Thesis 348

Bike safety among children in Sweden

Whit a study of a SCAFT-area

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Abstract:

This master thesis investigates the current safety situation for biking children in Sweden. It investigates an international and a historical perspective, which gives comparable information about bike safety for children in other societies. Alterations over time in total biked length is studied and its impact on the safety are considered. Reduction in levels of biking are found to be a vital factor for the safety and to make improvements of the safety situation among biking children in Sweden the levels of biking needs to be considered. A local interview of 11-year-olds are done to investigate their bike habits and estimate the perceived safety among them. A questionnaire with similar questions are given to the parents and their opinions about the situation for biking children are compared with the children's opinions. The results show that both children and parents are positive to bicycling and find safety important. Almost all the children use to bike to the school, most of them also to their leisure time activity, but still some safety improvements were asked for. The children are describing good and bad examples of traffic environments for biking by help of photos, while the parents take a stand on statements and in free text describe their child's traffic environment while biking. A field study of the area around the interviewed children's school are done. The area around the school are highly affected of the principles in the planning tool SCAFT. A description of the area is done and results from the interview are compared with the reality.

Sammanfattning:

Detta examensarbete undersöker den nuvarande situationen för cyklande barn i Sverige. Den undersöker ett internationellt och historiskt perspektiv, vilket ger jämförbar information om säkerheten för cyklande barn i andra samhällen. Variationer över tiden i totalt cyklad längd studeras och dess inverkan på säkerheten är noga övervägd. Minskade cykelnivåer visar sig vara en avgörande faktor för säkerheten och för att göra förbättringar i säkerhetssituationen bland cyklande barn i Sverige behöver hänsyn tas till cykelnivåerna. En lokal intervju av 11-åringar görs för att undersöka deras cykelvanor och bedöma den upplevda säkerheten bland dem. En enkätundersökning med liknande frågor ges ut till föräldrarna och deras åsikter om situationen

för cyklande barn jämförs med barnens åsikter. Resultaten visar att både barn och föräldrar är positiva till cykling och tycker att säkerhet är viktigt. Nästan alla barn brukar cykla till skolan, de flesta av dem även till sina fritidsaktiviteter, men trots det är säkerhetsförbättringar efterfrågade. Barnen beskriver bra och dåliga exempel på trafikmiljöer för cyklande med hjälp av fotografi, medan föräldrarna både tar ställning till påståenden och i fritext beskriver deras barns trafikmiljö när de cyklar. En fältstudie av området runt de intervjuade barnens skola görs. Området runt skolan påverkas i hög grad av principerna i planeringsverktyget SCAFT. En beskrivning av området görs och resultatet från intervjun jämförs med verkligheten.

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Preface

This Master Thesis (30 ECTS) is written as the final project at the Civil Engineering program with alignment Transport and Road. It is written for the Road and Transport Institution at Lund University in collaboration with SWECO Society AB.

Firstly, I want to give a big thank you to SWECO Society AB for letting me write my thesis at your company. I want to give an extra big thank-you to my supervisor Jessica Sundberg for giving me valuable comments and being there to support me during the process. I want to thank Pia Sartorius that was my supervisor in the beginning of the process and gave me some valuable advice. I also want to thank Christina Granér, Charlotte Wahl and Vanessa Stjernborg for their expertise about how to ask children, questionnaires and interviews.

Secondly, I want to thank Fäladsskolan and its principal Håkan Bengtsson Diurlin for letting me do the study at your school. I want to thank the teachers Sara Unkel and Emilia Hansson together with their pupils and the pupil's parents for showing interest in my study. Without you this study would be impossible. I also want to thank my course mate Joel Bergman for helping me taking notes during the interviews.

Thirdly, I want to thank Lund University for giving me this education and a special thank you to my supervisor Aliaksei Laureshyn for answering my questions during the process. I also want to thank the friends I have made during my study time, because of you I have had much fun in the latest years. I never think I had the opportunity and want to take the opportunity to thank all the teachers that I have had during the school years for inspiring me all the way to finishing a master at the University, even though I come from a family that totally lack that type of background.

Lastly, I want to thank the little girl that crashed into me with her bike when I was taking a calm walk in Westpark one day during my exchange semester in Munich. Without you I would not have got the idea to write this thesis.

Lund, January 2020.

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1 Introduction

1.1 Background and purpose

The *Convention on the Rights of the Child* was adopted by the United Nations in 1989 (Unicef n.d.). Sweden have considering itself to be the best country for children and was the first country in the world to forbid corporal punishment of children (Sveriges Radio 2015). However, in 2015 Sweden got critique by United Nations for not following the Convention on the Rights of the Child (CRC 2015). On 1st of January 2020 the Convention on the Rights of the Child became Swedish law (Unicef n.d.), wherefore children's right is a highly actual topic in Sweden. To be able to follow the convention, improvements will need to be done and one thing of importance is to better research issues that are relevant for children to be able to take decisions based on fact. There are four articles in the Convention on the Rights of the Child that are related to the safety among biking children. Article number 6 is about the child's right to life, survival and development, which is related to the traffic safety among biking children and the development in form of learning how to use a vehicle. Article number 15 is about the child's right to freedom of association, which is related to biking since biking is the fastest transport mode a child is old enough to use on their own and where they are not dependent on any adult to be able to use it. Article number 16 is about the child's right to privacy, which is related to biking children since biking makes it possible for a child to do independent trips longer than what is possible only by walking. Article number 24 is about diminishing child mortality and to develop preventive health care, which is related to the traffic safety among biking children since traffic safety is of importance for maintaining a low child mortality and biking is one way to get physical active. Therefore the legislation of the convention makes traffic safety among biking children in Sweden a current topic and the purpose is to investigate this topic closer.

1.2 Question at issue

What are the current safety levels for biking children in Sweden and what can be done to improve the safety among biking children in Sweden? To be able to answer this question it was of importance to do a literature study to describe the safety levels of biking children in Sweden today. An international and historical comparison will be done to be able to put the results in a context. It was also necessary to investigate the levels of biking because it has a conjunction. To estimate the perceived safety both children and their parents' opinions were needed to investigate. A case study then followed-up by investigating the area around the children's school and where they described that they used to bike. The thesis investigates children in general, but the main focus will be on 11-year-old children.

1.3 Study features

- The availability of survey and case study results are limited to one school only. It would have been preferable to conduct the study at more schools, but since a number of schools chosed not to participate it was not dueable. The sample size is limited to 16 children and 28 parents.
- The survey is only done among children in 5th grade (most of them were 11 years old) and there parents.
- Deeper investigations on socioeconomic status, etnicity and cultural behaviour in traffic are not done in the survey or case study. Since those factors vary within the country the reults from this study can differ a lot compared to other swedish children. The results from the survey cannot be directly connected to the statistics of accidents either since they are made on a national level.
- The time limit of 20 weeks for this thesis made it not possible to contact more schools or do deeper investigations.

2 Method

2.1 Literature review

Chapter 3 were mainly based on existing literature. First there will be a comparison of the international situation for biking children, to be able to find Sweden's place in the world, and a comparison of the historical perspective in Sweden to find out how development until today's situation have been (chapter 3.1). Then the main text will be focusing on safety for biking children in a national context in Sweden, combined with some examples from existing international studies that are possible to be true for Sweden as well, or at least worth considering. The risk for a biking child to get killed or harmed is investigated (chapter 3.2), the risks for biking compared to the risk of not biking is described by using a foreign study and comparing how the risk factors would differ for Swedish children based on information found in other literature. Then it will be described how the levels of biking children are changing in Sweden in the latest years (chapter 3.3), since the alteration in levels of biking will have an essential effect on the statistics and therefore needs to be considered when studying the safety risks. There will follow an investigation of which factors that are considered important among bikers (chapter 3.4), which is a preparation since the following text will focus on more complex questions that could be affected by more factors than only safety. There will follow a concrete description on safety equipment, to get to know about required equipment for biking safe and information about required legislation (chapter 3.5).

2.2 Calculations

In chapter 3.2 calculations are done based on existing national data of dead and injured individuals compared to existing data from national travel surveys. The purpose of those calculations is to compare the safety risk while biking with the safety risk for other transport modes.

2.3 Focus interviews

In chapter 4 a survey was done to estimate the opinions about the perceived bike safety among children and their parents. Both children and parents were told that the survey was about children's bike habits and neither of them were told that the study was focusing on bike safety, since that could have affected the result and made them exaggerate the safety risks. All answers were anonymous, wherefore the result will not show any cross references if they were not able to do and at the same time keep the person anonymous.

Different study methods were chosen between children and parents. The children were interviewed in focus groups in their school. It was considered whether the children should answer a questionnaire or get interviewed. Interviewing as method was chosen since it was considered being easier to understand way the children answer as they do if it was possible to ask supplementary questions and the risk of misinterpretation of questions could also be reduced since the interviewer where able to add more info if a question was hard to understand. The reason that focus groups were chosen was because it was estimated to be easier to collect the children's opinions when they were speaking freely with each other than if they would have been interviewed and only answering the interviewer's specific questions. The studied age was chosen since the children was estimated being old enough to have valuable opinions about their bike habits and being able to share them, and at the same time they were estimated to be young enough to be willing to voluntary participate in a study like this.

Two groups of eight children each, in 5th grade, was interviewed. The interview measures the perceived safety among children in some specific traffic situations and made them rang how important they found bike traffic safety compared to some other factors relevant for bikers. Notes were taken by another person sitting beside the interviewer during the interview and afterwards the interviewer wrote down notes to remember things that were said without having checked the other

notes made during the interview. Later those documents have been used to complete the result. Photos of placements of cards were also taken.

2.4 Questionnaire

The parents got an internet questionnaire to answer. Both children and parents were asked questions in the same themes and the main goal with the parent survey was to estimate if the parents' and the children's opinions were the same or different. The traffic environment theme was asked differently for the parents and the children, since the children were estimated to discuss what they find relevant better if giving them a picture and let them speak freely, while the parents got more concrete questions since that was easier to measure in a questionnaire. For practical reasons the parents have been answering an internet questionnaire.

2.5 Case study

In chapter 5 a case study was done in the area around the school the interviewed children go to. An investigation of the traffic environment the children are used to bike in are done. The percentage of biking children using helmet are studied at a place close to the school and compared to the result of the survey. Some specific situations that the children describe as problematic in the interview are also investigated.

3 Literature

3.1 Comparison with international and historical perspective

3.1.1 Prerequisites for biking among children in different countries

Firstly, biking as a transport mode and children's own mobility are not always prioritized subjects in a worldwide perspective. On the *International traffic safety conference 2018* that where hold in Qatar 2018 biking was not mentioned in the name of any event on the agenda. Children where mentioned in the title of two events: "Child restraint use in young children in Qatar" and "Kids and cars: child safety and driving in Qatar" (ITSC 2018, pp. 1-4). Both titles are revealing that they involve information on how to protect the children from the dangerous traffic and none of the titles tells about children's mobility. The titles of the events hold at *International road safety conference* in Bucharest 2019 (ETSC 2019, pp. 1-2) are more general about transport and none of them discloses that they will include neither biking nor children's mobility.

