish authorities. Inspiration might be brought from abroad to enable new ideas and methods to be regarded for the development of the Swedish public transport system.
- It might be an alternative to delimit the analysis of the public transport authorities to the major cities Stockholm, Gothenburg and Malmö respectively as most of the travel occurs here. However, in Skåne it would be invalid as the travel is much more spread out between the cities of Malmö, Lund and Helsingborg and with Denmark and Copenhagen connected. Therefore the whole regions will be studied with the different factors of the regions in mind. Different modes of public transport and the length of the trips will not be used as factors when dealing with the traffic data.

1.5 General method

In this section the methods used in this report will be synoptically presented. The more detailed methodology can be found in their respective chapter.

1.5.1 Literature study

To obtain information about the effects the COVID-19 pandemic has had on travel and societal behavior research material from institutes like K2 (*Kollektivtrafikcentrum*, Center of public transport) and Svensk Kollektivtrafik (Swedish Public Transport) will be analysed. Changes in total travel and travel share between different modes of transport will be analysed and specific COVID-19 recommendations published by the Public Health Agency of Sweden (*Folkhälsomyndigheten*) will be studied.

1.5.2 Interviews

Information about the strategies from the three major public transport authorities will be collected via interviews with representatives from the authorities. As the pandemic is ongoing the interviews will be carried out digitally via video meetings.

1.5.3 Traffic data analysis

To gain knowledge about differences in public transport travel during the pandemic, travel data for the three major regions for the years 2019 and 2020 is needed and

will be searched for via respective public transport authority. The sought data is total travel per month and per hour during the day.

1.5.4 Elimination matrix

To determine if the sought effects from the so far produced material are positive or negative, they are put in an elimination matrix with criterias that are crucial for public transport development.

2
Literature study

In this chapter the result from the introductory work of the report, the literature study, will be presented. Firstly previous research within the subject for this report will be acknowledged and put in relation to this report. Thereafter relevant literature will be presented to answer the relevant objectives of this work related to transport and societal changes due to the COVID-19 pandemic. One summary will conclude the transport related part and one will conclude the transport and society related parts combined.

2.1 Research focus

In this section the previous research in the field is presented followed by a comparison to the research of this report.

2.1.1 Previous research

One year into the COVID-19 pandemic several research articles have already been published about the supposed connection between the pandemic and public transport. An article published in October 2020 (Jenelius et al., 2020) investigates the changes in public transport ridership in the three major regions of Sweden during February-June 2020 based on ticket sales, ticket validation and automatic passenger counting. The result was presented in respect to different ticket types and public transport modes. Another article (Almlöf et al., 2021) investigates which groups continued to travel with public transport during Spring and Autumn 2020 in Region Stockholm. The authors analysed the use of 1,8 million smart cards and what impact socioeconomic factors have had on public transport during the pandemic. Another paper (Vitrano, 2021) investigates the changes and challenges in public transport connected to public health during the pandemic such as virus transmission and peoples' attitudes. It also looks into how public transport authorities can adapt their business to meet these challenges. In a report published by the Swedish knowledge center of public transport (Nationellt kunskapscentum för kollektivtrafik, 2021), the focus lies on finding future solutions to manage public transport after the COVID-19 pandemic.

2.1.2 This research

This work will inevitably investigate some things similar to some of the works mentioned in 2.1.1. This includes the change in ridership in the three major regions and future solutions for public transport. The work is thought to be distinguished by a

greater focus on mobility, where public transport is seen in a bigger perspective as one of several modes of transport and one of several changeable factors in society. Therefore the change in ridership of several modes of transport will be analysed nationally. The change of why, when and how people travel with public transport will be investigated. Non-transport related changes such as consumption and remote working will also be analysed and related to transport. The work will also deal with traffic data from all of 2020, January-December, with focus on the period of the pandemic from March-December, compared to 2019.

2.2 The Public Health Agency's general guidelines on transportation

As a part of their assignment to strengthen and develop public health the Public Health Agency of Sweden, *Folkhälsomyndigheten*, published general guidelines during all of 2020 on how to avoid the spread of COVID-19. The Public Health Agency states that there lies a personal responsibility by every individual to protect themselves and others from the spread of the Coronavirus. 1 April 2020, the guidelines were updated to include restrictions on travel with public transport. The guidelines stated that unnecessary travel and travel during rush hours should be avoided and that distance should be kept to others when traveling with public transport. It was also recommended to work from home when possible and to avoid social gatherings (Folkhälsomyndigheten, 2020a). 13 June 2020, additional guidelines were enforced stating that public transport with non-bookable spots should be avoided and that modes of transport such as walking and biking should be used instead (Folkhälsomyndigheten, 2020b). 7 January 2021, protective masks were recommended when traveling with public transport during rush hours (Folkhälsomyndigheten, 2021a). These guidelines have been observed to influence peoples' behavior when it comes to travel, see 2.3-2.5, and behavior in general, see 2.8.

2.3 Travel changes for all modes of transport

In this section the travel changes for the overall travel regardless of mode of transport will be presented.

2.3.1 Change in the number of daily trips within Sweden

Data collected from the mobile network of Telia has been used to show how the number of daily trips has changed during the pandemic as can be seen in Figure 2.1. From March 2020 to January 2021 the travel has consistently been lower compared to one year prior. The travel at the beginning of 2020 in January and February was approximately at the same level as in 2019. In March 2020 the travel decreased by ca 22% over a few weeks, and these travel rates remained until May 2020. Then the travel increased to be only about 10% lower compared to 2019, and this remained until October 2020. Next a steady travel reduction reached its peak in December 2020 with ca 36% lesser travel compared to one year prior. In January 2021, the travel was about 26% lower compared to 2020 (Telia, 2021).

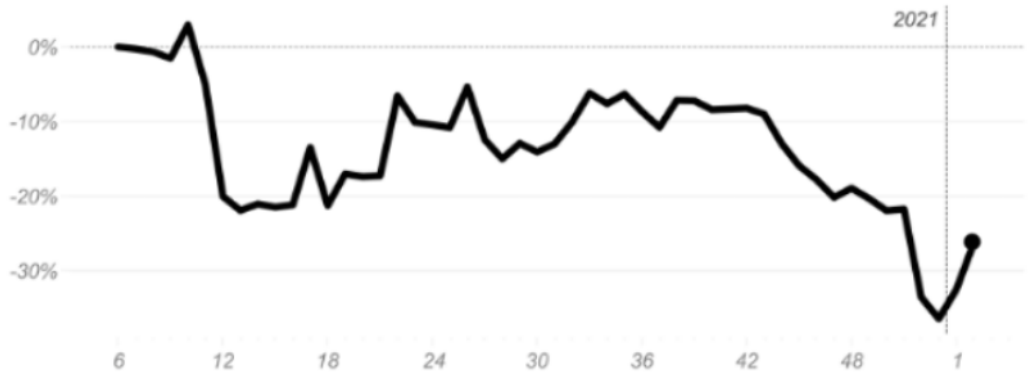

Figure 2.1: Percental weekly change in the number of daily trips within Sweden 2019-2020 (Telia, 2021).

2.3.2 Change in the number of daily trips to, from and within the three major counties of Sweden

When comparing the change in numbers of daily trips carried out in the three major regions of Sweden they generally follow the same pattern, see Figure 2.2. Region Stockholm has had the biggest decrease compared to one year prior with a maximum in December 2020 with ca 42% lesser travel. Region Skåne seems to have recovered more quickly with travel rates in April-September 2020 being less than about 10% lower compared to 2019, while the rates of Stockholm lie between 13-33% during the same period. From October 2020 until January 2021, the travel patterns of the three regions resemble each other more with only a few percentage points differing them at the most (Telia, 2021).

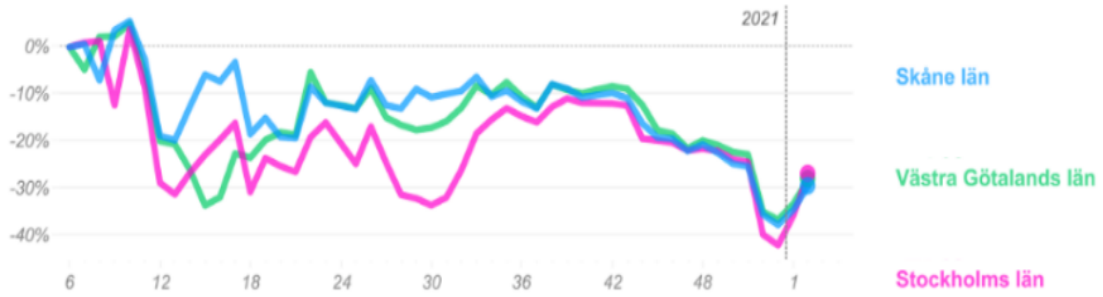

Figure 2.2: Percental weekly change in the number of daily trips to, from and within three major counties of Sweden 2019-2020 (Telia, 2021).

2.3.3 Travel within and outside of rush hours

As recommendations on avoiding traffic in rush hour have been introduced, there seem to have been a change in when during the day the trips are carried out. Statistics from Trafikanalys (2020) show that the travel reduction in March-August 2020 has been greater during rush hours compared to outside of rush hours.

2.4 Travel changes for different modes of transport

Firstly air traffic and rail traffic, here classified as national modes of transport, will be presented followed by car, bike and pedestrian traffic and finished by public transport, classified as regional and local modes of transport but referred to as simply local modes of transport. Passenger and freight transport will be presented for rail and car traffic.

2.4.1 Air traffic

Air traffic is undeniably the mode of transport that has been the hardest hit due to the COVID-19 pandemic. Domestic flights have decreased by 60% during March-December 2020 compared to 2019 and international flights by 75%, see Figure 2.3 (Trafikanalys, 2021).

2.4.2 Rail traffic

Railway passenger transport decreased by 14% while railway freight transport increased by 1%. However, the freight transport was also reduced during the first months of the pandemic, but increased to even higher levels than in 2019 during 2020's second half year. There are also indicators showing that the punctuality for trains has increased during the pandemic; according to Trafikverket (2021) passenger trains had a punctuality of 91,3% in 2019 and 93,5% in 2020. The reduced travel due to the COVID-19 pandemic is mentioned as one of several reasons.

2.4.3 Car traffic

The car usage on the Swedish national road network has decreased with 11% during March-December 2020 compared to 2019, see Figure 2.3 (Trafikanalys, 2021). Similar to rail traffic the passenger transport has experienced a greater reduction than freight transport as the heavy road traffic decreased by only 2% during the same period. Since the national road network only takes up about 15% of all roads in Sweden (Trafikverket, 2019) this development is only an indication of how the national car traffic has changed during the pandemic.

2.4.4 Bike traffic

Indicators show that compared to other modes of transport biking has not been very affected by the pandemic. According to the travel results in March-August 2020 by Trafikanalys (2020) biking was the only mode of transport increasing its traffic volume in 2020 compared to 2019, although slightly. According to traffic data analysed in TravelViewer (Trivector, 2021) there was no significant change in the number of bike trips carried out between 2019 and 2020.

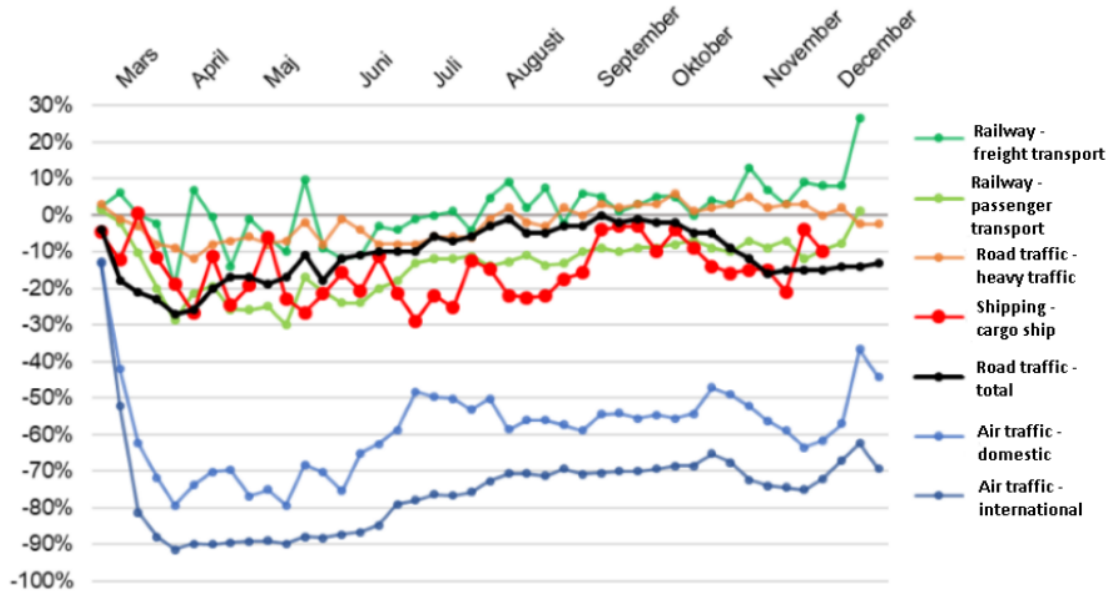

Figure 2.3: Percental change in traffic volumes for several modes of transport March-December 2019-2020 (Trafikanalys, 2021).

2.4.5 Pedestrian traffic

It is hard to find valid sources on how pedestrian traffic has changed during the pandemic. According to Trafikanalys (2020) walking has slightly decreased during March-August 2020, which is an indicator of pedestrian traffic being a mode of transport which has not experienced a significant travel reduction during the pandemic.

2.5 Travel changes for public transport

For this report public transport is defined as the modes of transport operated on behalf of public transport authorities to obtain passenger transport. The modes of transport identified are bus, tram, train and boat, and the travel is local (inner city) and regional (inter city). Travel with the mentioned modes of transport carried out on behalf of private companies will not be considered as public transport.

2.5.1 Change in number and share of trips with public transport

There has been a clear change and reduction of public transport trips during the pandemic. According to Trivector (2021) the number of public transport trips per passenger and day decreased by 36% between 2019 and 2020. A consequence of this has been heavy budget deficits of 7 billion SEK during 2020 and an expected deficit of 8,6 billion SEK during 2021, where 3 billion SEK has been given to the public transport authorities from the Swedish Government in subsidies (Svensk Kollektivtrafik, 2021a). The number as well as the share of trips have changed; the share of trips carried out by public transport decreased from 27% to 17% in 2020 compared to 2019 (Svensk kollektivtrafik, 2020b). During the same time the share of trips

made by car increased from 50% to 56%, by bike from 8% to 9% and by foot from 4% to 5%. Public transport has seemingly become a less frequent used traffic mode while car, bike and pedestrian travel have become more common modes during the COVID-19 pandemic; the market share for public transport decreasing from 32% to 21% between 2019-2020 among motorized vehicles is another indicator of it (Svensk Kollektivtrafik, 2021b). At the same time there are indicators of an increased punctuality of public transport during the pandemic; other than the higher punctuality of railway traffic (see 2.4.2) the punctuality of public transport increased by several percentage points to 85% during 2020 compared to 2019 (Svensk kollektivtrafik, 2021b).