The prerequisites for biking among children vary a lot all over the globe. There are big differences in how physical active children in different countries are (Tremblay et al. 2014, p. S113). The number of bikers differs a lot worldwide and there are also big differences in percentage of trips made by bike between different cities in the same country (Coya 2019). To be able to make a comparison between the bike safety in an international perspective it is first necessary to study the number of bikers in different countries. Because if there are few accidents it does not automatically mean that it is safe. It could also be the result of that people do not dare to bike. According to Coya (2019) that have ranked 90 cities worldwide after their biking climate the top three cities worldwide are Utrecht (Netherlands), Munster (Germany) and Antwerp (Belgium), which all are considered small cities (less than 500 000 inhabitants). Among medium sized cities Copenhagen (Denmark) and Amsterdam (Netherlands) get the highest scores and among large cities (more than 1 000 000 inhabitants) Hangzhou (China) get the highest score. Many north European cities are in the top of Coya's list, but not exclusively.

3.1.2 Comparison between bike safety among children in Sweden and in an international context (Europe)

One thing that has been studied is which countries that have bicycle helmet laws and which ones that does not. As shown in chapter 3.5.2.2 the bicycle helmet laws on their own does not correlate with countries that are considered safe for bikers though.

In the article *Exposure-Adjusted Road Fatality Rates for Cycling and Walking in European Countries* (Castro et al. 2018, p. 19) it shows that Netherland, Denmark and Germany are the three countries with high or very high reliability of the fatality rate that have the highest average exposure per person for cycling in the WHO European Region. The authors explain that the fatality rate has been estimated and compared to the exposure of travelled kilometres per year. A trend line could be drawn that show that countries with more biked kilometres per person and year also have a lower fatality rate for cycling (se figure 1). Sweden is placed much lower than the trend line in the diagram below, which means that Sweden has a low fatality rate compared to other European countries with the same number of travelled kilometres per person and year. Compare for instance with Austria that have approximately the same number of travelled kilometres per person and year as Sweden according to figure 1.

Figure 1. Diagram showing fatality rates for cycling compared to average exposure per person for cycling (Castro et al. 2018, p. 17).

While studying the fatality rates in the figure above Sweden is a safe country to bike in compared to many other European countries, but there are also countries with a lower fatality rate than Sweden. In the figure above four countries are found with high or very high reliability rate of the fatality rate that all have a lower fatality rate than Sweden: Norway, Denmark, Germany and Netherlands. What all of them have in common is that they have a higher average exposure per person for cycling compared to Sweden.

3.1.3 Underreporting of data

Underreporting of data is an issue that affect the reliability in the statistics. Only the countries in the WHO European region with high or very high reliability of the fatality rate are showed in the diagram above. In Europe, underreporting is mainly related to lower severe accidents while it is less important for fatal or severe injury accidents. However, in the case of cyclists, the single accidents, even if severe may be not reported, and this is why figure 1 define a different reliability even for fatal accidents in EU countries.

When studying figure 1, underreporting in the accident statistics makes a lower fatality rate. Since the fatality rate depends on the average exposure, underreporting in the exposure statistics makes a higher fatality rate. Therefore, underreporting in the data could affect the fatality rate both to the better and to the worse depending on which data that is missing. Drawing the conslusion about which countries that have lower fatality rate than Sweden is only possible since they all have high reliability in the data. Further in the rapport it should be remembered that there could be underreporting in data when studying the statistics.

3.1.4 Bike safety in the different countries (Worldwide)

OECD is collecting road safety data from a lot of different countries which have been analysed in the article *Road safety annual report 2018* (Kim 2018). The data is self-reported from the countries to an international data base and in most cases also validated by IRTAD (Kim 2018, p. 4). The rapport

concludes that a strong increase in biked kilometres per year have been registered among the countries that have reported biked kilometres (Kim 2018, p. 13). The rapport shows changes in number of death cyclists in each county over the years 2010-2016 (see table 1), which can be used for a very basic view of how the bike safety is changing in the country at the moment.

It is good that it exists some initiative for a data base that collect the same data from different countries together to be able to make comparisons. However, there are big differences in number of reported death cyclists within the same countries during the last years (Kim 2018 p. 29), which makes it questionable whether the data can be trusted. When reading table 1 it should be remembered that many countries only have a few death cyclists every year, which can lead to a big percentual difference when just the data from two specific years are studied, especially for countries with few inhabitants. The tables neither tell whether the data has been collected the same way over all years nor if there been any losses in data somewhere for a specific reason. For instance, there are known losses of data in the Swedish police reports between 2013 and 2016 (Transportstyrelsen 2018a), which can have affected the result, and it is likely that the rest of the countries also have losses in data somewhere.

3.1.4.1 Differences in numbers of dead bikers between 2010-2016

Table 1. Percentual change in dead cyclists 2010-2016 with data from police rapports (except from Netherlands that also include other national data). Table 1 are based on data from Road safety annual report 2018 (Kim 2018, p. 29).

Europe	**% change**	**Asia**	**% change**
Czech Republic	-33.8	Israel	-50.0
Lithuania	-26.1	Japan	-24.1
Greece	-21.7	Korea	-13.3
Hungary	-20.7		
Slovenia	-18.8	**Oceania**	**% change**
United Kingdom	-5.4	New Zealand	-50.0
Poland	-3.2	Australia	-23.7
Switzerland	-2.9		
Finland	0.0	**North America**	**% change**
Luxembourg	0.0	Canada	-27.9
Spain	0.0	United states	+34.8
Belgium	+1.4		
Germany	+3.1	**South America**	**% change**
Italy	+3.8	Chile	-34.4
Sweden	+4.8	Argentina	(no available data)
Portugal	+6.5		
France	+10.2	**Africa**	**% change**
Netherlands	+16.7	(no countries have reported)	
Denmark	+19.2		
Austria	+50.0		
Iceland	(to few observations)		
Ireland	(to few observations)		
Norway	(to few observations)		

The increase in biked kilometres per year that is noted in the OECD rapport (Kim 2018, p. 13) can be a sign that people in the world are biking more, but it can also only be a sign that there are more collected travel data. The rapport also lacks specific data for biking children. Still table 1 shows the closest international comparable data that were able to be found that shows in what direction the safety among bikers in each country are pointing.

3.1.4.2 Analyse of the bike safety in the different continents

As seen in the table above (table 1) there are big differences in bicycle data worldwide. There are many countries in *Europe* reporting data to OECD about dead bikers, but whether the numbers are increasing or decreasing and to what extent varies a lot. Most of the European countries that have an increasing in dead cyclists are placed in North Europe. All of them have a comparable low total number of road fatalities, less than 6 per 100 000 inhabitants in 2017 (Kim 2018, p. 19), which means

that only a little change in numbers of bicycle fatalities every year will lead to a big percentage change. Most of the European countries with a big percentage decrease in dead bicycles are placed in Eastern Europe.

Only three geographically small countries in the biggest continent *Asia* have reported data to OECD, which makes it hard to say something about the bike safety in general on that continent. Hangzhou is the city with more than one million inhabitants that have the best biking climate according to Coya (2019) and China is also the country with most inhabitants in Asia wherefore it would be interesting to see more studies about biking in China.

In *Oceania* the two big countries have reported data to OECD. Australia has a long tradition of trying to improve the safety for bikers, since it was the first country in the world to introduce compulsory bike helmet law in 1989 (Curnow 2008, p. 141) and a lot of bike helmet research from Australia have been found.

The changes in deaths are big in *North America* according to the reported data to OECD and it is hard to draw any easy conclusion about possible reasons, since both United states and Canada have much regional regulation that affect bikers. For instance, bicycle helmet laws differ between the different states in both Canada and United States. In Canada all states have bicycle helmet laws including children up to 17 years old and most of the states have bike helmet laws including all ages (Olivier et al. 2018, p. 18), while in United States there are only some states and cities that have bicycle helmet laws and none of them are including adults (Olivier et al. 2018, p. 21). As seen in figure 2 United States have a low number of bikers per inhabitants compared to many European countries. The development in the last 60 years in United States have led to a more automobile-centric pattern, which makes other transport modes impractical and inconvenient according to Kuzmyak and Dill (2012, p. 4). People in United States still walk and bike for recreation and exercise but not for transport (Kuzmyak & Dill 2012, p. 4). In the United States 47%, almost half of the bike trips, are made for social or recreational reasons and only 17% of the bike trips are towards work, school or church, which can be compared to that in Europe two-third of the trips are made for utilitarian purposes (Kuzmyak & Dill 2012, p. 10).

In *South America* there are only one country reporting data to OECD, which makes it hard to say something in general about South America. However, Chile had a high number of reported dead cyclists in 2010 and have made a big improvement in only six years, even if there still are more than 100 dead cyclists every year (OECD 2018a, p. 14).

No country in *Africa* have reported statistic about how many cyclists that dies every year to OECD. The only country reporting data about road accidents is Nigeria. The reported number of road deaths in 2016 was 5121 but the estimated by WHO was around 40 000, which means that there are a big under reporting (OECD 2018b, p. 2). However, the statistic shows that nearly 40% of the reported fatalities are children (OECD 2018b, p. 2) which means that there is a lot to do to improve safety among children in traffic. OECD´s rapport does not tell whether the statistics is based on protected or unprotected road users. In Nigerian law it is compulsory to use seat belt when car-driving and bike helmets when biking, but there are no enforcements for not wearing seat belts in the rear seats or not using bike helmet (OECD 2018b, p. 4)

3.1.4.3 Safety in numbers

The phenomenon that more users lead to lower fatality rates is named safety in numbers. This phenomenon is known from the nature were animals moving together can reduce the risk of getting eaten by a predator compared to if they would be moving on their own (Hamilton 1970, p. 295).

When studying road traffic, the same phenomena can be seen. If more people are biking the number of biking accidents per kilometre is reduced, and that have been confirmed in many studies (Jacobsen 2003 p. 205; Robinson 2005, p. 47; Castro el al. 2018, p. 22). According to Jacobsen (2003, p. 205) the safety in number phenomena is true for bikers and walkers in different countries,

different cities and communities of different sizes, down to specific intersections and over time periods. Jacobsen (2003, p. 205) claims that the motorists change their behaviour when there are walkers and bikers nearby, wherefore the risk of a collision between a motorized vehicle and an unprotected road user is less likely when there are a bigger number of bikers and walkers. The following figure illustrates the safety in number affect by showing the relationship between biked kilometres and number of killed bikers in different countries.

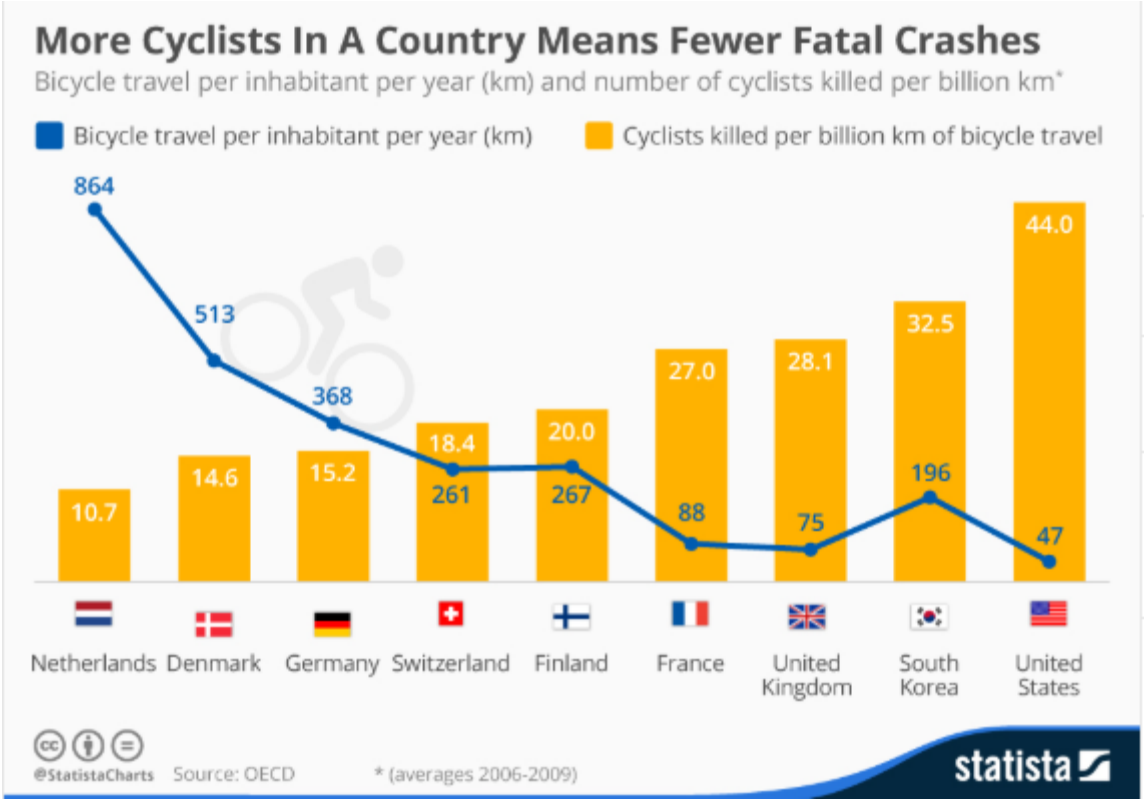


Figure 2. Showing relationship between average biked length per inhabitant and number of killed cyclists per kilometres in nine different countries (McCarthy, 2015).

3.1.4.4 Differences in bike safety conditions between countries

The safety in numbers effect can explain that countries to the left in figure 2 have lower fatality rate among bikers than countries to the right. However, there are also other differences that cannot be explained by the safety in number effect only. The laws and the economic conditions to be able to make safety improvements varies between countries for instance. There are also differences in driving culture between countries for both bikers and motor vehicles. For instance, an aggressive driving style among motor vehicles has more negative effects for the bikers safety in mixed traffic environments than a defensive driving style among motor vehicles.

3.1.5 Comparison between bike safety among Swedish children today and historically

While studying bike safety among children historically in Sweden in a longer perspective (1970-2018) there have been big improvements since both the numbers of killed children in traffic and killed bikers in traffic have reduced to a big extent (see figure 3). What should be remembered when studying statistics over that long time periods though is that the reporting system have been changed over the time period and there is always a risk of loss of data somewhere. This data loss will affect all the graphs shown below in this chapter (figure 3 – figure 7). The data in the graphs below (figure 3 and figure 4) shows number of killed and seriously injured children and bikers in Sweden since the 1970's according to national statistics. This does not show all killed and seriously injured in traffic, since all accidents are not reported to the police and there are also intern losses (Transportstyrelsen 2018b).

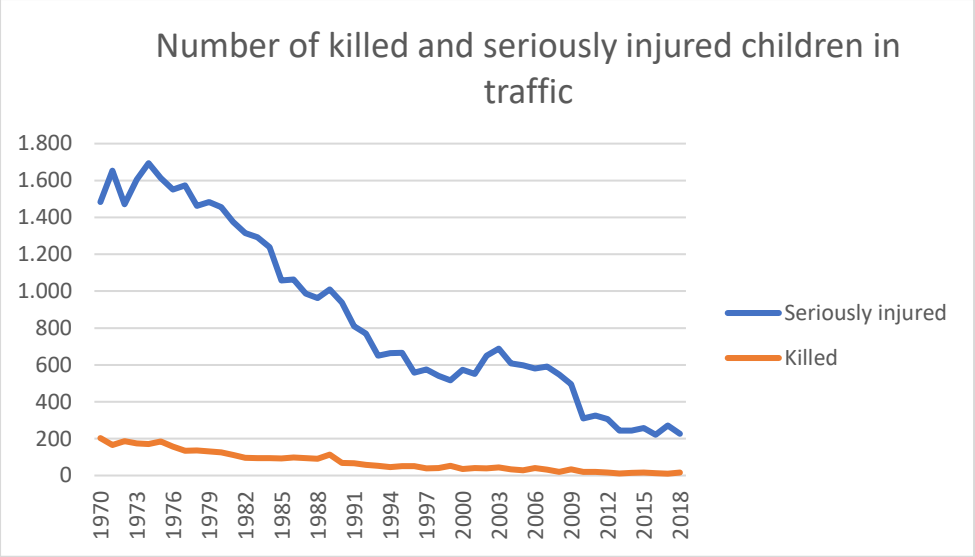


Figure 3. According to police rapports. (Self-made diagram based on data from Transportstyrelsen 2019b).

In the Swedish Traffic Accident Data Acquisition (STRADA) both the police and hospitals are reporting data (Transportstyrelsen 2018c). The hospitals started to rapport successively between 1999 and 2015 (Transportstyrelsen 2018d). However, the hospital's rapports are not included in the official statistic that are used in figure 3-7 and table 2. Therefore, they cannot explain the top in seriously injured around 2003 that are showed in figure 3. Since 2016 the police have prioritized road accidents lower to get more time for other duties which will have an impact on the official statistic (Transportstyrelsen 2018b).

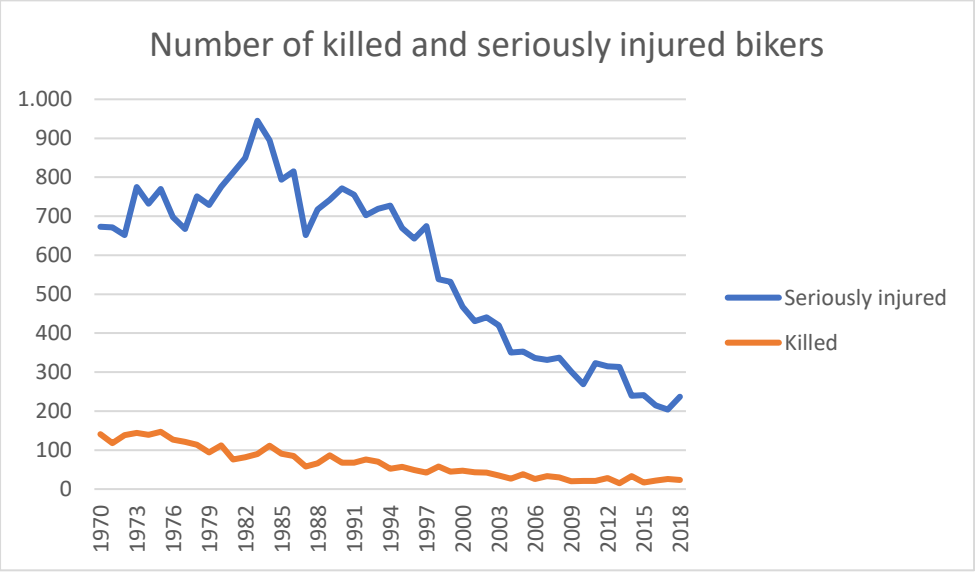


Figure 4. According to police rapports and since 1999 also data from hospital rapports (Self-made diagram based on data from Transportstyrelsen 2019c).

All the graphs in figure 3 and figure 4 shows a distinct falling trend among killed and injured road users. The fact that the number of killed and seriously injured bikers and children have decreased with such a big percentual change is a good sign of better traffic safety over the years. The concept of Vision Zero was born in Sweden in 1995 and aim towards that no one should get killed or get lifelong injured in the road traffic (Trafikverket 2019). The Vision Zero have been important to be able to reduce the number of killed and injured road users to such a big extent in the last 25 years.

To get a more specificly view of the safety among biking children, specifically data for killed, seriously injured and slightly injured from 2006 and forward where studied (figure 5 & figure 6). The

number of killed biking children have been betweeen 0-3 per year during the time period 2006-2018 (see figure 5). That is to few to be able to say whether there have been any changing trend or it is just normal variety during the years.

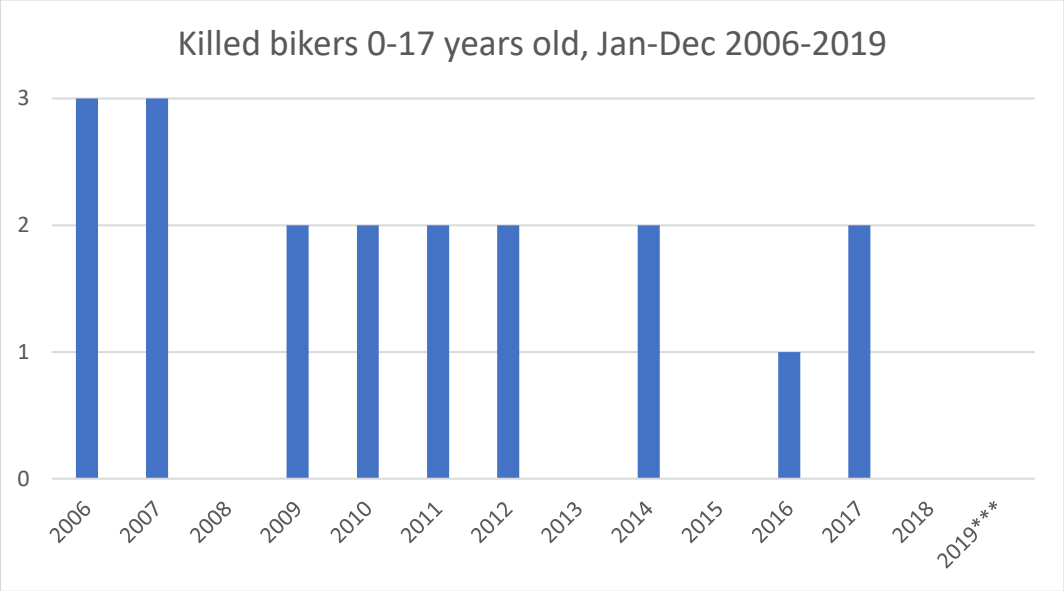


*Figure 5. Changes in number of killed biking children. (Self-made diagram based on data from Transportstyrelsen 2020). ***2019 data can still be changed.*

Both the number of seriosuly and slightly injured bikers between 0-17 years old have been reduced during the time period 2006-2018 (see figue 6). The officiall data that was publiced on the web page of the *Swedish Transport Agency* (Transportstyrelsen 2019a) was only showing data specifically for biking children until the month before download data for each year. Since most of the calculations were done on data downloaded in September it will only show values for the months January to August. This data will therefore not be seen as the total numbers of killed and injured but can be used to compare differences over years.