2.5.2 Mode choice associated with public transport

As a consequence of the COVID-19 restrictions the reasons for and the way of traveling with public transport during the pandemic have changed. In the report Kollektivtrafikbarometern (Svensk Kollektivtrafik, 2021c) 33% stated that they have avoided public transport entirely while 23% stated that they have continued to travel as usual. Overall however, the study shows that the majority has changed their travel behavior connected to public transport due to the pandemic. The report also shows that the majority of those who stopped using public transport canceled their trips or carried out the aim of the trip in other ways, e.g. by working remotely. Of those who instead changed traffic mode a majority changed to car, and this was the most common solution when replacing a public transport trip. A change of mode of transport has also appeared towards biking and walking but not to the same extent (Svensk Kollektivtrafik, 2021c). The most common reason to travel with public transport was work both in 2019 and 2020. Another change is that all ticket types decreased in sales during 2020 except for single tickets which increased (Svensk Kollektivtrafik. 2021c). Even though the overall satisfaction with public transport has not changed remarkably during 2020 compared to previous years and a majority is prepared to resume travel with public transport after the pandemic (Svensk Kollektivtrafik. 2021c), the perception of public transport has changed within certain groups. The worry of COVID-19 is greater among groups that used public transport less frequently before the pandemic, and it is also greater among those who have stopped to travel with public transport entirely during the pandemic. Measures mentioned that would help people return to public transport after the pandemic would for example be provided hand sanitizer, extra cleaning and greater physical distance (Svensk Kollektivtrafik, 2021c).

2.6 Summary of travel changes

- There has been a general reduction in travel nationally as well as in the major regions during the COVID-19 pandemic. The travel changes can be connected to the recommendations from The Public Health Agency as the biggest declines in travel have occurred around the time for introduction of new recommendations.

- Passenger transport has decreased more than freight transport and have therefore seemingly been more affected by the COVID-19 restrictions. The mode

of passenger transport most affected is air traffic as it has been reduced by about 60%. Among the local travel public transport has been reduced the most with 36%. Car traffic has also decreased significantly but not as much. It is hard to determine if bike and pedestrian traffic have increased during the pandemic but they have not decreased significantly. The shares of local modes of transport (car, bike and pedestrian traffic) have increased at the expense of public transport decreasing.

- The COVID-19 pandemic has brought changes in how we travel by public transport. The most common reason to travel with public transport is work both before and during the pandemic, but as people have stopped using public transport during the pandemic a majority has carried out the aim of the trip in other ways like working remotely. The most common way of replacing a public transport trip was to go by car and single tickets have increased in sales compared to period tickets. Those who traveled the least with public transport before the pandemic are also the most worried about the exposure of COVID-19 with public transport, although the overall perception of public transport has not changed significantly with the pandemic. People have adjusted their travel behavior to the recommendations during the pandemic which state that public transport should be avoided. One of the consequences seems to be increased punctuality for departures of public transport.

2.7 The Public Health Agency's general guidelines

To limit the spread of the COVID-19 virus the following was included in the Public Health Agency's general guidelines 1 April 2020 (Folkhälsomyndigheten, 2020a):

- Be careful with your hand hygiene and wash your hands thoroughly
- Keep a distance indoors and outdoors where people gather
- Refrain from participating in larger social contexts

19 October 2020 regional recommendations with the following additions were enforced (Folkhälsomyndigheten, 2020c):

- Refrain from visiting people in risk groups and people living in special forms of housing for the elderly
- Refrain from staying in indoor environments where people gather, with the exception of necessary visits to e.g. grocery stores and pharmacies
- Refrain from participating in meetings and public events
- Refrain from visiting restaurants such as bars, restaurants and cafes
- Avoid having physical contact with other people than those you live with

14 December 2020 a publication was created with partly new and partly current, developed guidelines. The developed guidelines stated the following (Folkhälsomyndigheten, 2020d):

- Limit new close contacts

- Keep a distance and avoid crowded environments
- Perform sports and leisure activities in a way that minimizes the risk of infection
- Work from home as often as possible

Seemingly the form of the recommendations from The Public Health Agency have successively changed during 2020. As the spread of COVID-19 has intensified the recommendations have become more strict and detailed. All recommendations contain the same message; to avoid physical contact with other people as much as possible. May 2021, most restrictions are remaining. The Swedish Government has created a plan to remove restrictions slowly but steadily as the rates of COVID-19 goes down, which has been postponed several times during Spring 2021 (Folkhälsomyndigheten, 2021b).

2.8 Non-transport related changes

As a consequence of the COVID-19 restrictions the inhabitants of Sweden have changed their behavior in other ways than those connected to transport. According to studies carried out on behalf of the Swedish Civil Contingencies Agency (Myndigheten för samhällsskydd och beredskap, 2020) in March-May 2020 the most common changes were to wash and sanitize hands more often, avoid physical contact such as handshaking, hugging and kissing, avoid social activities, keep a distance in public places and follow the news more frequently. Further changes are presented below.

2.8.1 Remote work

As the restrictions have been advising people to work from home a consequence has been a rise in remote work. According to a study carried out by the mobile network Tele2 (2020) remote work increased from 12% of the total work in February 2020 to 51% in April 2020. During the same time the share of people remotely working full time grew from 2% to 32%. Although the majority, 51%, answered that after the pandemic they will work remotely to the same extent as before the pandemic and not more, as much as 37% answered that they will work remotely to a greater extent instead (Tele2, 2020).

2.8.2 Visiting outdoors

There are several indicators showing that the recommendations on avoiding indoor gatherings have led to a higher demand for outdoor visiting. The visits and users on the Swedish digital OutdoorMap grew by ca 160% during 2020 compared to 2019 (OutdoorMap, 2020). A majority of the outdoor actors asked in a survey carried out by the Swedish Environmental Protection Agency (Naturvårdsverket, 2020a) answered that they had experienced a great increase in visitors during Summer 2020.

2.8.3 Consumption

As recommendations on avoiding public places such as shops and restaurants were introduced, consumption has decreased overall as well as changed. A consumption report from the University of Gothenburg (Roos, 2020) shows that the biggest reduction in consumption 2020 happened during the second quarter of 2020 while in the third there was a slight recovery. During the second and third quarter of 2020 certain consumption areas were especially affected; consumption abroad decreased with 59% while consumption carried out by foreigners in Sweden decreased with 47% compared to the same period in 2019. Hotels, cafées and restaurants similarly was reduced with 30% and clothes and shoes with 21%. At the same time consumption for alcohol and tobacco, IT-related services and home related products increased with ca 5% (Roos, 2020). E-commerce in Sweden has increased steadily since the millennial shift with an average of 20% per year 2004-2015 (HUI Research, 2017). During the pandemic the expansion has been even more drastic; during the second and third quarter of 2020, e-commerce increased with 49% respectively 39% compared to 2019. The biggest increase occurred for everyday commodities with 115% respectively 101% (Postnord et al., 2020a-b).

2.9 Summary

- As the COVID-19 virus has spread in our society and recommendations aimed to avoid the spread of it have been introduced successively during 2020, people have adjusted their daily behaviors on a large scale towards reduced physical contact with other people. Both work and consumption have growingly been carried out remotely. This together with the overall recommendation to avoid travel are seemingly two crucial reasons that travel decreased with up to 36% in a month in 2020 compared to 2019, that passenger transport was harder hit than freight transport and that national transport, especially air traffic, has been harder hit than local modes of transport.

- Due to the combined changes toward less travel and physical contact in 2020, public transport has been the worst hit among the local modes of transport with a reduction of about 36% in both numbers and modal split.

- Indicators show that the punctuality has increased and that travel has been evened out during the day for public transport. The overall perception of public transport has not changed significantly due to the pandemic, except for groups of less-frequent travelers with public transport.

- Although car traffic also has decreased, it has simultaneously increased the modal split with 12% and has reportedly been the top choice when refraining from public transport trips during the pandemic, being more preferable than biking or walking. The fact that car traffic increases its modal split at the expense of public transport could be problematic in terms of aiming for sustainable mobility and needs to be addressed further on.

- As especially indoor activities have been discouraged outdoor activities have met an increased interest. The first indication of this is the generally increased

interest to visit the outdoors. The second is that bike and pedestrian traffic have not been reduced as significantly as other modes of transport during 2020 but rather there are indicators showing that they have increased; this is happening although the reasons for travel have decreased for these modes of transport as well.

3
Interviews

In this chapter the measures from the three major public transport authorities in Sweden implemented during the COVID-19 pandemic will be presented. First the methodology of the interviews will be presented. Thereafter the results from the interviews will be presented. Lastly, a summary of the results will conclude the chapter.

3.1 Method

Interviews with representatives from the public transport authorities of SL, Västtrafik and Skånetrafiken were carried out to obtain answers about the different measures they have implemented due to the COVID-19 restrictions. Because of the ongoing pandemic the interviews were held online in the format of a video meeting. The aim of the interviews was to gain a deeper knowledge about the measurements. The interviews were therefore qualitative and semi-structured where one or two persons from each authority were interviewed with respect to the topics and questions below. The full interviews are found in text format in Appendix A-C.

- Information about the authorities
  - What is the mission for the public transport authority? Which area does it cover and what modes of transport do they possess?
- Recommendation for passengers
  - What recommendations have been given for passengers by the public transport authority?
  - Where, how and when?
- Information
  - What information has been given by the public transport authority?
  - Where, how and when?
- Capacity
  - What changes have been made by the public transport authority directly affecting the capacity?
  - Where, how and when?
- Safety measures
  - What safety measures have been made by the public transport authority for passengers?
  - What safety measures have been made by the public transport authority for the on-board staff?
  - Where, how and when?
- Ticket control

  - What changes have been made by the public transport authority in terms of ticket controls?
  - Where, how and when?
- Other changes
  - What other changes have been made by the public transport authority?

3.2 Result

In this section the common COVID-19 measures for the three public authorities SL, Västtrafik and Skånetrafiken will be presented with respect to each interview 1, 2 and 3 (see Appendix A-C). The interview answers will be presented in the seven interview categories (see 3.1). For clarity the answers in the category *Information about the authorities* will be divided into the three authorities. Since this category *Recommendations for passengers* became longer than expected it was divided into the categories *The Public Health Agency's recommendations* and *Congestion forecast*. No answer was given for the category *Other changes* by SL or Västtrafik. Answers that were given for the same question during different categories, for example regarding ticket income, will be presented in *Other changes*.

3.2.1 Information about the public transport authorities

SL
SL (1) provides Region Stockholm, the capital of Sweden, with public transport by bus, tram, train, boat and metro.

Västtrafik
Västtrafik (2) provides Region Västra Götaland, with its capital city Gothenburg and second-biggest city Borås, with public transport by bus, tram, train and boat.

Skånetrafiken
Skånetrafiken (3) is part of Region Skåne, the southernmost region of Sweden. Their public transport services consist of train, tram and regional and local bus traffic. The capital city of the region is Malmö and is accompanied by the two other major cities Lund, where the tram operates, and Helsingborg. They also provide public transport by Öresundståg within the region of Greater Copenhagen, which includes international travel between Malmö and Copenhagen.

3.2.2 Recommendations for passengers

To minimize the spread of infection from COVID-19, all three public transport authorities (1, 2, 3) have advised their passengers to follow the recommendations from the Public Health Agency (see 2.2 and 2.7).

3.2.3 The Public Health Agency's recommendations

Information about the recommendations from The Public Health Agency has been put up by all three authorities (1, 2, 3) physically on stops, vehicles and electrical

signs as well as online on their websites, apps and social media platforms. SL (1) has placed out hubs where staff equipped with ticket inspection tools and plexi glass could control passengers tickets (see *Ticket control*) and give them information, Västtrafik (2) has placed informants at stops specifically to help passengers to keep their distance and inform them about upcoming departures and Skånetrafiken (3) has not implemented such measures. In October 2020, Västtrafik (2) started handing out canvas bags to the passengers passing by the central station of Gothenburg. The bags were thought to be placed on the seat beside the passenger to occupy the seat from other travelers, to ensure that distance could be kept, as this message was printed on them.

3.2.4 Congestion forecast

To avoid congestion all three authorities (1, 2, 3) have published information about the expected capacity on their vehicles. The information is based on automatic vehicle counting that registers boarding passengers. Since Autumn 2020, when searching for departures with SL (1) a warning message appears when the searched travel is at a higher risk of congestion. On their webpage Västtrafik (2) has published information on which routes, stops and times that usually are crowded. Since February 2021 preliminary percental congestion data is accessible for trips searched via the mobile application of Västtrafik. Skånetrafiken (3) shows the preliminary percental congestion of departures when searching for a trip in the mobile application, on the website and via an interactive map on the website since Autumn 2020. Since there are no automatic vehicle counting on Öresundtåg the congestion prognosis is only available for bus, tram and Pågatåg.

3.2.5 Capacity

The three authorities (1, 2, 3) have made an effort to increase the vehicle capacity when needed. This includes more frequent departures in rush hours, and Skånetrafiken (3) and SL (1) have also extended the train vehicles with additional wagons. At the same time some departures have been canceled. March 2020 SL (1) decreased their departures with bus, tram and local train, but from April 2020 until now they provide the normal level of departures and higher levels when possible. March-April 2020 several departures of bus, tram and train running for Västtrafik (2) were canceled due to staff shortage, but has since also been operating with higher capacity levels than normal. The departures of boat traffic have with few exceptions been changed for either SL or Västtrafik (1, 2). The number of vehicles in operation from Skånetrafiken (3) has not changed during the pandemic but rather been redistributed from less-frequent to rush hour departures.

3.2.6 Safety measures

All three authorities (1, 2, 3) claim that the work environment responsibility lies with the traffic operation companies but have nonetheless implemented safety measures for the bus drivers, including closed front doors and blocked front seats. However, SL (1) and Västtrafik (2) implemented these measures in March while Skånetrafiken (3) did so in April only after a safety stop was carried out according to the Work

Environment Act. Västtrafik (2) has not shut down any other parts of the vehicles than the front doors and first seat rows of buses while SL (1) and Skånetrafiken (3) have blocked crew and train driver cabins. All three authorities (1, 2, 3) offer free masks that can be picked up from their customer centers. During Spring 2021 SL (1) has started to open the front doors on some buses again as protection glass has been installed, while Västtrafik (2) and Skånetrafiken (3) are working on it.

3.2.7 Ticket control

All three authorities (1, 2, 3) paused the ticket inspection during Spring 2020 with increased fare evasion as a consequence. They have since then increased the inspections over time and carried them out in a safe way by keeping a distance and not entering full vehicles. The mission of the ticket crews from SL (1) and Skånetrafiken (3) changed from controlling tickets to reporting congestion. During Summer 2020 ticket control started to be carried out normally again by SL (1) and Skånetrafiken (3). Västtrafik (2) increased their inspector crew successively during the Summer to normal levels and to even higher levels during the Autumn. Ticket crew and informants from SL (1) and Västtrafik (2) sometimes controlled tickets before passengers entered the vehicle.

3.2.8 Other changes

All three authorities (1, 2, 3) stated that they have experienced decreased ticket income as a consequence of the lesser travel. A temporary 7-day ticket was released by Skånetrafiken (3) in 2021 to enable less frequent commuting with public transport than a 30-day ticket provides. The ticket was valid for seven different days and costs a fourth of a 30-day ticket. In March 2021 the 7-day ticket was replaced by a flexible ticket valid for 10 different days during a 30-day period costing 75% of a 30-day ticket, to increase ticket incomes.