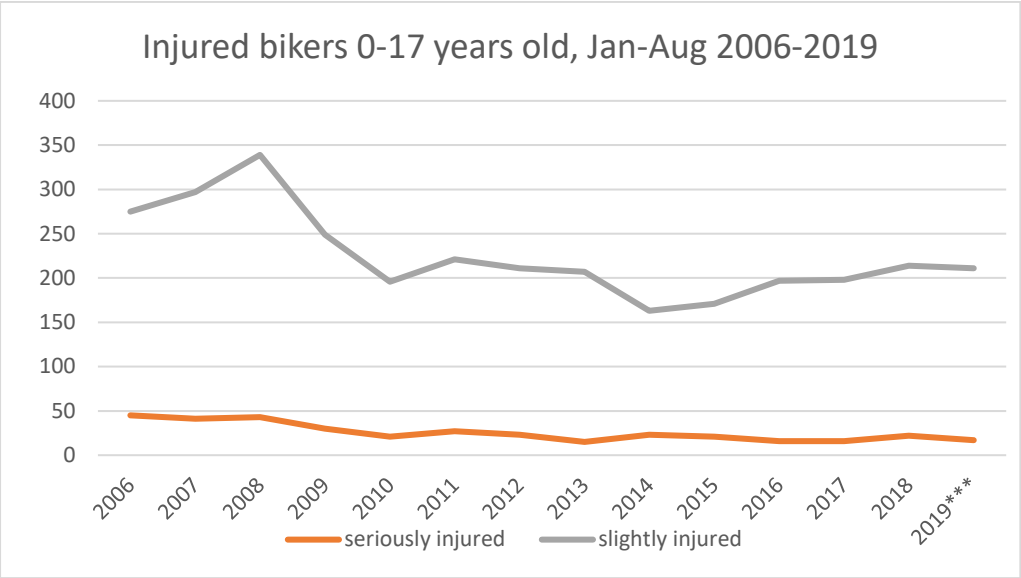


*Figure 6. Changes in number of killed and injured biking children over the years 2006-2019. (Self-made diagram based on data from Transportstyrelsen 2019d). ***2019 data can still be changed. Observe that the diagram is only based on data from January to August.*

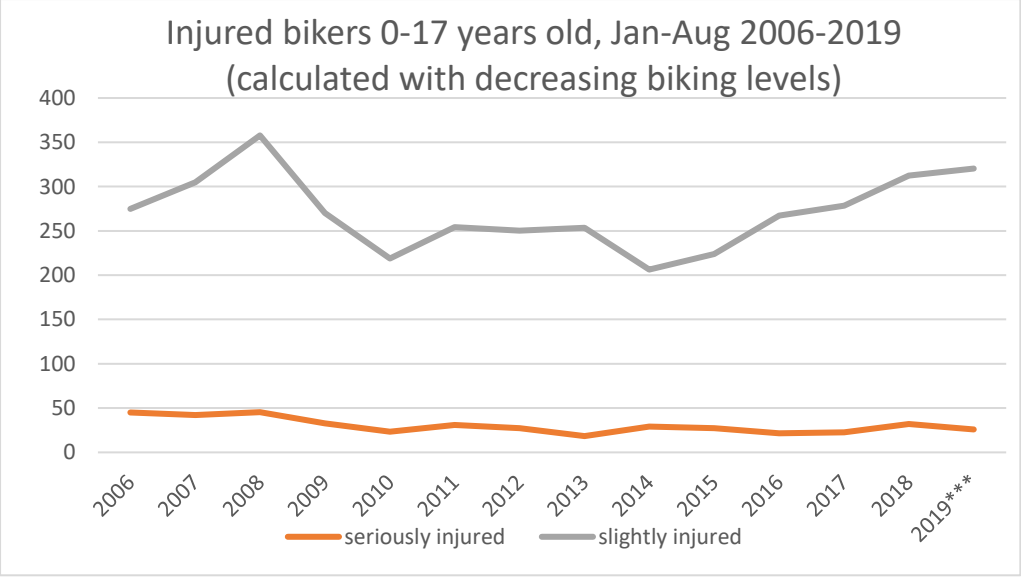


*Figure 7. Changes in number of slightly injured, seriously injured and killed biking children, while considering reduced levels of biking. The graphs show how many that would got killed or injured if the levels of biking where still the same as in 2006. Compare with figure 6 for national statistic over the same time period. (Self-made diagram based on data from Transportstyrelsen 2019d and Saxton 2015). ***2019 data can still be changde. Observe that the diagram are only based on data from January to August.*

If the number of total biked kilometres sinks, the numbers of killed and injured will of course sink if the risk is assumed to be almost unchanged. Therefore, looking at the data in figure 4-6 only, does not tell if there have been improvements in the safety and should be compared to whether the levels of biking are decreasing or increasing. The average number of biked kilometres per day have sinked with 42% during a time period of 16 years in the group 7-14 years old in Sweden (more about this in chapter 3.3.2). This gives an average of 2,6% less biked kilometers per day among children each year. If asuming the continuence of that trend the number of killed and injured children can be calculated to the levels they would have had if the amount of biked kilometers would have been unchanged during the timeperiod (see figure 7). That would make the number of killed and injured children more compareable over the timeperiod.

As seen in figure 7 the levels of seriously injured children is still decreasing after calculating with decreasing levels of biking during the time period 2006-2018, but to a smaller extent. The levels of slightly injured children is almost unchanged during the time period 2006-2018. Considering the fact that there could be some loss in the data in the time period 2013-2016 (Transportstyrelsen 2018a) it cannot be said whether there have been any actual rise in rapported slightly injured or not in the time period 2014-2018 (see figure 7). The big varieties in the data about slightly injured can also be explanied with that accidents that only inlude slightly injured are less likely to be repported than accidents including seriously injured or killed, since slightly injured people are not that likely to contact the police.

The levels of slightly injured and seriously injured will tend to follow each other when the safety becomes better or worse. One possible explanation of fewer seriously injured compared to the level of slightly injured can be better health care and one possible explanation for more slightly injured compared to seriously injured can be that a higher percent of accidents are reported. Therefore it is likely that there is other factors affecting if the curves of slightly and seriosly injured are not following each other.

After studying the numbers of killed and slightly injured children in bike traffic compared with the average length of biking over the years it cannot be found any bigger difference in safety (neither to the better nor to the worse) among biking children in Sweden during the time period 2006-2018. Though it can be found a small improvement of the safety during the years while studying the seriously injured, despite considering decreasing levels of average biked kilometres per day.

3.2 Comparison of the fatal and injury risk between biking and other transport modes

3.2.1 Traffic safety - Risk to get killed or injured with different transport modes

This thesis is mainly focusing on the transport mode bicycle. But to be able to tell something about the actual safety while biking it is necessary to compare with the safety while not biking. Official data according to police rapports about how many that were killed, seriously injured or slightly injured for different transport modes for the years 2014-2016 was found at the webpage of the *Swedish Transport Agency* (Transportstyrelsen 2019e) and an average was calculated. The official data only showed the time period January to November when the data was downloaded, but since it will only be used for comparison between different transport modes, injury types and age groups the result will most likely be similar as if the data for the whole year was used. The age group used for the statistics about killed and injured are 0-17 years-olds.

Data about total travel distance and total travel time for each transport mode have been found from the national travel survey from 2014-2015 (Trafikanalys 2019a) and 2015-2016 (Trafikanalys 2019b). The travel survey data used are an interpolation between the statistics from age 6-14 years-olds and 15-24 years-olds to be able to represent the age group 6-17 years-olds. Bikers and walkers where unfortunately not separated in the national travel survey data. Calculations on how many people that die or get injured per travelled distance have been done. See appendix A for the results in the different calculation steps. In the table below it will only be shown how many that die or get injured per distance and the values are divided so that there will be 1 dead per distance both when considering children and all ages.

Table 2. Dead, seriously injured and slightly injured children per distance. (Self-made table based on data from Transportstyrelsen 2019e and Trafikanalys 2019a & b).

	Children (up to 17 years old)	**Biking and walking**	**Car drivers and passengers**	**Other modal choices**	**All modal choices**
1.	**Dead children per distance**	1	0.05	0.11	0.11
2.	**Seriously injured children per distance**	13.2	1.3	2.0	2.1
3.	**Slightly injured children per distance**	92	13	12	16

Table 3. Dead, seriously injured and slightly injured all ages per distance. (Self-made table based on data from Transportstyrelsen 2019e and Trafikanalys 2019a & b).

	All ages	**Biking and walking**	**Car drivers and passengers**	**Other modal choices**	**All modal choices**
1.	**Dead people per distance**	1	0.14	0.11	0.16
2.	**Seriously injured people per distance**	7.5	1.5	0.8	1.5
3.	**Slightly injured people per distance**	40	11	3	10

Among other road users both public transport users can be found that has a low injury risk per travelled kilometres (was not separated in the police reported traffic accident data) and moped and

motor cycle users that has a low travelled distance (was not separated in the national travel survey data). As mentioned before there are known losses in data from the police between 2013 and 2016 (Transportstyrelsen 2018a) and especially among the slightly injured there are most likely many accidents that never got reported. Since only a few people dies every year the data among dead individuals is small and should only be seen as approximately when comparing the columns. The average travelled distance data probably also have losses since it is hard to remember every trip during a day and the youngest travel survey participants have probably gotten help from their parents to fill the data in.

It is seen that bikers and walkers take a higher traffic accident risk if they go for a certain distance than car users and other road users, based on data from 2014-2016 (see table 2 & table 3). However, there are explanations for those data and the way it is calculated are not makes it not completely comparable to the real safety risk. A biker and a walker need in general a shorter distance even if they are traveling between the same nodes because they are more flexible in being able to use all roads in a city and do not need to take detours to the same extent as a car in the city would need to do and definitely not like a bus would need to. If considering this the gap between bikers/walkers and all modal choices will decrease a little. The fact that unprotected road users take a bigger risk than car users are not unique for Sweden. The rapport *Cycling, Health and Safety* written by OECD (2013) refer to a meta-analysis study done in 2009 showing that the risk for cyclists to get injured is 9.8 times higher than for car occupants. According to OECD (2013, p. 38) one reason that the number is that big is because motorway driving is relatively safe and if that was excluded in the statistics the number would be lowered. Since bikers and walkers are unprotected road users the safety risks compared to protected road users will always be bigger, but there are other winnings of being a biker when it comes to protecting life.

What is concerning though is that the walking and biking children takes a higher risk than walkers and bikers when considering all ages. Compare the differences for biking and walking with car drivers and passengers in the difference rows first in table 2 and then in table 3. The risk to get seriously injured for biking and walking children were ten times higher than for children going by car in 2014-2016 per the same travelled distance (see row 2, table 2). While studying the same data for all ages the risk to get seriously injured for bikers and walkers were only five times higher than for car users in 2014-2016 per the same travelled distance (see row 2, table 3). One explanation why it could be a bigger traffic risk for a child to walk and bike than to use other transport modes is that a child can walk and bike by itself and are maybe not that observant if it is playing at the same time, but while using other transport modes children use to be passengers. Based on that explanation it could be easy to draw the conclusion that children should rather get driven than travel on their own, but that solution is straight against several articles in the Convention of the Right of the Child. As mentioned in the introduction the child has the right to development (article 6), freedom of association (article 15) and privacy (article 16) and to fulfil those children cannot be rejected for traveling on their own, instead it is needed to improve the safety for children when that is needed.

3.2.2 Individual health effects

Physically activity is important for the health. According to the World health organization children between 5-17 years old should do some sort of physical activity at least 60 min per day, and there are more health effects to be won for children that do more exercise than that (WHO n.d.). Those recommendations are higher than WHOs recommendations for adults 18-64 years old (WHO 2011a). Biking is a way to get physical activity and can be used both for fun and for transportation.

Biking is a good transport mode for the age group mentioned above, 5-17 years old, since they are old enough to be able to bike and young enough to not be able to drive a car, which often make biking the fastest option for independent transportation. It does not have to take a lot of extra time from stressed weekdays to get enough physical activity either if biking, since time would be needed for transport no matter which transport mode is chosen.

Physical activity can prevent chronic diseases, premature death and reduce the risk for cardiovascular diseases:

> *"We confirm that there is irrefutable evidence of the effectiveness of regular physical activity in the primary and secondary prevention of several chronic diseases (e.g., cardiovascular disease, diabetes, cancer, hypertension, obesity, depression and osteoporosis) and premature death. … Physical inactivity is a modifiable risk factor for cardiovascular disease and a widening variety of other chronic diseases, including diabetes mellitus, cancer (colon and breast), obesity, hypertension, bone and joint diseases (osteoporosis and osteoarthritis), and depression. The prevalence of physical inactivity (among 51% of adult Canadians) is higher than that of all other modifiable risk factors."*
>
> *(Warburton et al. 2006, p. 801)*

The *concentration* will also get improved if a child bike or walk compared to if it uses motorized transportation. A Danish study shows that children who used their own legs to get to the school were able to concentrate better for the coming four hours and that the movements effect on the concentration where bigger than the effect of having eaten breakfast (Lauritsen, 2012).

Biking can give a lot of health effects in form of physical activity, but to know if biking is a good choice for an individual that want to live longer, it is of interest to study how big this health benefits are compared to the risk of getting injured or killed because of traffic safety reasons. A study comparing how many years of lives are gained because of physical activity while biking compared to how many years are lost because of biking accidents have been done by Hillman (1993). According to Hillman (1993, p. 24) the health benefits of cycling overweight the traffic safety risk with 20:1. This number could may have been different if the study would be done in Sweden or among children, but it still shows that health benefits of biking are much bigger than traffic safety risks, which makes biking a good choice to live longer.

Except from traffic safety risks a biker is also exposed for air pollution to a bigger extent than a protected road user. Hartog (et al. 2010 p. 1109) have made a similar study as Hillman but he also considered air pollution as a factor. In Hartog's study (et al. 2010 p. 1109) a scenario was used were 500'000 people 18-64 years old changed their shorter than 7,5km car trips to bicycle trips. The result of Hartog's study shows that the extra physical activity for biker gave on average 8 more months to live, while the air pollution gave on average a loss of 21 days and the traffic accidents on an average a loss of 7 days (table 4). This means that an average individual that bikes regularly lives longer than an average individual that are not regularly biking because the health benefits of physical activity are much bigger than the disadvantages in form of higher risk of traffic accidents and diseases related to air pollution.

Table 4. Table showing gain in years for a biker when considering air pollution, traffic accidents and physical activity (Hartog et al. 2010, p. 1114).

Stressor	Relative risk	Gain in life years[a]	Gain in life days/ months per person[a]
Air pollution	1.001 to 1.053	–1,106 to –55,163 (–28,135)	–0.8 to –40 days (–21 days)
Traffic accidents	0.996 to 1.010[b] 0.993 to 1.020[b]	–6,422 to –12,856 (–9,639)	–5 to –9 days (–7 days)
Physical activity	0.500 to 0.900	564,764 to 111,027 (337,896)	14 to 3 months (8 months)

In Hartog's study the levels for air pollutions was based on measurements in some different bigger European cities and are therefore probably higher than the average levels that Swedish children are exposed for. According to Sabelström (2017, p. 13) children are more urgent affected of high air pollution levels than adults are.

The relative risk for a traffic accident in Hartog's study are based on data from all ages in the Netherlands while comparing car and bicycle. As Hartog's (et al. 2010 p. 1112) data show the relative risk ratio is higher for children than adults, which means they got a bigger relative risk for a traffic accident which can assumed being true for Swedish children as well.

The risk for not getting enough physical activity among adults in Sweden are lower than the average risk used in Hartog's study (Hartog et al. 2010 pp. 1112-1113). Though according to Carlson (2019, pp. 62, 130) it is only 8.5-23% among children 11-15 years old that get enough physical activity according to WHO recommendations. This means that the relative risk to not get enough physical activity among children in Sweden are between 0.780 – 0.915, which median is higher than the median of the risk interval used in Hartog's (et al. 2010 pp. 1113) study which was 0.500-0.900.

Some differences have been found both to the better and to the worse while comparing what the values would be for Swedish children, wherefore the total gain in life could be assumed being approximately the same, or maybe even more because the physical activity is the most vital factor.

Years of living have been chosen since it is easy to study and compare. It is a very hard value though and should only be seen as the top of the ice berg of all injuries in the case of traffic accidents and all diseases in the case of health problems.

3.2.3 Public health effects

A child's health will not only be improved if that child starts to bike to a bigger extent, but also if people around that child start to bike to a bigger extent instead of using motorized traffic. Negative health effects that could be found in children because of motorized traffic, and that would be improved if other children and other adults around them would start to bike instead of using motorized traffic to a bigger extent, will be found below:

3.2.3.1 Air pollution

Respiratory tract infections (RTI), asthma and reduced lung function is more common for children growing up in areas with high levels of air pollution (Sabelström et al. 2017, p. 6). Children are more affected of air pollutants than adults because the air pollutants more easily are sticking to their lungs. Schools and preschools are often placed centrally or near bigger roads, which is locations that are extra affected of air pollutants. Children are also often outside in the morning and afternoon, when the air pollutants levels are as the highest (Sabelström et al. 2017, p. 9).

When air pollutants levels are high in the city area, more children need to visit the hospital urgent because of difficulties in breathing. This effect is bigger among children than among adults. (Sabelström et al. 2017, p. 13).

Air pollutants effects the cognitive development of a child's brain, which affects the development of language, memory, thinking, learning, creativity etc. Studies in USA have found that schools with high air pollution levels have pupils with lower intellectual. A Swedish study found out that children living close to places with a lot of air pollution use more medication against psychiatric diagnoses (Sabelström et al. 2017, p. 17).

3.2.3.2 Noise

Noise contribute to cognitive impairment in children. Especially reading and learning have been shown affected negatively in many studies (WHO 2011b, p. 45). Studies of the relationship between transportation noise and cardiovascular effects have been done and more and more evidences are pointing on that there is a connection both for adults and for children (WHO 2011b, p. 16).

According to European commission (2019) a one-third reduction of car trips within the city would reduce the noise levels with 9%, but those numbers are only based on an estimation from the 1980s and the effect would not be perceived that big in reality. Since the decibel scale is logarithmic a fifty percent reduction of the noise levels will reduce the noise with 3dB (Tibell 2019). Somewhere between 4-7dB reduction in noise is needed to note the change and a reduction of 8-10dB is needed to perceive the change in noise as a fifty percent reduction (Transportstyrelsen 2013a). According to Kempen (2010, p. 45) a shift from cars to bikes would not significantly affect the noise levels over a bigger area, but it can still be effective on minor roads with a low traffic flow. However, Kempen (2010, p. 45) refers to that there have only been a few studies measuring noise levels when changing transport modes from cars to bicycle but if driving patterns are not changing only negligible noise level reductions can be seen.

3.3 Alteration in levels of biking including the reasons

When the term levels of biking have been used in this text it is referred the number of biked kilometres, the number of trips biked and the number of individuals that are biking and not to biking skills or altitudes. According to Stockholm municipality (2019) the levels of biking among all ages was as highest in the 1940's, then they sank fast to the lowest levels of biking in the 1970's and after that they have been slowly risen. The fast decreasing between the 1940's and the 1970's can be explained by that many people bought a car in this time period due to the economic growth (Stockholm municipality 2019). How the levels of biking among Swedish children have been changing between the 1970's and the 1990's have not been found. According to Svensk cycling (2019) 90% of the children either walked or biked to school in the 1970's, but today that level have been reduced to approximately 50%. How the levels of biking among Swedish children have been changed since the middle of the 1990's can be found in the text below.

3.3.1 Decreasing levels of biking in the time period 1995 to 2014

In the article *Cyklandets utveckling i Sverige* published by the *Swedish Transport Analysis* (Saxton 2015) bicycle data has been compiled from Swedish national travel surveys and separated in four different time periods. This article shows that the total length of biked kilometres in Sweden has been reduced by 16% since the middle of the 1990's and the decreasing levels of biking could be found in all types of municipalities, all ages and both genders (Saxton 2015, p. 9). The number of bicycle trips have sunk even more, 34 % during the same time period (Saxton 2015, p. 9), which means that the average bicycle trip has been longer. This is explained with longer distances to schools and workplaces.

During the same time period the amount of people living in Sweden have risen with 8% (Saxton 2015, p. 9). While studying the data closer thought it is possible to see that the only age categories with decreasing bike levels since the 1990's, if the confidence interval is considered, is the ones that involve children, 6-14 years old and 15-24 years old (see figure below).