3.3 Summary

The three authorities are mostly in the same position both before and during the COVID-19 pandemic with the mission to provide a safe public transport as a part of a fair society. The pandemic has brought a shift in the aim for public transport authorities, from encouraging travel with public transport to instead discourage it. All three authorities have experienced decreased travel and ticket income with assumed budget deficits as a consequence. The Public Health Agency's guidelines have been implemented and communicated toward the passengers with the message of only travel when necessary and if so, avoid congestion. The tolerance towards congestion has therefore seemingly lowered while the actual congestion has decreased. Information has been published online and physically and departures have generally been increased in rush hours to ensure that passengers can keep their distance. Ticket inspections were paused during Spring 2020 and the front doors of buses were shut down as a safety measure for the staff, leading to increased fare evasion for all authorities. Resumed ticket inspections and protection glasses with opened front doors are some common measures that have either been or are planned to be implemented to revert to the pre-pandemic features of public transport. Different

approaches have been made by the different authorities, the main difference being how and when the strategies were carried out. Congestion forecasts via the mobile application was launched by Västtrafik six months after SL and Skånetrafiken, while Västtrafik resumed the ticket control a few months earlier than SL and Skånetrafiken did. In a short period in the beginning of the pandemic departures were canceled for different reasons; by SL due to decreased income, Västtrafik due to staff shortage and Skånetrafiken due to lower travel demand. As the traffic situation has become more stable Skånetrafiken has redistributed their existing vehicle fleet while SL and Västtrafik have operated more vehicles than before the pandemic. The biggest difference in measures could be that Skånetrafiken adapted their ticket alternatives to the changed travel patterns in 2020, by introducing a flexible ticket, which neither SL nor Västtrafik did.

4

Traffic data analysis

In this chapter the method and result of the traffic data analysis will be presented with a concluding summary. The analysis is made to investigate how the public transport has changed in each major region during the pandemic, how the result differ and if it can be connected to the different measures of the authorities presented in Chapter 3. The pandemic period is defined as the period of March-December. By morning rush hour means 7-9 a.m. and afternoon rush hour means 4-6 p.m.

4.1 Method

Traffic data provided by SL, Västtrafik and Skånetrafiken has been used to visualize how travel with public transport has changed during the pandemic, where data from 2020 is compared with data from the same period of 2019. This will be done for two different periods, the full year and the pandemic period, to gain a more representative value of the travel changes during the pandemic as well as the overall travel changes from 2019 to 2020. The data has been received individually from each public transport authority and is found in Appendix D-E. The numbers investigated are presented below.

4.1.1 Total travel per year

The total travel per year will be presented as the total amount of trips carried out or the total amount of boarding passengers in 2020 compared to 2019. The data can be found in Appendix D.

4.1.2 Total travel per month

The total travel per month will be presented as the total amount of trips carried out or the total amount of boarding passengers per month in 2020 compared to 2019. Data will be analysed for all months during 2019 and 2020 including January and February when the pandemic restrictions had not been enforced yet, to see the travel changes before and around the introduction of the pandemic as well as during the pandemic period. The data can be found in Appendix D.

4.1.3 Hourly travel distribution

The hourly travel distribution will be presented as the boarding share of trips carried out each hour (00:00-00:59, 01:00-01:59 etcetera) from 00:00-23:59 during an average day for the whole year of 2020 compared to 2019. The boarding share will be

presented by how much each hour stands for of the total travel during the day. The aim of this is to investigate if people travel more evenly distributed over the day during the pandemic as people during this period have been advised to avoid travel in rush hours. The data can be found in Appendix E.

4.1.4 Conditions and errors

The conditions and errors for the data will be presented in this section for each region separately.

SL
The total travel data consists of the total number of boarding passengers collected from counting sensors on bus, metro, tram, local train and commuter train 2019-2020, and so boat traffic is excluded. The numbers are re-calculated to give a correct number from the 20% coverage. The data only include weekdays, but as they normally make up most of public transport travel they are considered comparable. The hourly travel data consists of the total number of turnstile passages for commuter train and metro for all months 2019-2020.

Västtrafik
The total travel data consists of the total number of boarding passengers collected via Västtrafiks' KRS (*Kundräkningssystem*, Customer Counting System) which includes 95% of all trips. Included are railway traffic and most buses outside of Gothenburg and all trams and buses in Gothenburg except for two heavy bus lines. Boat traffic and some bus routes are not included in KRS but are in a control data which covers 5-8% more of the travel than KRS. Therefore the result from the total travel data will be compared with the control data. The control data is however not available for the hourly travel data, which consists of the total number of boarding passengers per hour collected via KRS and so about 5-8% of the traffic is excluded from the hourly travel data, mainly several bus routes outside of Gothenburg and boat traffic.

Skånetrafiken
The total travel data consists of the total amount of trips collected from regional buses, local buses, Pågatåg and Öresundståg. The collection has been carried out differently; regional buses via validated ticket, local buses via validated tickets and APC (Automatic Passenger Counting), Pågatåg via APC and Öresundståg by manually counting passengers. The numbers have been compared with sales numbers and when necessary been re-calculated by Skånetrafiken to gain representative total numbers. The hourly travel data consists of the total number of boarding passengers collected via APC from Pågatåg and local buses in Lund. Although the data might give good indicators on travel changes it only represents a limited part of the travel with Skånetrafiken and it should be kept in mind that it excludes travel with Öresundståg, regional buses and local buses in all cities of Skåne except for Lund.

4.2 Result

In this section the result from the traffic data analysis will be presented.

4.2.1 Total travel per year

In Table 4.1 the change in total travel 2019-2020 is presented for all year and for the pandemic period. The control data from Västtrafik is also included.

Table 4.1: Total change in public transport trips 2019-2020 over the whole year versus during the pandemic period [%].

Authority	Change all year	Change pandemic period	Control data
SL	-35	-42	-
Västtrafik	-31	-38	-31
Skånetrafiken	-38	-45	-
Total	-33	-40	-

The results show a clear decrease in public transport trips in the major regions during 2020 compared to 2019.

4.2.2 Total travel per month

The total number of public transport trips carried out in the major regions during 2019 and 2020 is presented in Figure 4.1. This number consists of summed up traffic data from the major regions. The percental change in public transport trips 2019-2020 is presented monthly for each region in Figure 4.2.

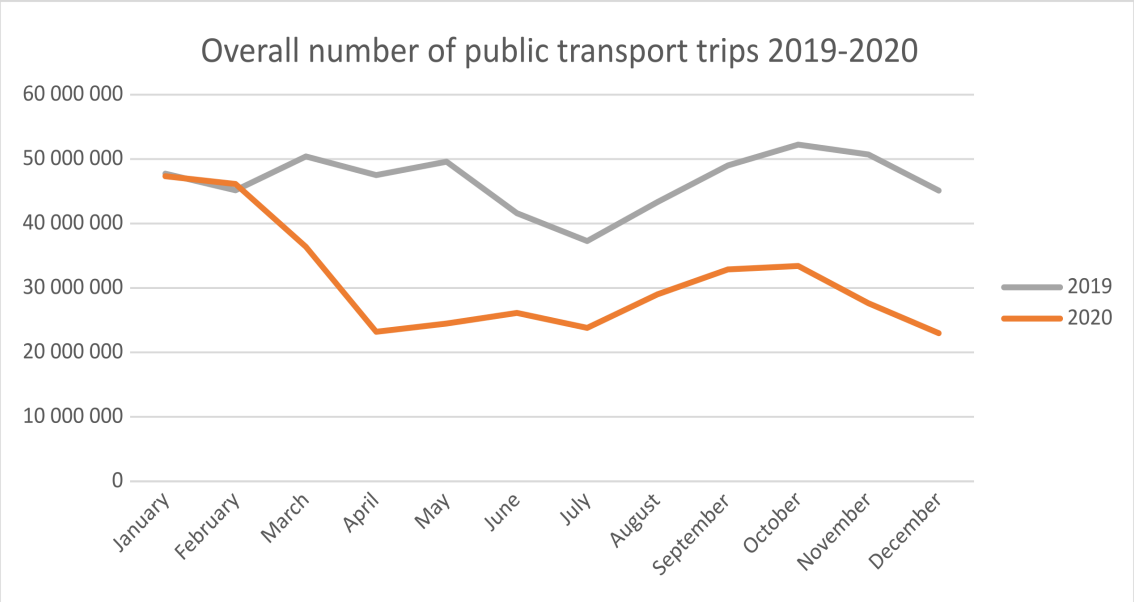

Figure 4.1: Total number of public transport trips 2019-2020.

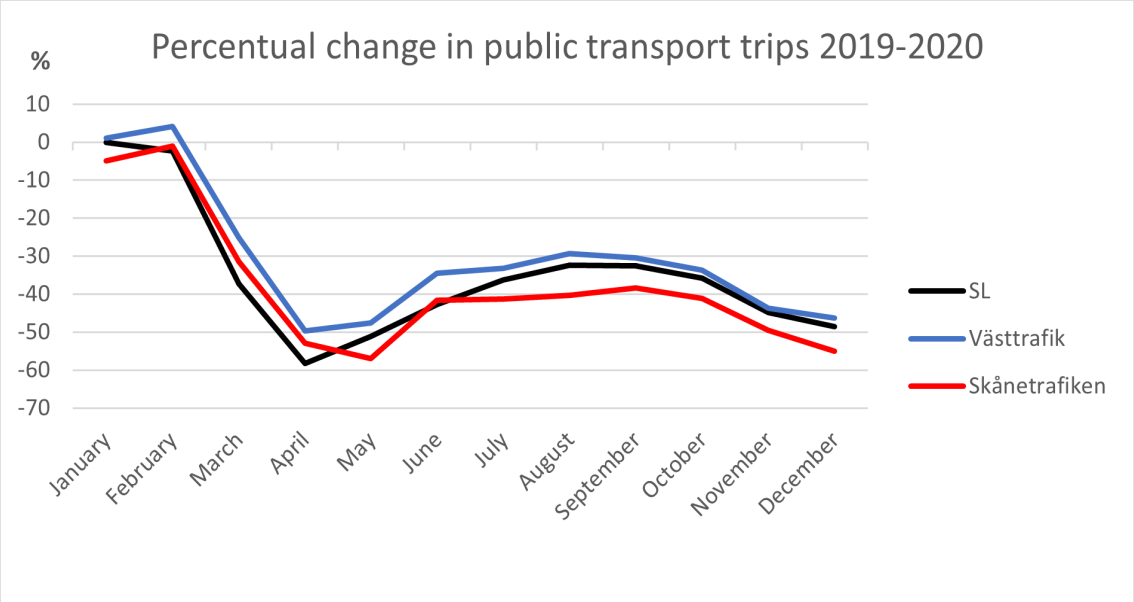

Figure 4.2: Percental change in public transport trips 2019-2020.

Like Table 4.1, Figure 4.1-4.2 show a clear decrease in public transport trips in the major regions during 2020 compared to 2019. The change of public transport trips follows the same pattern in all three regions. In January-February 2020 travel numbers were similar to those in 2019. In March a big decrease of 50-60% occurred lasting until May. A minor recovery occurred during June-September with a decrease of only 30-40%. In October-December the travel rates decreased to about the same numbers as during March-May. There are some minor changes; during Spring, SL was slightly harder hit. During Summer and Autumn and for the biggest period of the year, Skånetrafiken had the greatest relative reduction with 38%, thereafter SL with 35% and Västtrafik with 31% (see Figure 4.2). The total decrease for public transport travel in all three regions during 2020 was 33%. When looking only at the pandemic period (March-December) the total decrease was higher, 40%. During this period Skånetrafiken still had the greatest reduction with 45%, SL thereafter with 42% and Västtrafik with 38%. The second half year, June-December, the travel trend is similar for both years with an increase in trips June-October, a peak during October and a decline November-December, although there were about 50% less trips in 2020 than 2019 during this period (see Figure 4.1).

4.2.3 Hourly travel distribution

The hourly travel distribution is presented as the boarding share over the day during the pandemic period 2019-2020 in Figure 4.3. The change in boarding share 2019-2020 for the whole year and the pandemic period is presented in Figure 4.4 and the change in boarding share 2019-2020 during the pandemic period for each region is presented in Figure 4.5.

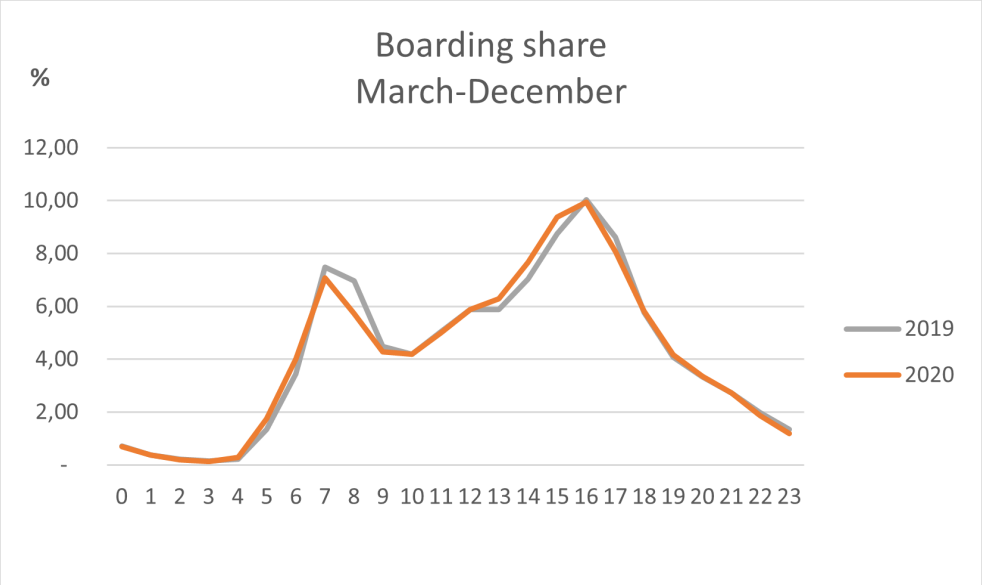

Figure 4.3: Boarding share during the pandemic period 2019-2020.

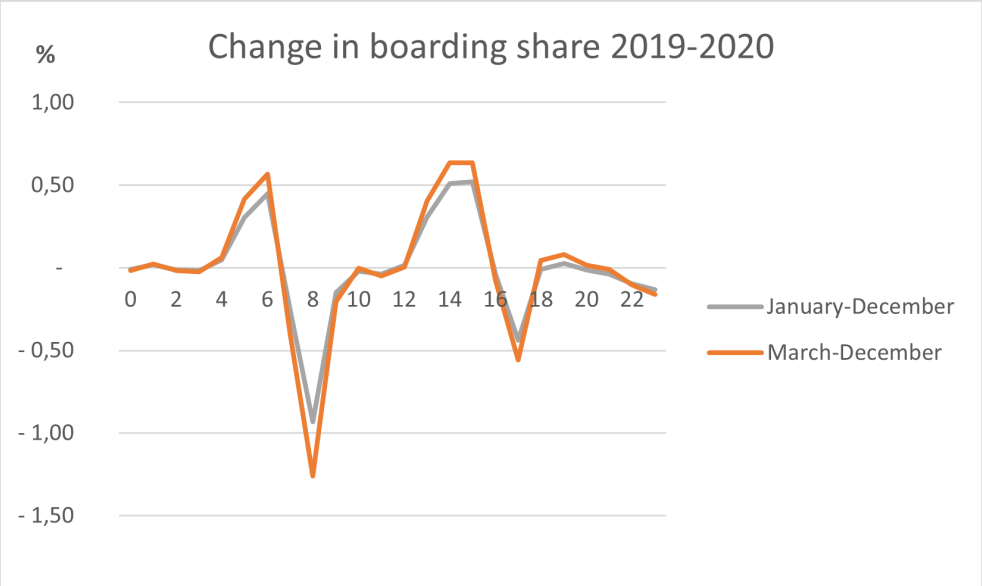

Figure 4.4: Change in boarding share 2019-2020, for the whole year versus the pandemic period.

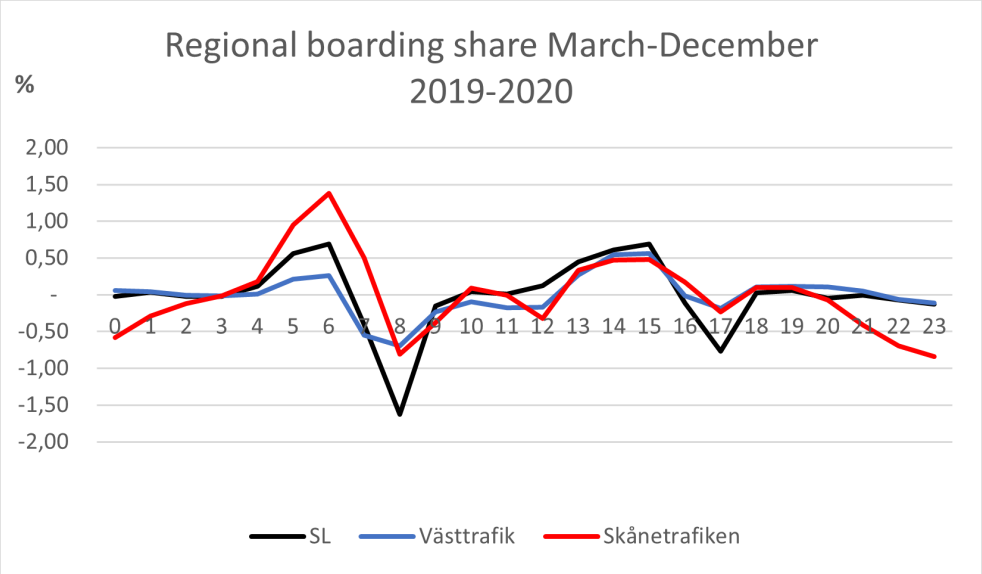

Figure 4.5: Change in regional boarding share during the pandemic period 2019-2020.

Overall the travel distribution in 2020 does not differ much from 2019, as can be seen in Figure 4.3-4.4. The difference in share distribution is slightly greater during the pandemic period than the whole year (see Figure 4.4). The average change is maximum +-1,3 percentage points but follows a pattern with increased travel share 1-2 hours before the morning and afternoon rush hours followed by a decreased travel share during the rush hours. This can be observed in all regions separately as well (see Figure 4.5). The maximum change for SL was a decrease of 1,6 percentage points before the morning rush hour and Västtrafik has had a minor difference of +-0,5 percentage point over the day. For Skånetrafiken where only Pågatåg and local buses of Lund are included the maximum change is an increase of 1,4 percentage point before the morning rush hour. A steady decrease over the night hours can also be observed for Skånetrafiken. The regional differences are observed to be greater in the morning than in the afternoon.

4.3 Summary

The amount of public transport trips carried out in the major regions decreased significantly during 2020 compared to 2019. This reduction occurred during the pandemic period of March-December, while there was no major difference in January-February. The total reduction during all of 2020 was 33%, during the pandemic period as much as 40%. The monthly decrease differs however from 30-60%, as the biggest decrease occurred during the Spring with a slight recovery during Summer and another decrease during Autumn and Winter. The travel development is similar for the three major regions but Skånetrafiken has had a slightly greater decrease than SL and Västtrafik of 45% during the pandemic period. During 2020 a greater travel share of up to one percent was made up by trips carried out one-two hours before rush hour compared to 2019. However, the travel peaks are still during morning and afternoon rush hours and so the change is not considered significant. The hourly travel distribution has overall not become more evenly distributed during 2020.

5

The pandemic's effect on public transport

Firstly the effects of the COVID-19 pandemic on public transport identified in the material produced in Chapter 2-4 will be presented. Secondly criterias of maintaining and developing public transport in general will be presented. Thereafter the pandemic effects will be categorized as positive or negative via an elimination matrix. Lastly, the potential long-term effects will be presented.

5.1 Potential pandemic effects on public transport

Effects found in the produced material of this work that the COVID-19 pandemic has been shown to have on public transport:

Decreased travel numbers
Travel with public transport in Sweden has decreased with 36% during 2020 compared to 2019 (see 2.5.1).

Decreased travel share
The modal split of public transport has decreased from 27% to 17% among local modes of transport (see 2.5.1).

Increased punctuality
The punctuality has increased for public transport during the pandemic (see 2.5.1).

Increased budget deficit
SL, Västtrafik and Skånetrafiken have experienced heavy budget deficits during the pandemic (see 3.3).

Changed aim
The public transport authorities have changed their aim from encouraging public transport to dissuading it during the pandemic (see 3.3).

Increased fare evasion
SL, Västtrafik and Skånetrafiken have experienced increased fare evasion during the pandemic (see 3.2.7).

Less objective congestion

With the lesser travel (see 2.5.1) the congestion is assumed to have decreased as well.

Increased experienced congestion
As a physical distance has been crucial to keep during the pandemic, the tolerance for an acceptable distance has lowered and the experienced congestion has increased although travel overall has decreased (see 3.3).

Less contact between on-board staff and passengers
SL, Västtrafik and Skånetrafiken have experienced less contact between the on-board staff (including bus drivers, train crew and ticket inspectors) and the passengers due to closed front doors and cabins (see 3.2.6).

Increased information
SL, Västtrafik and Skånetrafiken have invested in information during the pandemic with e.g. informant staff, published messages physically and digitally and congestion forecasts (see 3.2.2-3.2.4).

5.2 Criterias

The criterias have been created to determine if the alleged effects in 5.1 have had a mainly positive or negative impact on public transport during the pandemic. They are crucial factors when it comes to develop public transport supported by several sources on the topic. The pandemic period will be studied specifically in the matrix and 5.3.1 where the effects will be based on the development of public transport during 2020, excluding the potential long-term, post-pandemic effects on public transport; those will be presented in 5.3.2. Level of service is considered to directly affect a majority of the criterias and will therefore not be presented separately. If one effect is fulfilled by only positive or only negative criterias, it will be classified as fully positive or fully negative. If one effect is fulfilled by mainly positive or negative criterias, it will be classified as generally positive or generally negative. Some criterias are considered more crucial than others; traffic income, travel times, ticket prices, and share of trips carried out by car, in order. These will determine the final classification; it can be changed between overall positive and overall negative, but not from or to fully positive and fully negative.

Travel time
This criteria is considered positive when decreasing and negative when increasing. Travel time is one of the highest valued criterias for all passengers, but even more for non-public transport travelers (Urbanet Analyse et al., 2017). Reduced travel time for public transport has been shown to utilise vehicle use and thereby reduce the costs, while it also makes public transport more competitive with car traffic. A measure used for this is the travel time ratio, saying that the travel time should not be more than twice as long for public transport trips as for car trips with the same distance, to enable this competition.

Ticket price

This criteria is considered positive when decreasing. Ticket prices are always expected to rise due to inflation, but also due to other factors like expanded infrastructure supply and increased comfort (Urbanet Analyse et al., 2017). Generally reduced ticket prices lead to more passengers, especially in the long-term. A lower ticket price compared to car connected costs (e.g. fuel price and congestion charge) also contributes to public transport being more competitive with car traffic. If the supply is to be maintained however, financing has to come from elsewhere, see *Ticket income*. This criteria is considered negative when increasing as the effect then is reversed with less passengers as a result.

Ticket income
This criteria is considered positive when increasing and negative when decreasing. Higher ticket income means a greater financing of public transport. As public transport in Sweden is financed half by ticket incomes decreased ticket incomes mean that financing needs to come from elsewhere, or costs need to be cut down with a loss of either quantity or quality of supplies (Urbanet Analyse et al., 2017). Overall according to the interviews (see 3.2.5) the supply has not been reduced during the pandemic, and this combined with less passengers have led to significant budget deficits for the public transport authorities even with governmental subsidies. A budget deficit which is not remediated will inevitably lead to raised ticket prices, fewer departures or canceled routes as the public transport authorities have to save money (Svensk Kollektivtrafik, 2021a). Stable framework conditions are crucial when planning public transport in the long-term and as the travel and thereby ticket income decrease of 2020 has been abrupt, a lower ticket income risk disturbing the public transport system in a long-term perspective as well (Urbanet Analyse et al., 2017).

Simplicity and information
This criteria is considered positive when increasing and negative when decreasing. A simple, understandable public transport system is crucial both to gain new passengers and to increase the satisfaction of existing passengers (Urbanet Analyse et al., 2017). If an infrastructure system is too complicated people tend to choose modes of transport which are perceived as less complicated. Simplicity is also important because it gives passengers greater control over their transportation. Simplicity can be implemented in many ways, for example via information and departure intervals. However, the main factor for simplicity will be considered information as it overlaps the whole public transport system. For this criteria information will be the main factor considered and departure interval is presented as a separate criteria below.

Departure interval
This criteria is considered positive when decreasing under 15 minutes and negative when increasing above 15 minutes. More frequent departures generally result in more passengers but when the interval is 15 minutes or lower, the effect is not as significant (Urbanet Analyse et al., 2017). This is considered an average value as the standard differs between urban and rural traffic; to enable a competitive public transport the departure interval should be under 10 minutes for urban traffic and under 30 minutes for rural traffic (Sveriges kommuner och landsting et al., 2012).

Hourly travel distribution
This criteria is considered positive when the hourly travel distribution becomes more even. In the short-term a more even travel distribution over the day leads to shorter

travel times, fewer delays and decreased congestion (Urbanet Analyse et al., 2017). In the long-term it leads to decreased traffic costs as the efficiency of every vehicle increases when travel times are shortened. If the travel is bound to increase it is cheaper to use the existing infrastructure outside of rush hours than to expand the already loaded infrastructure in rush hours. This criteria might however be negative if the travel is very low and congestion is not a problem, where more evened out travel could lead to canceled departures due to passenger shortage. As the whole public transport network is analysed and not specific routes this criteria will be considered negative when the travel distribution becomes less even.

Staff safety
This criteria is considered positive when increasing and negative when decreasing. According to Anund et al. (2017) bus drivers and train crew are exposed to the spread of infections which has increased during the pandemic, as well as threat and violence from passengers. It is reasonable that ticket inspectors are exposed to this risk as well as they also carry out their work on board public transport vehicles in contact with passengers, and another indicator of it is the medial reporting with examples of increased violence and police support on riskful routes (Mitti, 2017). A safe working environment for the on-board staff is important to guarantee a stable working fleet without high sick rates or unsafety as functioning public transport systems are highly dependent on staff driving vehicles, controlling tickets and providing information to passengers. Although the on-board staff is employed by traffic companies they represent the public transport authorities to a large extent, which makes staff safety a concern for the authorities as well.

Local modal split

Bike traffic
This criteria is considered positive when increasing and negative when decreasing. As biking is considered a sustainable mode of transport just as public transport, an increased cycling modal split is considered positive as it will lead to increased incentive to bike as well as to promote investments in bike infrastructure. For shorter trips of up to 3 km biking is considered as more competitive towards the car than public transport is (Urbanet Analyse et al., 2017). Increased biking also shows to result in improved public health. However, when biking increases at the expense of public transport a lower ticket income on shorter trips might be a consequence. This also applies for walking, see *Pedestrian traffic*.

Pedestrian traffic
This criteria is considered positive when increasing and negative when decreasing, see *Bike traffic*.

Car traffic
This criteria is considered positive when decreasing and negative when increasing. To increase the share of public transport it is not sufficient if the public transport trips are increasing - the share of car traffic needs to decrease as well (Urbanet Analyse et al., 2017). Car traffic as a mode of transport has dominated society for 70 years but is also in many ways the least sustainable one as it has been shown to

increase congestion, global CO2-emissions as well as local emissions of e.g. metal and microplastics, noise and traffic unsafety. The infrastructure of car traffic requires more space than other local modes of transport and can therefore be seen as the most inefficient mode of transport in this category.

5.3 Result

The matrix is found in Appendix F and the classification of pandemic effects are found in Table 5.1. The potential long-term, post-pandemic effects on public transport are described below and in Table 5.2.

Table 5.1: Classification of pandemic effects on public transport divided into four categories.

	Fully positive effects
1	Increased punctuality
2	Less objective congestion
3	Increased information
	Generally positive effects
	-
	Generally negative effects
4	Decreased travel numbers
5	Decreased travel share
6	Changed aim
7	Increased experienced congestion
8	Less contact between on-board staff and passengers
	Fully negative effects
9	Increased budget deficit
10	Increased fare evasion

The budget deficits have not led to any significant changes during the pandemic, but in the long-term perspective a budget deficit which is not treated risks leading to higher ticket prices and canceled departure intervals. This is especially risky as the number of passengers might not revert to pre-pandemic numbers directly. As concluded in 2.7, public transport travel has been highly correlated to the amount of COVID-19 restrictions and the restrictions are planned to be removed slowly but steadily depending on the pandemic situation. It can therefore be assumed that the travel numbers will follow the same trend and that a longer time period is required to reset them to normal, and so decreased travel numbers are considered a stated pandemic effect as well as a potential long-term effect.

Table 5.2: Potential long-term effects of the COVID-19 pandemic on public transport.

Potential long-term effects
Increased ticket prices
Decreased departure interval
Canceled routes
Decreased travel numbers

6
The potential solutions

In this chapter the potential solutions on how to fulfill the positive effects and counteract the negative effects that were formulated in 5.3 will be presented. The solutions have been brainstormed, investigated and checked with sources on the subject to determine what effects the solutions contribute to, e.g. with the help of the material produced for the criterias in 5.2. Firstly, the potential solutions that the public transport authorities can implement will be presented. Thereafter, additional solutions that can be implemented on a local, regional and national level will be investigated.

6.1 Public transport authorities

In this section the solutions that the public transport authorities can potentially implement are presented.

Expanded ticket supply
During the pandemic, the sales of period tickets decreased while single tickets increased (see 2.5.2) and flexible tickets were introduced by Skånetrafiken during the pandemic as an answer to the changed demand of tickets from passengers (see 3.2.8). To adapt the ticket supply can potentially increase the ticket income and should be considered by all authorities to secure incomes in a short-term and a long-term perspective. The tickets could e.g. be valid for an amount of single trips during a certain time period (like the flexible tickets of Skånetrafiken) or certain times during the day or days during the week (in combination with *Time-differentiated taxes*).

Time-differentiated taxes
As mentioned in 5.2, *Daily travel distribution*, an increase in passenger numbers is best distributed where the infrastructure as well as the capacity exists; outside of rush hours. It should therefore be considered to introduce time-differentiated taxes where it is cheaper to travel when the capacity is the fullest. The strength of this strategy is to utilise the infrastructure system for both existing and new passengers to gain more passengers as well as income. There might be consequences of increased ticket prices in rush hour; for example people who only can travel during rush hours might choose to travel by car instead. There is still a significant will among passengers to adapt their time of travel during the day, especially if it means lower ticket prices. Examples from the Netherlands, London and Copenhagen have shown how time-differentiated taxes can change peoples travel behavior and that the general long-term effect is an increase in both income and passengers (Urbanet Analyse et al., 2017); these are however examples of high-dense populated areas and might therefore not be directly comparable with the regions of Sweden but rather seen as inspiration. Instead of increasing the ticket prices during rush hours, ticket

prices outside of rush hours could be lowered. This has been implemented for senior cards in Sweden which enable free public transport outside of rush hours. The price could also be differentiated for a certain ticket type such as monthly or single tickets. However implemented it is crucial that the time-differentiated system is designed to be simple to use and understand, as a risk when differentiating is that fairness is promoted at the expense of the simplicity and understanding of it (Sveriges kommuner och landsting et al., 2012). As every region has its conditions it should be discussed how the differentiation can be best implemented for the current public transport authority.