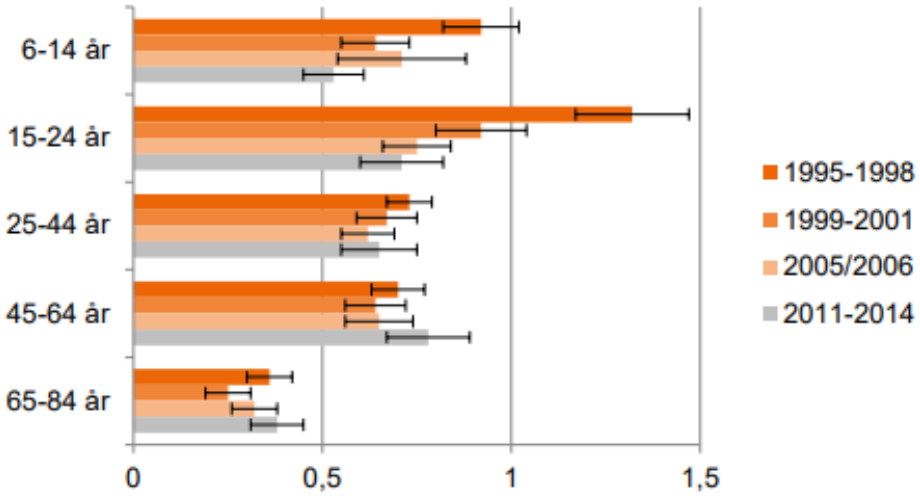


Figure 8. Biked length in kilometres per inhabitant and day, showed over age, with 95%-confidence interval (Saxton 2015, p. 16).

3.3.2 Reduction of free time trips

It could be of importance to separate school trips and free time trips from each other. School trips are done between the home and the school and are often easier to control since they are done at the same place and at the same time five times a week, while free time trips are all other trips and can be done anywhere at any time with different time interval between iterations, if there is any. The number of school trips have reduced with a total of 48% during the time period from 1995-1998 to 2011-2014, which is mentioned many times in the rapport as alarming data (Saxton 2015, pp. 9, 17, 26). However, it is not that distinctly showed that according to the same rapport the total length of school trips are only decreasing with 34% during the same time period (Saxton 2015, p. 17). If that is compared with the group 6-14 years old (figure 9) the mean value of total length of biking trips have been decreasing more than 34% during the time period and therefore the free time trips are likely to have been decreasing more than the school trips. If measuring in the figure below the mean value have been decreasing with 42% if comparing the values for 1995-1998 and 2011-2014.

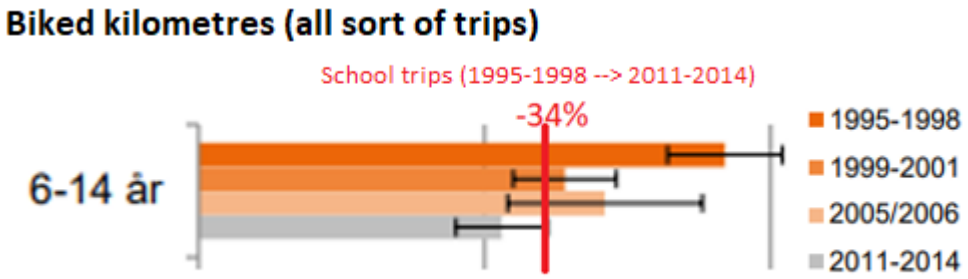


Figure 9. Enlargement of parts of figure 8 (Saxton 2015, p. 16). A marking of a 34% reduction in biked kilometres compared to year 1995-1998 is showed. As it can be seen the mean value for 2011-2014 is lower than a reduction of 34%.

It has been hard to find studies about how big parts of the bike trips that are done as free time trips and what kind of free time trips that are done. Niska (et al. 2017, p. 28) claims that there is lack of knowledge about both more specifically which kind of bike trips that are mostly reducing and which groups of children that are biking more or are biking less. Parts of this subject is studied in the context theme in the questionnaire to see what kind of free time trips the children does, but it is only focusing on children at a specific age at a specific school due to limitation of the extent of this thesis. More studies about free time trips among children would have been of interest.

3.3.3 Initiatives to make children bike more

Initiatives have been done to rise the number of biked kilometres among children. In a document provided by the *Swedish Transport Administration* (Hambesson 2005) an assembling of initiatives for making children bike to the school more can be found. However, almost all those initiatives are made only within the municipality and are only focusing on school trips. Two newer examples of different type of initiative are described below, where one of them is focusing on school trips and one of them is focusing on being able to leisure time activities.

3.3.3.1 Biking school bus or biking train

Several Swedish municipalities, for instance Malmö, Uppsala, Vaxholm and Östersund are encouraging to walking or biking school bus (Malmö municipality 2015; Uppsala municipality 2019; Vaxholm municipality 2019; Östersund municipality 2019). What is referred to as a biking school bus in this text is when some children who lives close to each other, bike to the school together, in company with one of the parents on a shifting schedule. In a brochure provided by the *Swedish Transport Administration* (Vägverket and municipalities in the region of Stockholm n.d.) parents and children tell about changes since they started a biking or walking school bus. The parents tell that it saves them time not having to drive the children to the school every morning, the mornings have become less stressed and that the children are calmer at the morning assembly because of the

movement. The children describe it as fun to discover the school path and hang out with friends before the school day starts.

3.3.3.2 Fun on wheel in Malmö

Fun on wheel was a bike school that was active in Malmö in the years 2016-2018 and was arranged by a local football club in partnership with the municipality and some other local associations (Kul på hjul n.d.). The bike school was addressed to 6-13-year olds and its purposes was to increase integration, improve health and increase learning. The reason the bike school was started was that it was shown that children living in socioeconomic less favourable had fewer leisure time activities. The main reason was that they had less transportation possibilities, combined with that many of those children did not have a parent that could bike wherefore Fun on wheel was arranged to teach children how to bike. Fun on wheel was financed by the Swedish Inheritance Fund. The bike school is not active anymore, but it is possible to register on the web page to get information and recommendations on important things to consider if starting a biking school.

3.4 Safety compared to other factors for modal choice.

There are many factors of importance of bikers. This thesis is focusing on safety, but if the people chose not to bike at all because of any of the other important factors for bikers, there is no point for either the society or the individual to spend money on improving the bike safety. In this chapter the important factors for bikers that have been found are listed, but it is not excluded that other factors can exist. The factor cycling infrastructure have been deeper studied since that will be investigated in the interview and the questionnaire.

3.4.1 Important factors while choosing bicycle as a transport mode

There are many factors to take into consideration while choosing a transport mode. The five important cycling infrastructure quality factors according to CROW (Niska et al. 2017, p. 53) is *cohesion*, *directness*, *attractiveness*, *safety* and *comfort*, where safety maintain both actual and perceived safety. In the handbook *GCM-HANDBOK* (Lindberg & Wärnhjelm 2010, p. 21) the directness and *travel time* are described as important factors for choosing bicycle. The detour factor is decided by comparing the shortest road distance with the shortest map distance and the travel time factor is decided while comparing the total travel time for the biker with the total travel time for a person using another transport mode (Lindberg & Wärnhjelm 2010, pp. 162-163). If compared with car the travel time factor should not be more than 1.5 to be considered competitive (Lindberg & Wärnhjelm 2010, p. 21). *Total distance*, directness and *difference in altitude* are all factors that are more important for a biker than someone using a motorized vehicle and those need to be limited to make biking a good option (Lindberg & Wärnhjelm 2010, p. 22).

The factors mentioned above are in general important factors for bikers. Studying children other factors can have bigger effects. For children around 6-12 years old it is important with a neighbourhood traffic environment that is *perceived safe* enough by parents to let their children bike there. Separating from car traffic and avoiding of intersections with car traffic is common solutions for this (Lindberg & Wärnhjelm 2010, p. 9), which can be a complex solution if that is straight against some other road quality factor as directness for instance. Children can also use the bike for playing, wherefore *having fun* is another important factor for children (Niska et al. 2017, p. 47).

It is hard to say how important those factors are compared to each other though. In the survey in chapter 4.3.2 it has been investigated how important some of those factors are considered among 11-year old children and their parents.

3.4.2 Cycling infrastructure

Considering the *velocity* of bikers in the city, they could have more in common with drivers than walkers and could therefore be better situated to share infrastructure with motorized traffic than with walkers (Svensson Lecture 2016), if they need to share with one transport mode because of limitations in the spatial room which often is the case in cities. However, children's needs can differ from the general biker. It has been shown in a British study that when bikers shared infrastructure with motorized traffic the stereotypical biker was a man wearing sport clothes (Aldred & Dales 2016, p. 348), but when there were protected cycle lanes children, elderly and women biked to a bigger extent (Aldred & Dales 2016, p. 359). This study was made in London which is a much bigger city with much more motorized traffic than Swedish cities in general, wherefore the result probably would differ from a similar study made in Sweden. But what this study show is that children are more dependent on protected bike lanes to be able to bike than the general biker.

3.4.2.1 Width

The rapport *En nationell cykelstrategi* (Johansson 2017, pp. 20-21) concludes that there is lack of basic data on how bicycle roads will be designed, which can lead to development and maintenance that not is the best for the bikers. There is a need of a more common view on categorising of the

bicycle road net and how the different parts will be maintained. The rapport also says that the cycling infrastructure needs to be able to handle a diversity of bikers: fast bikers, free time bikers and at the same time being able to handle other transport modes in form of walkers and new alternatives to the traditional bikes.

According to *the GCM-handbook* (Lindberg & Wärnhjelm 2010, p. 25) a normal bike has the width of 0.75m and a three-wheeler for adults can have width up to one metre. Thereto it is added that a biker needs extra wobbling space and the total width of a one-way cycling road is recommended to be between 1.6-2.0m depending on the flow (Lindberg & Wärnhjelm 2010, p. 70). The minimum width on a cycling road is only 0.5m though (Lindberg & Wärnhjelm 2010, p. 39), which is smaller than a bike and there is nothing said about the needed width for a biking child in the GCM-handbook. The child bike is probably a bit smaller than a full-size bike, but a child that just have learnt how to bike will need more wobbling space, wherefore the width could be even more critical for a child.

To be able to clean the roads from snow in the winter and accomplish other necessary maintenance it is often needed a space for at least 2.5m (Lindberg & Wärnhjelm 2010, p. 26), wherefore it is a problem that no minimum width standard for biking roads exist in Sweden. Regarding the widths above none of them take into consideration the possibility to bike abreast. In the interview it was found to be common that children bike with friends when meeting outside or going to a leisure time activity (chapter 4.3.1) and in company of their parents when it is dark (chapter 4.3.4.2). No standard about which width is needed when biking abreast have been found though.

3.5 Safety equipment of bike and biker

Except of the environment around the bicycle, the safety for the biker is of course also affected of the bike and the biker. It is needed that the biker know how to maintain the vehicle in a safe way and that the biker and other traffic have common rules to follow. To be able to convey the bike there are some basics that needs to be fulfilled, but there also exists equipment that can improve the safety for the biker.

3.5.1 Equipment of the bike

New bicycles need to be tested according to EU standards. While discussing bikes for children in traffic there are two different standards that needs to be considered:

- Cycles – Safety requirements for bicycles for young children (SS-EN ISO 8098:2014)
- Cycles – Safety requirements for bicycles – Part 1: Terms and definitions (SS-EN ISO 4210-1:2014)
  Cycles – Safety requirements for bicycles – Part 2: Requirements for city and trekking, young adult, mountain and racing bicycles (SS-EN ISO 4210-2:2015)

The first standard is applied to bicycles for young children, which is defined by a maximum saddle height between 435 and 635 mm (SS-EN ISO 8098:2014).