Distance-differentiated taxes

Like *Time-differentiated taxes* this strategy aims to utilise the existing infrastructure system by promoting travel which has the least burden on the system. In many regions today the ticket price is constant within zones which can have great radiuses. For a trip between two stations in Greater Gothenburg the ticket price is the same but the distance can vary between 200 meters and 40 kilometers and the price per kilometer from 170 kr/km to 0,85 kr/km (see Figure 6.1). In this way shorter trips are not promoted by public transport which can be good considering the good conditions for walking and cycling (see 5.2, *Bike traffic* and *Pedestrian traffic*) but can also be seen as unfair to the passengers. Flexible zones where the price of the ticket depends on the start and end point of the trip is already used by Skånetrafiken today and is one way to implement this strategy. However, differentiating risks leading to decreased simplicity also by distance as it becomes hard to predict both the price of the trip and the end point of the trip in advance (Sveriges kommuner och landsting et al., 2012). Distance-differentiated taxes should therefore be compared with the current zone system to evaluate the utility of enforcing it.

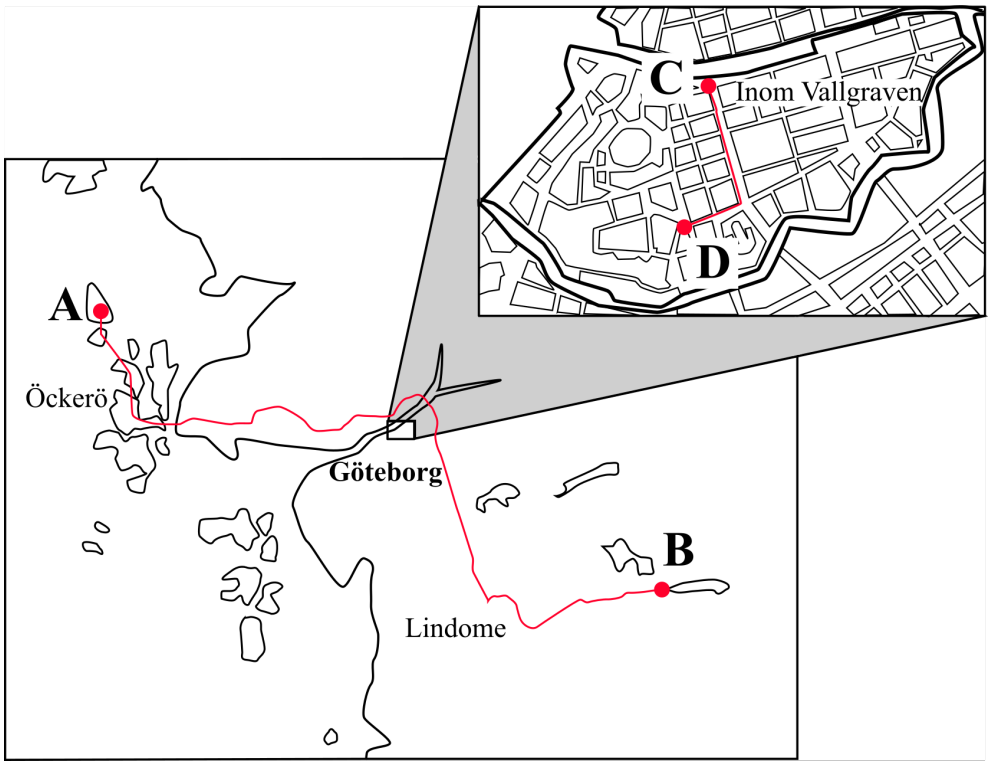

Figure 6.1: With Västtrafik's zone system a trip between the Nothern Archipelago (A) and Mölndal (B) costs the same as a trip between Domkyrkan (C) and Grönsakstorget (D).

More efficient ticket control

It is in the interest of public transport financing to reduce fare evasion, even more so as it has increased during the pandemic at the same time as ticket incomes have been diminished. More tickets need to be validated to reduce the fare evasion and increase the potential ticket income regardless of the amount of passengers. Increased ticket crew is a solution which Västtrafik already has implemented during the pandemic. However, this system enables passengers to travel without paying for a ticket as long as they avoid the inspectors. It might also not be the most cost efficient way of reducing fare evasion which is important as a major point of doing so is to increase the ticket income. Therefore other ticket validation methods should be considered. During the pandemic tickets have been controlled by SL and Västtrafik before entering the train (see 3.2.7), a solution which would enable an efficient vehicle boarding and should be applicable for other modes of transport (bus and tram) as well.

Promote public transport as well as other sustainable transport modes

To gain as many old as new passengers after the pandemic, the former aim of encouraging public transport should be reinforced by the public transport authorities as part of a broader information effort where all sustainable modes of transport separately and combined are encouraged (see *Combined mobility*). As walking and cycling are more competitive with car traffic than public transport is for shorter trips, public transport should not be promoted at the expense of other sustainable modes fulfilling the aim more efficiently. The negative aspect of this is the potential income loss for public transport on shorter trips, and so the implementation of this solution

should be evaluated by this risk for the current authority; it might be weighted up by other measures with the specific aim of increasing ticket incomes such as *Increased ticket prices* or *Rationalising the infrastructure system*, but especially by the potential increased public transport use with *Combined mobility*. This strategy should be carried out like the information was carried out during the pandemic; physically on stops and vehicles and digitally on websites, apps and social media platforms.

Combined mobility
Combined mobility is here referred to as the combination of public transport with any other mode of transport during the same trip; this includes bike and pedestrian traffic and also car traffic to enable car owners to use public transport more. As an example the combination of public transport, biking and walking would allow 80% of the inhabitants of Skåne to reach their working place within an hour (Region Skåne, 2017). The effect is especially high for longer trips which enables competition with solely car traffic as a mode of transport. Especially the combination of car and public transport could extend the catchment area of public transport in rural areas (Sveriges kommuner och landsting et al., 2012). To enable good implementations of other effectivising solutions such as *Rationalising the infrastructure system*, investments in combined mobility might be a crucial complement. Previously combined mobility has been implemented with the project form MaaS (Mobility as a Service) in the three major cities of Sweden with mixed results but is still considered to have a great potential of utilizing the infrastructure system by improved accessibility, lower travel costs and emissions when implemented efficiently (Hedegaard Sørensen et al., 2020). To ensure the utility of combined mobility the public transport authorities need to take a part in the development where their role and the aim of the strategy is clear.

Expanded traffic information
A simple, understandable public transport system requires clear and available information for potential passengers (see 5.2, *Simplicity and information*). At the same time certain passenger groups have been shown to appreciate the possibility to keep a distance when traveling with public transport after the pandemic (see 2.5.2). As a part of this strategy the authorities should keep and develop the congestion forecasts as passengers will be able to use it to either avoid congestion or prepare for it. As mentioned in *Time-differentiated taxes* a significant number of passengers are prepared to adjust their travel over the day which means that this strategy can lead to decreased congestion, both objective and experienced, as travel numbers are expected to rise after the pandemic.

Measures to avoid spread of diseases
There are certain measures that could encourage certain groups that are sceptical of returning to use public transport after the pandemic as they did before it, like offering hand sanitizer, performing extra cleaning of the vehicles and congestion forecasts (see *Expanded traffic information*). However, it has been shown that those who would benefit the most from these measures are those who rarely traveled with public transport before the pandemic, and those who stopped traveling with public transport entirely during the pandemic (see 2.5.2). Those who rarely traveled before the pandemic are new or less-frequent passengers that are desirable to attract

to public transport. This group of people is generally shown to use public transport more often when certain measures are introduced such as increased departures, increased comfort or worsened conditions for car drivers. This has been observed over many decades while the effects of COVID-19 measures after the pandemic have not been observed yet and are not guaranteed to happen. Therefore this kind of measures should be carried out with caution and in combination with other, more documented methods. However, as the pandemic situation with public transport is unusual, special measures like these are crucial to consider as well.

Protection for the on-board staff

A good working environment for the on-board public transport staff is vital to develop a sustainable public transport system. At the same time there is a great risk of threat and violence towards on-board staff which needs to be remediated. During the pandemic different forms of protections have been implemented due to COVID-19 which have reduced both the spread of the virus and the physical contact between staff and passengers. Currently authorities plan to implement protection glass in the front cabins to enable opened front doors without the risk of spreading the virus to bus drivers (see 3.2.6). This is presumably positive for the ticket income as it will contribute to decreased fare evasion when the drivers easier can carry out the ticket validation. The protection glass should also be formed so they can protect the drivers from violent passengers. To isolate the drivers from the passengers is however not only positive; as an example, about half of the drivers on the route MalmöExpressen in Malmö found the isolated driver cabin positive and half of them found it negative compared to the more open, standardized cabins (Anund et al., 2017). The reasons for the negative perception is the loss of social contact between driver and passenger and a dehumanizing experience for the drivers. At the same time a majority of the drivers found that the risk of exposure for threat and violence had decreased with the isolated cabins. The same could be assumed for open versus closed visitation of tickets, where the open visitation means that passengers do not need to show their ticket to the driver when entering the vehicle; this is a measure used by Västtrafik on trams and local buses in Gothenburg (See Appendix B). The physical contact is thereby both a condition for and a risk in the role of public transport staff. When producing measures to promote staff safety it is therefore important to aim for a safe, open and fair working environment where the risk of threat and violence is low, the possibility for contact between staff and passengers is acceptable, and ticket validations are carried out to a sufficient extent. Ticket inspectors are unlike train crew and bus drivers always dependent on passenger contact to carry out their work which needs to be taken into consideration; even with an open visitation system this staff group is still exposed to violence and threat. In their report Anund et al. (2017) recommend increased collaboration between the public transport authorities, traffic companies and public transport on-board staff where the strategy in potential threatful situations such as ticket inspection is clarified. This should be considered for ticket inspectors as well.

Rationalising the infrastructure system

As heavy budget deficits threaten the public transport authorities there is an alternative to reduce the quality of the infrastructure; to re-organize and optimize the infrastructure system rationally by prioritizing measures with the greatest effect on gaining more and satisfied passengers. This could include straighter routes which

leads to shorter travel times and costs, which could be used to increase the departure intervals of the route (Sveriges kommuner och landsting et al., 2012). A change in the infrastructure system will inevitably worsen the traffic supply for some people in terms of e.g. departure intervals or travel times. The goal of this solution is to make the public transport system better for as many as possible rather than seeing to everyone's individual need; when utilising transport infrastructure the realistic goal is to let most people benefit from it in the long-term perspective with the understanding that some people will be negatively affected (Urbanet Analyse et al., 2017). However, as public transport also has the goal to create accessibility and fairness there is a risk that these two goals will collide. A minimum supply level should be enforced where rural as well as urban areas get it better, which for example has been reinforced with good results in Zürich (Urbanet Analyse et al., 2017).

6.2 Local, regional and national level

These are the solutions that potentially can be implemented on a local, regional and/or national level. The strategies can vary a lot depending on the authority it is implemented by and so the solutions in this chapter should be considered as an introduction to how the current authority could best implement it.

Governmental subsidies
Subsidies have been given by the Government to the public transport authorities to cover up for the budget deficits, but they only cover about a fifth of it (see 2.5.1). Further subsidies could be a crucial tool in planning and developing a post-pandemic public transport. However, the subsidies should be enforced in combination with other measures such as those mentioned in this chapter, or with certain conditions, to ensure that the added resources are used as efficiently as possible.

Redistribution from car traffic resources
To effectivise public transport it is not sufficient to only improve the public transport itself; in a city with limited resources and space the whole traffic system needs to be redistributed. This could mean that space for the existing, dominating car traffic is redistributed to public transport, e.g. from car lanes and parking lots to bus lanes and bus stops. When expanding infrastructure in a society public transport has been shown to be cheaper and more space-efficient than car traffic (Urbanet Analyse et al., 2017). Redistribution could also be in terms of money where parking fees and congestion charges from car traffic both can regulate the car traffic and fund public transport; congestion charges can in this way be used as a time-differentiated tax for car traffic (see *Time-differentiated taxes*). This strategy has the potential to favor public transport overall but also the whole society on an economical and environmental level where the majority benefits from it (see *Rationalising the infrastructure system*). The travel time ratio between public transport and car traffic (see 5.2, *Travel time*) could be used to set goals and measure progress when implementing this strategy. However, a measure is not necessarily good because it is enforced with good intentions. Factors like traffic safety and accessibility, not the least for other modes of transport such as car, biking and walking, still need to be considered when working with redistribution to ensure as easy adjustments as possible for passengers of all modes of transport.

6.3 Summary

Table 6.1: The produced solutions and the effects they promote and counteract.

Public transport authorities	**Promoted positive effects**	**Counteracted negative effects**
Expanded ticket supply	3	4,6
Time-differentiated taxes	1,2	4,5,9
Distance-differentiated taxes		4,5,9
More effective ticket control	-	8,9,10
Promote public transport as well as other sustainable transport modes	3	6
Combined mobility	-	4,5,6
Expanded traffic information	2,3	6,7
Measures to avoid spread of diseases	-	4,5,7
Protection for the on-board staff	-	8,9,10
Rationalising the infrastructure system	1	4,9
Local, regional and national level		
Governmental subsidies	-	9
Redistribution from car traffic resources	-	4,5,6,9

7
Discussion

In this chapter the material produced in Chapter 1-5 will be discussed.

7.1 Transport in general

Travel has decreased drastically during 2020 compared to 2019. It is reasonable that long-way modes of transport such as air traffic would be the hardest hit as national borders have been closed. It is also reasonable that public transport was the hardest hit on a local level as the pandemic led to a need for less physical contact and what defines public transport is several people traveling together. The clear correlation between travel numbers and pandemic restriction rates is therefore logical as the restrictions have determined the current acceptable level of physical human interaction.

7.2 Local modes of transport

Different traffic data will give different angles and especially regarding number versus share; the number of car traffic has lowered during the pandemic but its share among local travel has increased. This is reasonable also because of the fact that when a public transport trip was canceled during the pandemic, the most common way of replacing it was by carrying it out by car. This is problematic in the context of aiming towards a more sustainable society where car traffic should decrease - after all, the goal for many cities is to decrease the share of car traffic and not the total number of car trips. The increased car share is a counteracting development for most cities who aim towards a lower modal split of car traffic. Still we can see how people talk about the positive effects of decreased emissions during the pandemic due to fewer car trips - for example, the air quality has improved in several Swedish cities during 2020 partly due to the reduced traffic volumes during the pandemic (Naturvårdsverket, 2020b). At the same time the number of trips carried out by bike and walking has not decreased significantly and the share of bike and pedestrian traffic has increased, which is considered positive. There has not been much data available on travel changes for these modes of transport compared to the other modes analysed in this work. This could be because of a lack of interest from authorities and politicians to study modes which generally cover shorter distances with a smaller range of financing, infrastructure and numbers overall. As bike and pedestrian traffic have great potential of utilizing the transport system by short-distance, a need which grows with the growing urbanisation and demand for sustainable cities, it is crucial that further research and investments in infrastructure involve the short-distance modes of transport as well as the long-distance, conventional ones.

7.3 Societal changes

Trends before the pandemic escalated during the pandemic such as e-commerce and remote work. The abrupt changes in how we live, work and travel are all proof of how much a society can adapt when needed and that the extensive limitations in the form of the COVID-19 restrictions enabled this adaptation. But the COVID-19 pandemic is to be considered as a short-term crisis, not a long-term like climate change or the health effects of traffic noise. For long-term changes other measures are needed. The current restrictions will also likely not be suitable in a scenario of a long-term pandemic where people's freedom and accessibility are continually limited, not the least by the restrictions affecting public transport as this mode of transport is aimed for these fundamental societal values.