The second standard is applied to bicycle for young adults, which is defined by a maximum saddle height between 635 mm and 750 mm (SS-EN ISO 4210-2:2015). That standard is also applicable for city and trekking bikes, mountain bicycles and racing bicycles with a maximum saddle high of 635mm or more.

Table 5. Definition of bicycle types (SS-EN ISO 4210-2:2015, p. 1).

Dimensions in millimetres

Bicycle type	City and trekking bicycles	Young adult bicycles	Mountain bicycles	Racing bicycles
Maximum saddle height	635 or more	635 or more and less than 750	635 or more	635 or more

The standards include requirements for brakes, steering, frames, front fork, wheels, wheel assembly, tyres, drive-chain etcetera (SS-EN ISO 4210-2:2015). Those are all basic equipment for the function of the bikes, which are necessities to be able to drive safely.

According to Cubus (n.d.) an 11-year old child has an average inseam of 69 cm, which gives a saddle height of 752 mm according to the Hamley method (Lindsay n.d.), therefore the second standard is applicable for children in the studied age category. For some of them the young adult bicycle could be used but depending on the length of the child a bike for adults are more likely recommended for most of them.

3.5.1.1 What equipment should a bike have according to Swedish law?

The minimum according to Swedish law is that the bike is going to have a bell (2. Chapter 20§ in TSFS 2009:31) and at least one brake (2. Chapter 2§ in TSFS 2009:31). This brake needs to be a foot brake if the maximum saddle height is between 435 and 635 mm (2. Chapter 2§ in TSFS 2009:31), which is a bicycle for young children according to EU standards.

If the bike will be used in darkness, which is more of a concern for the older children it is necessary to have light and reflexions. It is necessary to have a red backlight that is visible on a distance of 300 meter and a white or yellow front light that are visible on a distance of 300 meter or have a light strength so strong that the bike could be conveyed in an adequate way (2. Chapter 14§ in TSFS 2009:31). The bicycle also needs to be equipped with reflexions. It must be a white reflexion in front, red reflexion in back and orange or white reflexion sideways (2. Chapter 17§ in TSFS 2009:31) and

they must fulfil the classification standards set by Swedish authorities (2. Chapter 18-19§ in TSFS 2009:31).

3.5.2 Equipment of the biker

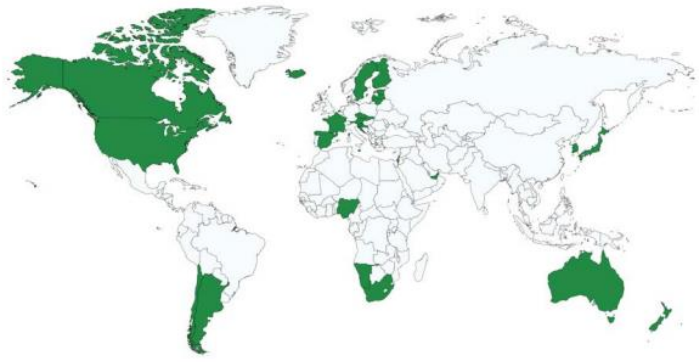
Except of safety equip the bicycle, the biker's safety could also be risen by letting the biker use safety equipment. In this thesis the focus will be on bike helmets, but there also exists other safety equipment for bikers, for instance reflective clothes.

3.5.2.1 The bicycle helmet rises the safety

It has been established in numbers of studies (Høje 2018a, p. 85; Attewell et. al. 2001, p. 345) that bicycle helmet use is an efficient way to reduce head injuries, facial injuries and the number of deaths. In the article *Bicycle helmets – To wear or not to wear? A meta-analyses of the effects of bicycle helmets on injuries* (Høje 2018a, p. 85) that is based on numerous of studies between 1989-2017 it is concluded that bike helmets reduces head injury by 48%, serious head injury by 60%, facial injury by 23% and the number of killed and seriously injured cyclists by 34%. Using a bike helmet reduces many different risks of injuries and is therefore a great idea to improve the safety. In Høje's (2018a, p. 85) meta-analyses study it was found that the effectiveness of bicycle helmets could be a little higher when the bicycle helmet was mandatory, and that the helmet wearing rate did not correlate to the helmet effectiveness.

3.5.2.2 Laws about bike helmet

According to Swedish law children under 15 years old must wear a helmet when biking (6. Chapter 4§ in Trafikförordningen 1998:1276). However, this law does not apply to kick-bikes and three wheelers since they are considered as toys (Transportstyrelsen 2013b). In 2018 there were in total 28 countries that had some sort of bicycle helmet law according to Olivier (et al. 2018, p. 14).



* Canada and the United States do not have legislation for all provinces or states

Figure 10. Countries that have some form of bicycle helmet law marked in green (Olivier et al. 2018, p. 15).

One way of studying how important safety among biking children is considered is to study which countries that have bicycle helmet laws specifically for children. Out of the 28 countries that have some form of bicycle helmet law 17 of the countries, for instance Sweden, have some sort of bicycle helmet law that only applies for children under a certain age (Olivier et al. 2018, p. 23). The rest of the countries that have some bicycle helmet law for children only are Austria, Canada, Czech Republic, Croatia, Estonia, France, Iceland, Israel, Japan, Jersey, Latvia, Lithuania, Slovenia, South Korea, Spain and United states (Olivier et al. 2018, p. 23). Having a bicycle helmet laws for children specifically somehow tells about that the country is prioritizing bicycle safety among children. It does not say anything about the safety among bikers in the country in general though. For instance, there are other countries that have bicycle helmet laws for all ages (Olivier et al. 2018, p. 23). It is also noticeable that out of the four countries that was found to have lower fatality rates than Sweden in

chapter 3.1.2: Denmark, Norway, Germany and Netherlands (Castro et al. 2018, p. 17) it is only Denmark who have any kind of bicycle helmet law (Kim 2018 p. 68-69).

The bicycle helmet law itself can therefore not be the main reason a country has better bike safety than another. The effect of safety in number that was discussed in chapter 3.1.3.3 seems to have a much bigger effect on increasing the safety rather than the bicycle helmet law has. It is not unlikely that it would be the opposite, that countries with low bike safety are more likely to introduce a bike helmet law. If a country has low bike safety if could be a political solution to introduce a bicycle helmet law, while a country that already have good bike safety maybe do not see any reason to introduce a bike helmet law.

3.5.2.3 The bicycle helmet law does not reduce the safety among bikers

A numerous of articles in different news sites or blogs draws the conclusion that bicycle helmet laws stop people from using bikes and therefore reduces the numbers of bikers which leads to more unsafe biking (Walker 2017; Abelson 2015; Johansson 2016). The Australian study *Head injuries and bicycle helmet* laws (Robinson 1996, p. 463) claims that this was the effect of the adoption of the bicycle helmet law in two Australian states, while the Canadian study *Trends in pediatric and adult bicycling deaths before and after passage of a bicycle helmet law* (Wesson et al. 2008, p. 605) claims the opposite, that the bicycle-related mortality among children 1 to 15 was significantly decreasing after introduction of a bicycle helmet law. An Australian meta-analyse-study made on behalf of the *Swedish Transport Administration* (Olivier et al. 2018, p. 103) studied 23 collections on studies from 7 different countries and could not find evidence for that bicycle helmet laws will affect the levels of biking negatively. A meta-analyse-study made by Høje (2018b, p. 239) that included 21 different studies could find a statistically significant reduction of head injuries of 20% if bicycle helmet legislation is mandatory for all cyclists and even larger reductions of seriously head injuries. The study also showed that the effect among children were bigger when bike helmet legislation was mandatory for all cyclists than when bike helmet legislation was mandatory for children only (Høje 2018b, p. 239).

The bike helmet rates among Swedish children (6-12-years-olds) have increased from 52% in 1996 to 80% in 2017 (see figure 11). As seen in figure 11 this happened mainly after 2005, which was when the bicycle helmet law in Sweden was introduced (6. Chapter 4a§ in SFS 2004:296). During this time period the number of biking children have also decreased (see figure 8 in chapter 3.3.1). It is not possible to say whether the bicycle helmet law has contributed to the decreasing levels of biking among Swedish children or not only by that fact, but it can at least not be the main reason that the biked kilometres per day have been decreasing among Swedish children between 1995 and 2014, since the main decrease in biked kilometres per day in that time interval was between the time periods 1995-1998 and 1999-2001 (Saxton 2015, p. 16), which was before the introduction of the bicycle helmet law.

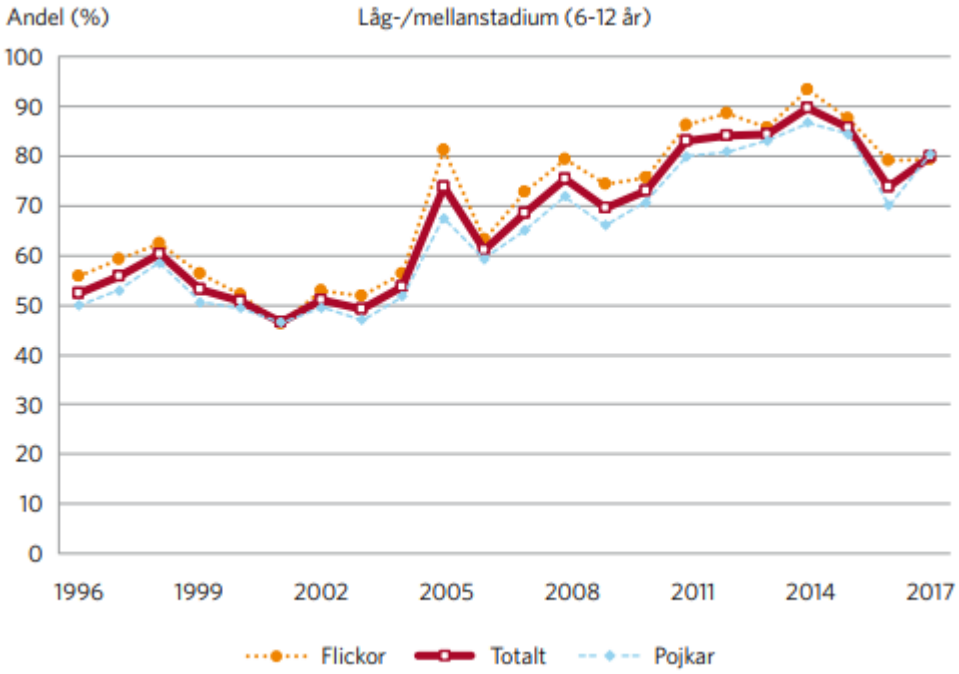


Figure 11. Percentage of children (6-12 years old) using bike helmet on their way to school during the years 1996-2017 (Lindholm 2018, p. 12).

4 Survey

The survey was made as an interview study in a group with 8 children in 5th grade. The same interview was made in two different classes at the same school which means there is a total of 16 children participating. The parents to all children in both classes got the possibility to participate in a questionnaire through an internet link. Both the interview and the questionnaire were based on four different themes: context, importance of safety, traffic environment and external factors.