7.4 The interviews

The public transport authorities mainly have the same mission, conditions and obstacles both before and during the pandemic. The travel development follows the same pattern and the measures carried out have been similar. Therefore it is hard to link certain measures to the change in numbers of trips. What can be concluded is that conditions like closed borders between countries have a bigger impact than canvas bags on the vehicle seats. This might also be the reason why Skånetrafiken has been slightly harder hit than SL and Västtrafik as the border between Denmark and Sweden has been closed for most people. Some questions that would have been suited in the interviews appeared after they were held. Although some complementary questions based on the interview questions could be held via personal communication, new ones like the effect on increased punctuality and the safety situation for ticket inspectors were found too great to add to the interviews afterwards. These were supported by other material, data respectively newspaper articles. Although the punctuality data can be considered more valid than the articles, both the punctuality and the ticket inspector safety would have benefited from the authorities view on the matter. For another research of the same type a follow-up interview might be suitable to add to the method to include questions coming up after the first interview.

7.5 Compared travel data

The travel development for public transport in the major regions (see Figure 4.2) have followed the same pattern as overall travel (see 2.1) but have had a greater reduction. It is also interesting to see that the travel with public transport has not been more evenly distributed over the day during the pandemic as it was expected to, as more people have worked with more flexible travel times and been advised to avoid travel in rush hour. This is especially so since the overall travel seems to have been evened out (see 2.3.3). It is also interesting to see that the travel has been moved earlier during the day. It might be that those who need to use public transport are those with un-flexible and early work hours. Also, people might have been advised to go to work earlier and leave earlier to avoid congestion. Overall however, people seem to want to travel during the same times of the day both before and after the

pandemic. It is important to note that although the peaks have been as high before as during the pandemic percentually, the number of passengers have been much lower during the pandemic. This means that pandemic rush hours are not the same as pre-pandemic rush hours, specifically because of the lesser congestion.

7.6 The traffic data analysis

The traffic data could have been further analysed, e.g. to foresee the future travel developments. However, to produce trends to forecast future travel developments was considered to give a too unreliable result as the travel numbers mainly have followed the restriction rates which have differed significantly over the year.

7.7 The effects

Ten pandemic effects and four potential long-term effects were established. Seven negative and three positive pandemic effects were determined; two fully negative, five generally negative and three fully positive while no generally positive effects were found. This does not automatically mean that the pandemic has had a neutral impact on public transport. The criterias which weighted some more (*Traffic income*, *Travel times*, *Ticket prices* and *Car traffic*) were mostly negatively fulfilled by the effects (see Appendix F) which can be seen as an indicator of it. It is also important to know that these effects were documented during the pandemic and not for the long-term. For example decreased ticket income risks lead to decreased departures, but this effect has not occurred during the pandemic as the authorities have continued to operate with the same supply as before the pandemic. However, in the long-term it might be a consequence but yet it is uncertain and can only be warned for. The long-term effects are more crucial than the short-term ones as they will determine the conditions for future public transport, but they are also more uncertain as they are neither documented nor guaranteed. The short-term effects are therefore just as crucial as the long-term ones to give a valid view of what has happened and to indicate the potential long-term effects. Four potential long-term effects were determined and out of them everyone was found negative. This is of course a sad indicator of the future of public transport, as there is a significant risk that the worst hit on public transport was not during the pandemic but might be a consequence of this hit in a fore-seeable future.

7.8 The solutions

Twelve solutions, ten aimed for the public transport authorities and two that can be implemented on a local, regional and/or national level were produced. The solutions need to be implemented together to give efficient results; there is no quick-fix to improve public transport in the long-term as public transport is just one of several organs in the organism we call society. It has been hard to give very specific instructions as the conditions differ from region to region and also within the regions. To gain more specific solutions the conditions would have needed to be more narrow. The solutions in this report are thought to be applicable for all public

transport authorities in Sweden and will therefore need to be further processed by the authority implementing them. When dealing with efficiency and rationalisation it is important to remind that public transport is not a goal in itself but an instrument to fulfill other goals. The realistic aim of improving public transport is to improve life for the majority of the people which will inevitably lead to some people having it worsened instead. To meet all the goals of public transport a minimum level of supply is therefore crucial to implement and fulfill. Otherwise there is an imminent risk that the solutions will benefit the economy of the public transport authorities more than the passengers or the staff. The solutions on a local, regional and/or national level need to be enforced by municipalities, counties and parliament in collaboration with public transport authorities. When researching for information about the violence and threats towards on-board staff, the focus of bus drivers and train crew were greater than on ticket inspectors even though they in many ways are exposed to the same threats. One of the main reasons bus drivers and ticket crew are exposed to threats and violence is when they control tickets, and as this is the main mission for the ticket inspectors, the lack of research for this work group should not be ignored. Even though there is a lack of scientific research in this area the media covers both sides; both the threat and violence towards ticket inspectors from passengers and the violence that the ticket inspectors exercise towards passengers.

7.9 The errors

This work has focused on the major regions of Sweden and should maybe have been more diverse with some minor regions too. Although the major regions stands for the major travel with public transport it might have gained a more representative view of how public transport has been affected in Sweden as most authorities have not been studied. It has been assumed that the pandemic will end in a foreseeable time but even as vaccinations have advanced during the work of this report, the certainty of this happening is not greater now in May 2021 than it was in January. In a scenario where the pandemic restrictions continue for many years many of the solutions of this work are still considered applicable; the pandemic effects will potentially extend and the potential long-term ones risk being realised to a greater extent than expected.

8

Conclusion

- Travel in general and public transport specifically has decreased drastically during 2020 compared to 2019 due to a need for physical distance with the restrictions of the COVID-19 pandemic.

- Although car traffic has gone down in total numbers its share among local travel has increased during the pandemic, which is problematic when aiming for a more sustainable society.

- The COVID-19 pandemic has shown that people are able to adapt their behavior quickly during a short-term crisis. However, for long-term crises such as a prolonged COVID-19 pandemic other measures will be needed.

- The travel development and measures carried out by the major public transport authorities in Sweden have been similar. Skåne has experienced a slightly higher decrease due to the closed border towards Denmark. The hourly travel distribution has not changed significantly during the pandemic meaning that even during the pandemic people tend to travel during certain times during the day.

- The COVID-19 pandemic has overall affected public transport negatively. There have been positive effects which with the right solutions can contribute to public transport even in the long-term. However, the most crucial effects are the potential long-term ones, which are all negative. The heavy budget deficits need to be remediated to avoid a drawn-out disarmament of the public transport system and the response lies with public transport authorities as well as local, regional and national planning.

- A majority of the presented solutions are meant for the public transport authorities to implement and need to be combined and adapted by every authority to best suit its condition and achieve the most efficient result. The major changes mean drastic measures which will affect the public transport systems as well as the society. The changes will not benefit everyone but the aim is that it will benefit most people. A lowest standard supply needs to be set up to guarantee a public transport available for everyone.

- As a consequence of the COVID-19 pandemic, public transport risks facing its greatest crisis yet both economically and faithfully. With the knowledge and experience of the first year of COVID-19 we can be as prepared as possible both for an extended pandemic and a post-pandemic society.

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A

Interview with SL

Public transport authority: SL
Date: 3/3 2021
Interview object: Kristina Abelin, affärsförvaltare/business manager at the traffic production for commuting travel at the traffic department and Mark Kesper, bus strategist at the department of strategic development

- Information about the authorities
  - What is the mission for the public transport authority? Which area does it cover and what modes of transport do they possess?

The English formulation of the mission of SL is that "SL plans, develops, commissions and markets public transport within the county. Transport services are run by both private and public transport companies". The modes of transport we provide are rail (commuting train, tramway, local train and metro), bus, boat, and some more exotic but rare modes of transport like helicopter.

- Recommendation for passengers
  - What recommendations have been given for passengers by the public transport authority?
  - Where, how and when?

The recommendations communicated from SL were to not travel with us, only travel when necessary, and "hang in there". One part of the recommendations was to inform about avoiding traveling, and another part about how to travel safely when traveling. The recommendations were based on the ones from the Public Health Agency and the regional ones, which did not differ significantly. The commercial pillars were secured to show information from 1177, The Healthcare Guide.

- Information
  - What information has been given by the public transport authority?
  - Where, how and when?

Information has been published via electrical displays, stickers in metro and buses and exclamations in trains. During October 2020, the message of risk of congestion was published in the mobile application and website during times when it was expected to occur. For the boat traffic, the staff should avoid to move around too much in the passenger areas. Hubs were placed out where staff equipped with ticket inspection tools and plexi glass could control passengers' tickets and give them information.

- Capacity
  - What changes have been made by the public transport authority directly affecting the capacity?
  - Where, how and when?

In March 2020, more and more people were at home remotely, and less and less were traveling with less income as a consequence. A bit hasty decision was made to decrease the traffic departures on weekdays to a mix between weekdays and Saturdays, at least for buses and presumably for tram and local train too - boat traffic was not as affected. However, congestion still occurred where it normally did before the pandemic, and it was uneven between different regions, as in some regions the car occupancy is higher and more people can work remotely than in others. From April 2020, full capacity has been operated with more vehicles in addition to this when possible. Longer trains were operated during Summer. There has been an obstacle to find drivers, since it is harder if they get sick, and so drivers from tourism companies have been recruited as well.

- Safety measures
  - What safety measures have been made by the public transport authority for passengers?
  - What safety measures have been made by the public transport authority for the on-board staff?
  - Where, how and when?

The working environment responsibility lies with the entrepreneurs, and rail traffic differs from bus traffic in terms of this. The front doors were shut off on all vehicles in March 2020 as well as the first seat rows of the vehicles. The driver's cabin in all vehicles has been shut off and has special cleaning. The train crew has access to the other, empty driver's cabin. During 2021, masks have been offered to passengers that can be picked up at some of the customer centers. SL has in January 2021 started to open the front doors on some buses where protection glass has been installed.

- Ticket control
  - What changes have been made by the public transport authority in terms of ticket controls?
  - Where, how and when?

In March 2020, the ticket controls were canceled with increased fare evasion as a consequence. The mission for the ticket inspectors changed from validating tickets to reporting congestion on platforms and vehicles. In June, ticket controls were resumed, first without the risk of fining and later with the risk of fining. Hand sanitizer and plastic gloves were accessible to the inspector crew who would keep their distance to passengers when controlling tickets, and the controls were only carried out if the distance could be kept, otherwise it was canceled. As mentioned, tickets were checked in hubs to some extent.

- Other changes
  - What other changes have been made by the public transport authority?

B

Interview with Västtrafik

Public transport authority: Västtrafik
Date: 4/3 2021
Interview object: Leif Gjulem, Head of department for disruption management

- Information about the authorities
  - What is the mission for the public transport authority? Which area does it cover and what modes of transport do they possess?

Västtrafik provides Region Västra Götaland, with its capital city Gothenburg, with public transport by bus, tram, train and boat.

- Recommendation for passengers
  - What recommendations have been given for passengers by the public transport authority?
  - Where, how and when?

Västtrafik communicated sustainability, environmental thinking etcetera before the pandemic, to get more people to travel by public transport. During the pandemic this changed, starting in March, as Västtrafik communicated the message to avoid public transport instead, based on the restrictions from the Public Health Agency.

- Information
  - What information has been given by the public transport authority?
  - Where, how and when?

Congestion informants were placed out in the public transport system; staff informing about keeping distance, waiting for the next departure if possible when crowded. From customer counting systems it could be determined where the need for informants were the biggest, like at stations and travel centers. Information has been published physically via real-time systems, digital signs and on vehicles and stations. It has also been communicated via digital channels like the website, mobile application and social media. Here, Västtrafik specifically informed about what times and departures during the day that normally should be avoided due to congestion. A forecast function, based on the customer counting system of the vehicles, was introduced in the application around 22 February 2021. Autumn 2020, Västtrafik handed out canvas bags printed with the text “I would like to sit beside you, but not right now - thank you for keeping your distance”, that could be placed on the empty seat next to the passenger to encourage physical distance.

- Capacity
  - What changes have been made by the public transport authority directly affecting the capacity?
  - Where, how and when?

Political decisions have determined that all traffic should be operated with full capacity. Extra traffic has been enforced for mostly buses, specifically those going to hospitals and industrial areas where a lot of people work. Also, specific areas have been prioritized, for example north-east of Gothenburg where the socio-economic status is generally lower and many people are dependent on public transport to travel. The existing vehicle fleet has been used to a maximum plus extra vehicles in addition to that when possible. Some traffic companies have had high sick rates, especially during the March-April 2020 and for Gothenburg Tramways (Göteborgs Spårvägar), and so some departures were canceled during this period. The boat traffic is more sensitive to these differences as the supply is lower, but efforts have been made to limit the amount of passengers per boat. The train traffic has operated according to plan, and the aberrations occurring during 2020 are of the kind that occur normally. No seats have been shut off.

- Safety measures
  - What safety measures have been made by the public transport authority for passengers?
  - What safety measures have been made by the public transport authority for the on-board staff?
  - Where, how and when?

As the on-board staff are employed by the traffic companies, the work environment responsibility lies with them and not with Västtrafik. However, the front doors of buses and trams have been shut off, as well as the first seat rows of the buses, and passengers can only enter and exit the vehicle via the middle and back doors, since March 2020. Staff that interacts with the passengers are carrying masks and visors. Currently, Västtrafik tries to implement protective glass in the driver's cabin, so that the front doors can be opened up again. During 2021, masks have been offered to passengers that can be picked up at customer centers.

- Ticket control
  - What changes have been made by the public transport authority in terms of ticket controls?
  - Where, how and when?

In the beginning of the pandemic, March-April, all ticket controls were canceled. During the Summer, ticket control was steadily resumed to normal levels as it was a sensitive subject where we have received criticism, where a distance was kept. Fare evasion has increased during this period, and as ticket incomes have decreased largely both due to this and a decreased travel overall, the ticket controls were extended to even higher levels than normal during Autumn. Although Gothenburg already has a system of open visitation today on local buses and trams where the driver does not check your ticket, fare evasion has also increased here. This is because there has been a change in attitude where it is increasingly considered okay to travel for free

with public transport during the pandemic, as traffic control was not carried out at all. Also, when possible, ticket visitation has been carried out on the platform, for example in Gothenburg.

- Other changes
  - What other changes have been made by the public transport authority?

C

Interview with Skånetrafiken

Public transport authority: Skånetrafiken
Date: 26/2 2021
Interview object: Carl Björklund, trafik strategist for bus and train

- Information about the authorities
  - What is the mission for the public transport authority? Which area does it cover and what modes of transport do they possess?

We usually describe it like this in English:

"Skånetrafiken is a part of Region Skåne. We offer sustainable travelling to everyone who wants and needs to travel within, to and from Skåne.Our public transport services are made up of city services, regional services and special transport services. All our bus, rail and special transport services are carried out by companies who are contracted through public tenders. The main tasks of Skånetrafiken are to develop, plan, procure, promote and market public transport in Skåne. We offer sustainable, extensive and accessible public transport services:

· Train services are the base and backbone for regional journeys within Skåne and to adjacent regions, including the Copenhagen area.
· With our city bus services we interconnect the cities and make it easier to travel from the outskirts to central parts and transfer stops for an onward journey.
· Regional bus services have a good accessibility and surface coverage to connect rural areas to bigger cities and workplaces.
· Together with the local councils we offer special transport services that adapt to individuals and the environment and are regarded as simple, safe and within easy reach."

- Recommendation for passengers
  - What recommendations have been given for passengers by the public transport authority?
  - Where, how and when?

Skånetrafiken has given clear directives as both the Public Health Agency and the regional Disease Control (Smittskydd) has advised so. These include to keep a distance when entering and exiting a vehicle, that masks should be carried, travel only if necessary, take a later departure if possible, stay at home if you are ill.

- Information

  - What information has been given by the public transport authority?
  - Where, how and when?

The information has been published via social media, infotainment signs, advertisement posters, exclamation aboard vehicles and the media. There was a discussion from March-April that people traveling with public transport experienced congestion, a change that has occurred fast, and so Skånetrafiken tried to make it easier for people to plan their travel. A function based on APC-vehicles was produced where the congestion on vehicles can be seen, and published on the website and mobile application. This was however only a forecast for the stations before the one the passenger would enter, and would not well determine the congestion for the upcoming stations. A new congestion forecast function was produced based on how much the customers would search for trips during the same day, and so it became more reliable than before, with an interactive map. It was introduced during Autumn 2020, but excludes Öresundståg and some buses. No informants have been specifically placed out during the pandemic.

- Capacity
  - What changes have been made by the public transport authority directly affecting the capacity?
  - Where, how and when?

As travel as well as the ticket income has decreased remarkably, some departures on some routes were canceled, but not in rush hour. The vehicles were redistributed so more vehicles could be put in rush hour when it was especially needed. Pågatågen (commuting train) have gotten more wagons while the departures of Öresundståg have decreased outside of rush hours. Some routes have been experienced as crowded, not necessarily because they have been.

- Safety measures
  - What safety measures have been made by the public transport authority for passengers?
  - What safety measures have been made by the public transport authority for the on-board staff?
  - Where, how and when?

The traffic companies have the employer - and working environmental responsibility and wanted to close the front doors. Skånetrafiken were afraid that this would lead to more congestion in the back part of the buses. They had to follow the demand from the Work Environment Authority eventually and close the front doors in April 2020. Skånetrafiken wants to implement plexi screens for the bus drivers, but it is a long process which the traffic companies must take responsibility for. The train crew cabins have been shut off together with the neighboring seats. Masks have been offered to the passengers that can be picked up at the customer centers.

- Ticket control
  - What changes have been made by the public transport authority in terms of ticket controls?
  - Where, how and when?

Ticket controls were canceled in the beginning of the pandemic, as it was unwise to increase the congestion on the vehicles. The ticket inspectors carried out other things instead, like counting passengers at bigger stations to collect info about the occupancy to the mobile application. As are evasion increased, ticket controls were resumed before Summer 2020.

- Other changes
  - What other changes have been made by the public transport authority?

As people wanted to travel less frequently during the pandemic, a 7-day ticket was introduced in February 2021 enabling travel during seven different days. It was not optimal in terms of usability and price, so a flexible ticket was introduced in March 2021, with 10 optimal travel days during a 30-day period.

D

Monthly traffic data

D.1 SL

Boarding passengers weekdays					
	2019	2020	Difference according to SL	Numerical difference	Percentual difference
January	2988500	2986500	–0,07%	-2000	-0,066923206
February	3025500	2954000	–2,36%	-71500	-2,363245745
March	3085200	1934000	–37,31%	-1151200	-37,31362635
April	2993300	1251000	–58,21%	-1742300	-58,20666154
May	2996800	1464000	–51,15%	-1532800	-51,14789108
June	2679200	1532000	–42,82%	-1147200	-42,81875187
July	1864400	1187000	–36,33%	-677400	-36,33340485
August	2429700	1641000	–32,46%	-788700	-32,46079763
September	2954300	1993700	–32,52%	-960600	-32,51531666
October	3073000	1974800	–35,74%	-1098200	-35,73706476
November	3206900	1768800	–44,84%	-1438100	-44,84393028
December	3162000	1627900	–48,52%	-1534100	-48,51676154
January-December	**34458800**	**22314700**		**-12144100**	**-35,2423764**
March-December	**28444800**	**16374200**		**-12070600**	**-42,43517269**

D.2 Västtrafik

Number of trips per month					
	2019	2020	Numerical difference	Percentual difference	Control number from Västtrafik (including 5-8% more of the travel)
January	30292000	30617000	325000	1,072890532	
February	28620000	29798000	1178000	4,116002795	
March	31941000	23897000	-8044000	-25,18393288	
April	30224000	15207000	-15017000	-49,68568025	
May	31826000	16671000	-15155000	-47,6182995	
June	26344000	17264000	-9080000	-34,46705132	
July	22564000	15063000	-7501000	-33,24321929	
August	27101000	19144000	-7957000	-29,3605402	
September	31463000	21888000	-9575000	-30,43257159	
October	33624000	22275000	-11349000	-33,75267666	
November	32609000	18351000	-14258000	-43,72412524	
December	28653000	15382000	-13271000	-46,31626706	
January-December	**355261000**	**245557000**	**-109704000**	**-30,87983201**	**-31%**
March-December	**296349000**	**185142000**	**111207000**	**-37,52568762**	

D.3 Skånetrafiken

Combined number of trips and boarding passengers				
	2019	2020	Numerical difference	Percentual difference
January	14447128	13737441	-709687	-4,912305062
February	13513718	13378162	-135556	-1,003099221
March	15379820	10552264	-4827556	-31,38889792
April	14299497	6735695	-7563802	-52,89558087
May	14776637	6350518	-8426119	-57,02325231
June	12570499	7330484	-5240015	-41,68501982
July	12847206	7546605	-5300601	-41,25878421
August	13804985	8228436	-5576549	-40,39518333
September	14596299	8996293	-5600006	-38,36593098
October	15551557	9160777	-6390780	-41,09414897
November	14887374	7500940	-7386434	-49,6154258
December	13298413	5971113	-7327300	-55,0990558
January-December	**169973133**	**105488728**	**-64484405**	**-37,93799871**
March-December	**142012287**	**78373125**	**-63639162**	**-44,81243373**

E

Hourly traffic data

In this chapter the hourly traffic data from SL (E1-E4), Västtrafik (E5-E6) and Skånetrafiken (E7-E10) is presented.

E.1 SL January-December 2019

Metro				Commuter train				Total			
2019	Hour	Total	Share [%]	2019	Hour	Total	Share [%]	2019	Hour	Total	Share [%]
	0	2484931	0,77492		0	458028	0,49611		0	2942959	0,712594062
	1	1301458	0,40586		1	214720	0,23257		1	1516178	0,367120113
	2	789058	0,24607		2	21056	0,02281		2	810114	0,196157142
	3	600480	0,18726		3	15103	0,01636		3	615583	0,149054333
	4	775672	0,24189		4	289118	0,31316		4	1064790	0,257823174
	5	3444048	1,07402		5	2100856	2,27552		5	5544904	1,342616621
	6	8461242	2,63863		6	4592804	4,97466		6	13054046	3,160844466
	7	21687354	6,76317		7	9036752	9,78808		7	30724106	7,439388557
	8	24827087	7,74229		8	7582340	8,21275		8	32409427	7,84746415
	9	14178124	4,42143		9	4261939	4,61628		9	18440063	4,464988946
	10	12990126	4,05095		10	3613212	3,91362		10	16603338	4,020253111
	11	15703776	4,8972		11	4163908	4,5101		11	19867684	4,810666289
	12	18265564	5,69609		12	4688672	5,0785		12	22954236	5,558029276
	13	18141013	5,65725		13	4628323	5,01313		13	22769336	5,513258472
	14	21475452	6,69709		14	5665356	6,13638		14	27140808	6,571745862
	15	27729830	8,64751		15	7929754	8,58905		15	35659584	8,634441671
	16	32836424	10,24		16	9728682	10,5375		16	42565106	10,30651185
	17	30731463	9,58357		17	7810854	8,46026		17	38542317	9,332452897
	18	19892713	6,20352		18	4582030	4,96299		18	24474743	5,926197593
	19	13632516	4,25128		19	3233305	3,50213		19	16865821	4,083809493
	20	10956121	3,41665		20	2787761	3,01954		20	13743882	3,327878067
	21	8962351	2,7949		21	2348850	2,54414		21	11311201	2,738840287
	22	6504463	2,02841		22	1571736	1,70241		22	8076199	1,955532325
	23	4297066	1,34003		23	998864	1,08191		23	5295930	1,282331243
	Total	**320668332**	**100**		**Total**	**92324023**	**100**		**Total**	**412992355**	**100**

E.2 SL January-December 2020

Metro				Commuter train				Total				
2020	Hour	Total	Share [%]	2020	Hour	Total	Share [%]	2020	Hour	Total	Share [%]	Difference from 2019
	0	1408283	0,76		0	300947	0,52		0	1709230	0,70	- 0,01
	1	814932	0,44		1	143935	0,25		1	958867	0,39	0,03
	2	429496	0,23		2	16495	0,03		2	445991	0,18	- 0,01
	3	304957	0,16		3	13104	0,02		3	318061	0,13	- 0,02
	4	534454	0,29		4	291900	0,50		4	826354	0,34	0,08
	5	2607375	1,41		5	1620542	2,79		5	4227917	1,74	0,39
	6	5751830	3,10		6	3135549	5,40		6	8887379	3,65	0,49
	7	12200278	6,58		7	5264121	9,06		7	17464399	7,18	- 0,26
	8	12225144	6,60		8	4096544	7,05		8	16321688	6,71	- 1,14
	9	7904060	4,27		9	2657379	4,57		9	10561439	4,34	- 0,13
	10	7524773	4,06		10	2275290	3,92		10	9800063	4,03	0,01
	11	9095921	4,91		11	2613116	4,50		11	11709037	4,81	- 0,00
	12	10741686	5,80		12	3007563	5,18		12	13749249	5,65	0,09
	13	11106922	5,99		13	3093571	5,32		13	14200493	5,83	0,32
	14	13317770	7,19		14	3794816	6,53		14	17112586	7,03	0,46
	15	17108903	9,23		15	5231320	9,00		15	22340223	9,18	0,54
	16	19033559	10,27		16	6019153	10,36		16	25052712	10,29	- 0,01
	17	16776792	9,05		17	4643428	7,99		17	21420220	8,80	- 0,53
	18	11454271	6,18		18	2932540	5,05		18	14386811	5,91	- 0,02
	19	7828925	4,22		19	2126447	3,66		19	9955372	4,09	0,01
	20	6172321	3,33		20	1777644	3,06		20	7949965	3,27	- 0,06
	21	5095764	2,75		21	1491651	2,57		21	6587415	2,71	- 0,03
	22	3612673	1,95		22	961374	1,65		22	4574047	1,88	- 0,08
	23	2255749	1,22		23	590379	1,02		23	2846128	1,17	- 0,11
	Total	185306838	100,00		Total	58098808	100,00		Total	**243405646,00**	100,00	

E.3 SL March-December 2019

Metro				Commuter train				Total			
2019	Hour	Total	Share [%]	2019	Hour	Total	Share [%]	2019	Hour	Total	Share [%]
	0	2133436	0,80016		0	397991	0,51129		0	2531427	0,734883632
	1	1078020	0,40432		1	179541	0,23065		1	1257561	0,365075112
	2	652094	0,24457		2	17397	0,02235		2	669491	0,194355981
	3	492799	0,18483		3	12737	0,01636		3	505536	0,146759172
	4	646159	0,24235		4	243102	0,31231		4	889261	0,258156113
	5	2881163	1,0806		5	1766316	2,26913		5	4647479	1,349182199
	6	7000744	2,62569		6	3837770	4,93027		6	10838514	3,146465031
	7	17748154	6,65659		7	7514887	9,65415		7	25263041	7,333964331
	8	20276650	7,60492		8	6324147	8,12445		8	26600797	7,72232038
	9	11755210	4,40889		9	3594997	4,61839		9	15350207	4,456227997
	10	10922515	4,09658		10	3076486	3,95227		10	13999001	4,063967358
	11	13166891	4,93835		11	3537872	4,545		11	16704763	4,849461155
	12	15243932	5,71736		12	3975211	5,10684		12	19219143	5,579395973
	13	15179481	5,69319		13	3929087	5,04758		13	19108568	5,547295598
	14	17931173	6,72523		14	4789851	6,15338		14	22721024	6,596006378
	15	23051721	8,64573		15	6669990	8,56874		15	29721711	8,628334503
	16	27141262	10,1795		16	8149270	10,4691		16	35290532	10,24498606
	17	25283204	9,48267		17	6534957	8,39527		17	31818161	9,23694253
	18	16537255	6,20243		18	3877480	4,98128		18	20414735	5,92648123
	19	11435934	4,28914		19	2760987	3,54696		19	14196921	4,121424345
	20	9229097	3,46145		20	2391896	3,0728		20	11620993	3,373621891
	21	7588424	2,8461		21	2021489	2,59695		21	9609913	2,789797125
	22	5561125	2,08574		22	1366814	1,75591		22	6927939	2,011209082
	23	3688967	1,38358		23	870689	1,11855		23	4559656	1,323686822
	Total	**266625410**	**100**		**Total**	**77840964**	**100**		**Total**	**344466374**	100

E.4 SL March-December 2020

Metro				Commuter train				Total				
2020	Hour	Total	Share [%]	2020	Hour	Total	Share [%]	2020	Hour	Total	Share [%]	Difference from 2019
	0	1013903	0,77		0	231202	0,54		0	1 245 105	0,71	- 0,02
	1	587269	0,45		1	106147	0,25		1	693 416	0,40	0,03
	2	292650	0,22		2	12808	0,03		2	305 458	0,18	- 0,02
	3	198682	0,15		3	10732	0,03		3	209 414	0,12	- 0,03
	4	408301	0,31		4	236266	0,55		4	644 567	0,37	0,11
	5	2046943	1,55		5	1281025	3,00		5	3 327 968	1,91	0,56
	6	4338463	3,29		6	2359425	5,53		6	6 697 888	3,84	0,69
	7	8429840	6,40		7	3664201	8,58		7	12 094 041	6,93	- 0,40
	8	7873647	5,97		8	2756428	6,46		8	10 630 075	6,09	- 1,63
	9	5552889	4,21		9	1948893	4,57		9	7 501 782	4,30	- 0,16
	10	5459765	4,14		10	1707234	4,00		10	7 166 999	4,11	0,04
	11	6537655	4,96		11	1944001	4,55		11	8 481 656	4,86	0,01
	12	7703434	5,85		12	2241674	5,25		12	9 945 108	5,70	0,12
	13	8118366	6,16		13	2336611	5,47		13	10 454 977	5,99	0,45
	14	9715510	7,37		14	2851345	6,68		14	12 566 855	7,20	0,61
	15	12377117	9,39		15	3882445	9,10		15	16 259 562	9,32	0,69
	16	13353676	10,13		16	4328309	10,14		16	17 681 985	10,13	- 0,11
	17	11482878	8,71		17	3293916	7,72		17	14 776 794	8,47	- 0,77
	18	8188837	6,21		18	2190586	5,13		18	10 379 423	5,95	0,02
	19	5664702	4,30		19	1624282	3,81		19	7 288 984	4,18	0,06
	20	4446226	3,37		20	1351886	3,17		20	5 798 112	3,32	- 0,05
	21	3721498	2,82		21	1137159	2,66		21	4 858 657	2,78	- 0,01
	22	2643114	2,01		22	738669	1,73		22	3 381 783	1,94	- 0,07
	23	1629902	1,24		23	452043	1,06		23	2 081 945	1,19	- 0,13
	Total	**131785267**	**100,00**		**Total**	**42687287**	**100,00**		**Total**	**174 472 554**	100,00	

E.5 Västtrafik January-December 2019-2020

2019	Hour	Total	Share [%]	2020	Hour	Total	Share [%]	Difference from 2019
	0	1977418,00	0,64		0	1532254,00	0,68	0,04
	1	1082877,00	0,35		1	873379,00	0,39	0,04
	2	687960,00	0,22		2	479366,00	0,21	- 0,01
	3	459646,00	0,15		3	297093,00	0,13	- 0,02
	4	527817,00	0,17		4	405591,00	0,18	0,01
	5	4231587,00	1,36		5	3422836,00	1,52	0,16
	6	12005930,00	3,86		6	9285595,00	4,13	0,27
	7	24302826,00	7,82		7	16776934,00	7,46	- 0,36
	8	18660898,00	6,01		8	12265533,00	5,45	- 0,55
	9	13817556,00	4,45		9	9627132,00	4,28	- 0,17
	10	13373660,00	4,30		10	9480303,00	4,22	- 0,09
	11	16415180,00	5,28		11	11583734,00	5,15	- 0,13
	12	19427587,00	6,25		12	13816954,00	6,14	- 0,11
	13	19592114,00	6,31		13	14659749,00	6,52	0,21
	14	23864293,00	7,68		14	18321882,00	8,15	0,47
	15	28003805,00	9,01		15	21319374,00	9,48	0,47
	16	30763293,00	9,90		16	22153675,00	9,85	- 0,05
	17	24279301,00	7,81		17	17117361,00	7,61	- 0,20
	18	17163662,00	5,52		18	12506405,00	5,56	0,04
	19	12270231,00	3,95		19	9022151,00	4,01	0,06
	20	9966545,00	3,21		20	7338926,00	3,26	0,06
	21	8073717,00	2,60		21	5861907,00	2,61	0,01
	22	5755043,00	1,85		22	4037416,00	1,80	- 0,06
	23	3995360,00	1,29		23	2678973,00	1,19	- 0,09
	Total	**310698306,00**	100,00		**Total**	**224864523,00**	100,00	

E.6 Västtrafik March-December 2019-2020

2019	Hour	Total	Share [%]	2020	Hour	Total	Share [%]	Difference from 2019
	0	1702917,00	0,66		0	1223006,00	0,71	0,06
	1	919945,00	0,35		1	684992,00	0,40	0,05
	2	583493,00	0,22		2	371050,00	0,22	- 0,01
	3	387484,00	0,15		3	223378,00	0,13	- 0,02
	4	443346,00	0,17		4	311740,00	0,18	0,01
	5	3520944,00	1,35		5	2693361,00	1,57	0,22
	6	10008712,00	3,85		6	7047655,00	4,11	0,26
	7	19942949,00	7,67		7	12214622,00	7,12	- 0,55
	8	15345415,00	5,90		8	8934763,00	5,21	- 0,69
	9	11495706,00	4,42		9	7188502,00	4,19	- 0,23
	10	11269979,00	4,33		10	7265422,00	4,24	- 0,10
	11	13793527,00	5,31		11	8794846,00	5,13	- 0,18
	12	16295550,00	6,27		12	10466278,00	6,10	- 0,17
	13	16454021,00	6,33		13	11311520,00	6,59	0,27
	14	19922565,00	7,66		14	14071235,00	8,20	0,54
	15	23302887,00	8,96		15	16332076,00	9,52	0,56
	16	25515587,00	9,81		16	16805485,00	9,80	- 0,02
	17	20221400,00	7,78		17	13021997,00	7,59	- 0,19
	18	14518624,00	5,58		18	9756547,00	5,69	0,10
	19	10480957,00	4,03		19	7111516,00	4,15	0,11
	20	8496406,00	3,27		20	5782916,00	3,37	0,10
	21	6908062,00	2,66		21	4636649,00	2,70	0,05
	22	4986612,00	1,92		22	3187865,00	1,86	- 0,06
	23	3462138,00	1,33		23	2085662,00	1,22	- 0,12
	Total	**259979226,00**	**100,00**		**Total**	**171523083,00**	**100,00**	

E.7 Skånetrafiken January-December 2019

	Local bus Lund				Pågatåg				Total		
2019	Hour	Total	Share [%]	2019	Hour	Total	Share [%]	2019	Hour	Total	Share [%]
	0	60432	0,51		0	262220	1,01		0	322652	0,85
	1	34791	0,29		1	125607	0,48		1	160398	0,42
	2	26576	0,22		2	46887	0,18		2	73463	0,19
	3	6041	0,05		3	6173	0,02		3	12214	0,03
	4	111	0,00		4	48554	0,19		4	48665	0,13
	5	67053	0,56		5	323997	1,25		5	391050	1,03
	6	353590	2,98		6	953949	3,68		6	1307539	3,46
	7	809758	6,82		7	2073281	7,99		7	2883039	7,62
	8	795784	6,70		8	2139051	8,25		8	2934835	7,76
	9	675736	5,69		9	1357136	5,23		9	2032872	5,38
	10	621049	5,23		10	1004145	3,87		10	1625194	4,30
	11	751341	6,32		11	1095095	4,22		11	1846436	4,88
	12	884091	7,44		12	1337303	5,16		12	2221394	5,87
	13	809435	6,81		13	1341460	5,17		13	2150895	5,69
	14	956679	8,05		14	1577269	6,08		14	2533948	6,70
	15	1088541	9,16		15	2002561	7,72		15	3091102	8,17
	16	1109539	9,34		16	2517569	9,71		16	3627108	9,59
	17	875109	7,37		17	2449229	9,44		17	3324338	8,79
	18	607266	5,11		18	1552078	5,99		18	2159344	5,71
	19	408618	3,44		19	1108856	4,28		19	1517474	4,01
	20	338477	2,85		20	899418	3,47		20	1237895	3,27
	21	270435	2,28		21	717992	2,77		21	988427	2,61
	22	193751	1,63		22	582239	2,25		22	775990	2,05
	23	135742	1,14		23	410218	1,58		23	545960	1,44
	Total	**11879945**	100,00		**Total**	**25932287**	100,00		**Total**	**37812232**	100,00

E.8 Skånetrafiken January-December 2020

	Local bus Lund					Pågatåg					Total			
2020	Hour	Total	Share [%]	Difference from 2019	2020	Hour	Total	Share [%]	Difference from 2019	2020	Hour	Total	Share [%]	Difference from 2019
	0	40229	0,51	0,00		0	66354	0,39	- 0,63		0	106583	0,42	-0,428552
	1	23210	0,29	0,00		1	29093	0,17	- 0,32		1	52303	0,21	-0,215761
	2	17123	0,22	- 0,01		2	9969	0,06	- 0,12		2	27092	0,11	-0,086318
	3	3909	0,05	- 0,00		3	2597	0,02	- 0,01		3	6506	0,03	-0,006374
	4	23958	0,30	0,30		4	39935	0,23	0,04		4	63893	0,25	0,1259208
	5	145847	1,85	1,28		5	296008	1,72	0,47		5	441855	1,76	0,7266646
	6	357585	4,53	1,56		6	769842	4,47	0,80		6	1127427	4,49	1,0349749
	7	507688	6,44	- 0,38		7	1520518	8,84	0,84		7	2028206	8,08	0,4580637
	8	459992	5,83	- 0,87		8	1340841	7,79	- 0,46		8	1800833	7,18	-0,585032
	9	414323	5,25	- 0,44		9	866231	5,03	- 0,20		9	1280554	5,10	-0,273042
	10	428997	5,44	0,21		10	666118	3,87	- 0,00		10	1095115	4,36	0,0661218
	11	510969	6,48	0,15		11	707803	4,11	- 0,11		11	1218772	4,86	-0,026195
	12	560726	7,11	- 0,33		12	850305	4,94	- 0,21		12	1411031	5,62	-0,251647
	13	601544	7,63	0,81		13	887565	5,16	- 0,01		13	1489109	5,93	0,2459493
	14	704794	8,93	0,88		14	1068187	6,21	0,13		14	1772981	7,07	0,3641789
	15	746933	9,47	0,31		15	1410330	8,20	0,48		15	2157263	8,60	0,4221207
	16	664943	8,43	- 0,91		16	1789550	10,40	0,69		16	2454493	9,78	0,1890771
	17	508740	6,45	- 0,92		17	1649453	9,59	0,14		17	2158193	8,60	-0,191
	18	355352	4,50	- 0,61		18	1088140	6,32	0,34		18	1443492	5,75	0,0418146
	19	264272	3,35	- 0,09		19	754761	4,39	0,11		19	1019033	4,06	0,0478057
	20	211329	2,68	- 0,17		20	592647	3,44	- 0,02		20	803976	3,20	-0,069839
	21	159473	2,02	- 0,25		21	406801	2,36	- 0,40		21	566274	2,26	-0,35736
	22	112135	1,42	- 0,21		22	259660	1,51	- 0,74		22	371795	1,48	-0,570565
	23	64337	0,82	- 0,33		23	132109	0,77	- 0,81		23	196446	0,78	-0,661007
	Total	**7888408**	100,00			**Total**	**17204817**	100,00			**Total**	**25093225**	100,00	

E.9 Skånetrafiken March-December 2019

	Local bus Lund				Pågatåg					Total		
2019	Hour	Total	Share [%]	2019	Hour	Total	Share [%]		2019	Hour	Total	Share [%]
	0	51343	0,53		0	236208	1,09			0	287551,00	0,91
	1	29089	0,30		1	113304	0,52			1	142393,00	0,45
	2	21920	0,23		2	42460	0,20			2	64380,00	0,20
	3	5081	0,05		3	5755	0,03			3	10836,00	0,03
	4	101	0,00		4	38694	0,18			4	38795,00	0,12
	5	54516	0,56		5	267249	1,23			5	321765,00	1,02
	6	288166	2,96		6	790987	3,64			6	1079153,00	3,43
	7	649000	6,67		7	1683906	7,75			7	2332906,00	7,41
	8	646615	6,64		8	1753382	8,06			8	2399997,00	7,63
	9	550676	5,66		9	1126671	5,18			9	1677347,00	5,33
	10	512321	5,26		10	850651	3,91			10	1362972,00	4,33
	11	620350	6,37		11	933965	4,30			11	1554315,00	4,94
	12	725429	7,45		12	1129122	5,19			12	1854551,00	5,89
	13	665458	6,84		13	1131555	5,20			13	1797013,00	5,71
	14	783770	8,05		14	1330478	6,12			14	2114248,00	6,72
	15	888204	9,13		15	1674522	7,70			15	2562726,00	8,14
	16	903383	9,28		16	2099548	9,66			16	3002931,00	9,54
	17	712568	7,32		17	2038570	9,38			17	2751138,00	8,74
	18	499899	5,14		18	1305704	6,01			18	1805603,00	5,74
	19	338641	3,48		19	943966	4,34			19	1282607,00	4,08
	20	283089	2,91		20	770880	3,55			20	1053969,00	3,35
	21	225856	2,32		21	617330	2,84			21	843186,00	2,68
	22	162156	1,67		22	501623	2,31			22	663779,00	2,11
	23	115162	1,18		23	355111	1,63			23	470273,00	1,49
	Total	**9732793**	100,00		**Total**	**21741641**	100,00			**Total**	**31474434,00**	100,00

E.10 Skånetrafiken March-December 2020

	Local bus Lund					Pågatåg					Total			
2020	Hour	Total	Share [%]	Difference from 2019	2020	Hour	Total	Share [%]	Difference from 2019	2020	Hour	Total	Share [%]	Difference from 2019
	0	30632	0,53	0,00		0	32147	0,25	- 0,84		0	62779,00	0,33	-0,580994
	1	17578	0,31	0,01		1	13397	0,10	- 0,42		1	30975,00	0,16	-0,288301
	2	12380	0,22	- 0,01		2	3774	0,03	- 0,17		2	16154,00	0,09	-0,118962
	3	2624	0,05	- 0,01		3	1590	0,01	- 0,01		3	4214,00	0,02	-0,012102
	4	23955	0,42	0,42		4	33120	0,25	0,07		4	57075,00	0,30	0,1791288
	5	134234	2,33	1,77		5	238289	1,82	0,59		5	372523,00	1,97	0,9513487
	6	295175	5,13	2,17		6	611888	4,66	1,03		6	907063,00	4,81	1,377022
	7	351673	6,11	- 0,56		7	1142857	8,71	0,97		7	1494530,00	7,92	0,5060646
	8	311556	5,41	- 1,23		8	975761	7,44	- 0,63		8	1287317,00	6,82	-0,804926
	9	288493	5,01	- 0,64		9	646358	4,93	- 0,26		9	934851,00	4,95	-0,376326
	10	320794	5,57	0,31		10	513185	3,91	- 0,00		10	833979,00	4,42	0,0880729
	11	380950	6,62	0,25		11	549957	4,19	- 0,10		11	930907,00	4,93	-0,006327
	12	403492	7,01	- 0,44		12	647993	4,94	- 0,25		12	1051485,00	5,57	-0,3214
	13	456008	7,92	1,09		13	684395	5,22	0,01		13	1140403,00	6,04	0,3325029
	14	531743	9,24	1,19		14	824633	6,29	0,17		14	1356376,00	7,19	0,4688307
	15	544209	9,46	0,33		15	1083540	8,26	0,56		15	1627749,00	8,62	0,4816889
	16	462633	8,04	- 1,24		16	1371232	10,45	0,79		16	1833865,00	9,72	0,1750954
	17	349288	6,07	- 1,25		17	1256129	9,57	0,20		17	1605417,00	8,51	-0,235247
	18	249511	4,34	- 0,80		18	851878	6,49	0,49		18	1101389,00	5,84	0,0985119
	19	193843	3,37	- 0,11		19	594461	4,53	0,19		19	788304,00	4,18	0,1014176
	20	155090	2,70	- 0,21		20	463269	3,53	- 0,01		20	618359,00	3,28	-0,072539
	21	114735	1,99	- 0,33		21	313878	2,39	- 0,45		21	428613,00	2,27	-0,408132
	22	81436	1,42	- 0,25		22	185258	1,41	- 0,90		22	266694,00	1,41	-0,695982
	23	42452	0,74	- 0,45		23	81309	0,62	- 1,01		23	123761,00	0,66	-0,838448
	Total	**5754484**	100,00			**Total**	**13120298**	100,00			**Total**	**18874782,00**	100,00	

F

Elimination matrix

In this chapter the Elimination matrix is presented.

P = positive	N = negative	- = not affected

	Effects	Decreased travel numbers	Decreased travel share	Increased buget deficit	Increased punctuality	Changed aim	Increased fare evasion	Less objective congestion
Criterias								
Travel time		-	-	-	P	-	-	-
Ticket prices		-	-	-	-	-	-	-
Ticket income		N	-	N	-	N	N	-
Simplicity/information		-	-	-	P	-	-	-
Departure interval		-	-	-	-	-	-	-
Hourly travel distribution		-	-	-	-	-	-	-
Staff safety		-	-	-	-	-	-	-
Modal split								
Bike traffic		-	P	-	-	P	-	-
Pedestrian traffic		-	P	-	-	P	-	-
Car traffic		-	N	-	-	N	-	-
Classification		Generally negative	Generally negative	Fully negative	Fully positive	Generally negative	Fully negative	Fully positive

Increased experienced congestion	Less contact between on-board staff and passengers	Increased information	Comments
-	-	-	The travel time has not been affected during the pandemic
-	-	-	The ticket prices have not been affected during the pandemic, but might be in the long-term
N	N	-	The ticket income has been very negatively affected during the pandemic and the consequences might be crucial in the long-term perspective
-	N	P	The information and simplicity have been slightly affected by the pandemic, both positively and negatively, but not drastically
-	-	-	The departure interval has with insignificant exception not been affected by the pandemic. It was briefly affected during Spring 2020 and also later on by Skånetrafiken, but is overall the same as before the pandemic
-	-	-	The travel distribution over the day has with insignificant exception not been affected by the pandemic; it has barely been less uneven, although a greater share travel 1-2 hours before rush hour during the pandemic
-	P	-	The staff safety has been positively affected by the physical distance and protective shields on vehicles. This does not mean that it is sufficient
P	-	-	The bike share has increased during the pandemic which is positive
P	-	-	The pedestrian share has increased during the pandemic which is positive
N	-	-	The car share has increased during the pandemic, which is a negative effect for the society
Generally negative	Generally negative	Fully positive	