4.1 How the school was chosen

From the beginning at the process the plan was to do the survey at two different schools in different areas to see if the nearby area affected if the children used to bike or not. Principals at two public schools in the same city closer to the city centre were asked to participate, but one school was too busy to participate in more studies now and one school did not answer either mail or phone calls. One private school in the same city was asked but they said they did not want to join the study because most of their pupils goes by bus or are driven in car to the school and almost none of their pupils are biking to the school. Another public school in a similar area as the participating school and a public school at the nearby countryside were also asked. Both their principals seemed positive to participate in the study, but no class teacher was found that were willing to set of time to make it possible for their class to participate.

The study was done at a public school named Fäladsskolan in Lund, Sweden. The school is located in the north part of the city and the area of the school is built according to the planning tool SCAFT, which means that the area looks like a typical Swedish building area from the 1960's. More information about the area of the school and the planning tool SCAFT can be found in chapter 5.1.

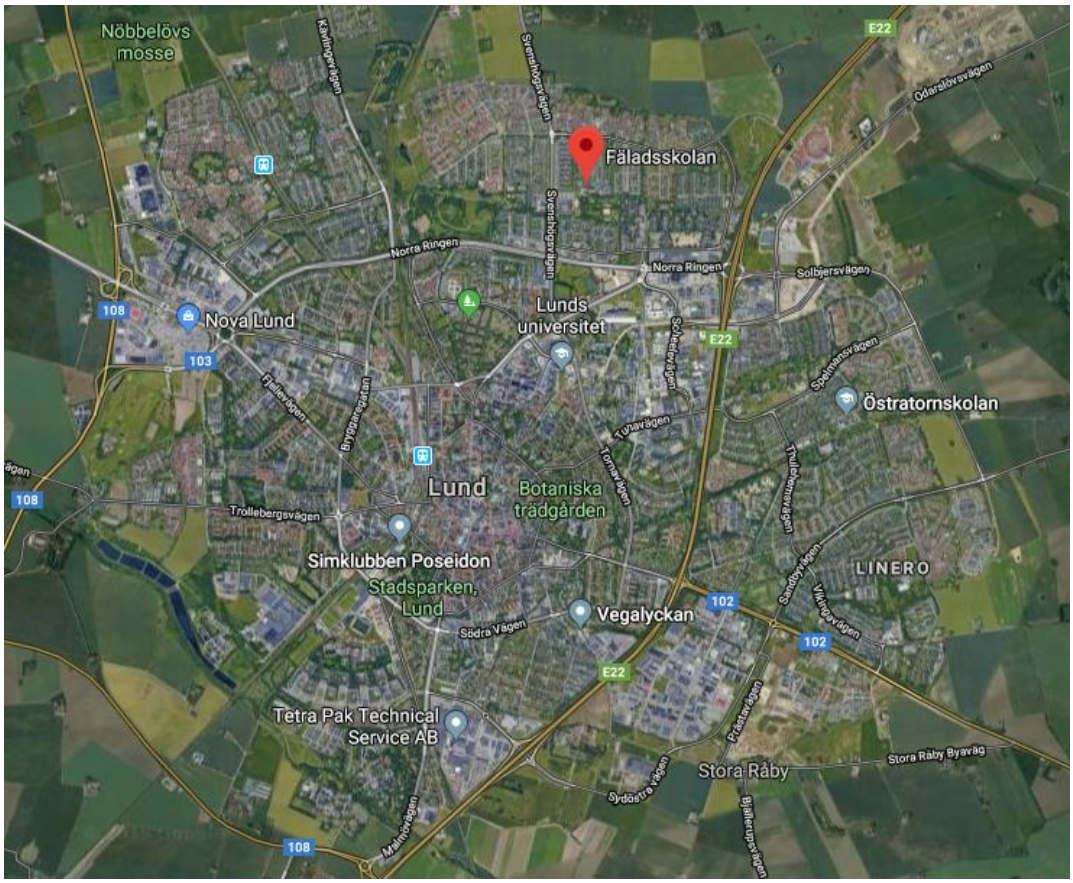


Figure 12. Map showing the city were the study was done, with the studied school marked with a red nail. Google Maps (2020-01-10).

4.1.1 How the children were chosen

The children were told that the interview was about biking, was asked to rise their hand if they wanted to join the interview and then four girls and four boys were chosen among them. The parents got access to the internet link for the questionnaire and had the possibility to answer the questions within two weeks. The study is only focusing on children around 11 years old and since it can happen a lot in the child's development in only a few years, these results are not representable for children of all ages.

4.2 Description of focus interview and questionnaire

With the children the study was done by help of cards with pictures and a short text. The purpose was that the cards in each theme should be possible for the children to sort from "good to bike" to "bad to bike" on a scale as they preferred. See appendix B below for the traffic environment cards. In the appendix there have been added English texts and numbers on the cards, which they did not contain when they were given to the children. With the parents the survey was done as a questionnaire through an internet link. See appendix C for the questions in the questionnaire as they looked when they were given to the parents (in Swedish).

The following themes were used in the survey:

4.2.1 Context (Children & Parents)

The main purpose of starting the interview with the context theme was to get a view of the children's bike habits. Cards with pictures of six different contexts where showed to the children one by one and they were told to say whether they used to bike in this context or not. The context cards contained a word or a phrase and a picture describing what was written. Then they got supplementary questions depending on their answers to get a better view about it (for instance destination of trip, if going alone or not, if there were a reason, they did not bike). The parents were able to bock in some boxes if their children used to bike in that context.

4.2.2 Importance of safety (Children & Parents)

There was one question about how important safety is considered. The question was asked after the context part. Five different aspects of biking were compared to each other, where safety was one of them. The children got to rank the different options by sorting the statements as paper strips together on a table. The children first sorted them after how important they found them. Then they sorted them after how important they though their parents found them when considering their child biking. The parents were able to rank the different options from one to five depending on how important they found them. The most important were ranked 1 and the last important were ranked 5. The five factors that were asked about in the different options were: traffic safety, directness, exercise, fun and status.

4.2.3 Traffic environment (Children)

To investigate the perceived safety in different traffic environment the children where shown pictures of different road types and crossings & intersections. They should answer whether it was a good or bad place to bike by sorting them on a line. First the road cards were sorted and then the crossing & intersection cards were sorted. When the children got the traffic environment card, they showed a picture but no text. In appendix B.1 it is possible to see the road cards and in appendix B.2 it is possible to see the crossing & intersection cards.

Road Types

For inspiration of different road types to use *the Life room model* was used. This model is categorising the city streets in five different rooms, from the first room that are only made for pedestrian and walkers, to the last room that are only made for motor vehicles, and then the middle rooms for different mixes (Wärnhjelm & Lindberg 2009, pp. 19-20). However, this model only gives a rough division of the city streets and was therefore not enough to be able to categorize different types of biking roads. The life room model is mainly separating between environments made for more spontaneously round moving walkers and bikers and fast forwards motor vehicles and does not separate between bikers and walkers. A biker is an unprotected road user just as walkers but are also more likely to move fast forward in one direction than a walker just as drivers, at least when considering all ages according to Svensson (Lecture 2016). Therefore, in lack of any better method to define different types of cycling roads a diagram was made where the x-axle shows to what extents the bikers need to share the space with the walkers and the y-axle shows to what extend the bikers need to share space with the motor vehicles.

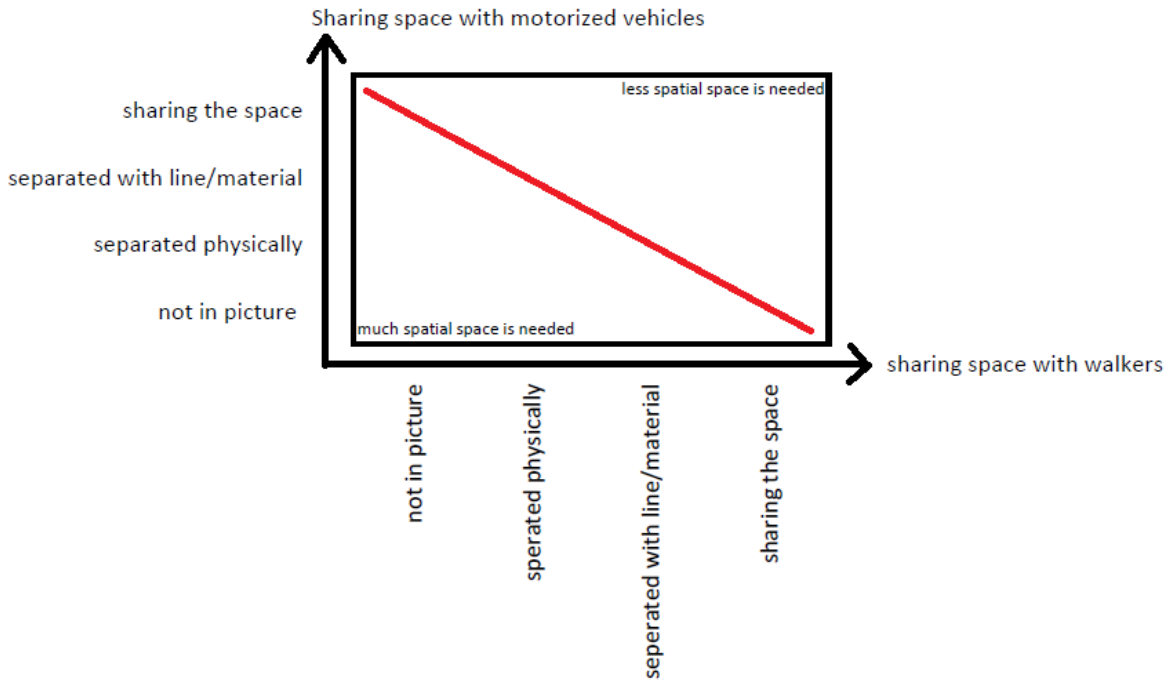


Figure 13. Diagram that could be used to describe to what extent the bike traffic is sharing space with motorized vehicles and walkers. (Self-made diagram).

Because of limitations in space the bikers almost always need to share space with either walkers or motorized vehicles. Therefore, the pictures on the cards used in the interview can be set up on a diagonal (red line in figure 13) were card A is placed in the right-down corner, after that card B etc. until card K that is placed in the left-upper corner in figure 13 above. The most cards are likely going to end up either on the red line or close to it because of some limitations in space, but the diagram makes it possible to distinguish cards that would get the same place at the red line.

The cards did not contain the letters used to describe them in this rapport during the interview and were given out to the children in a randomized order, to make sure that the previous sorting by the author would not affect their result. There is also one card (L) representing what happens if the cycling infrastructure ends suddenly, with a possibility to continue the route, but not straight forward as usually.

How to use diagram in figure 13

When using the diagram in figure 13 to distinguish cards that should be used for an interview, the cards should first be placed out on their best position in the black box as a point. Then a dashed line should be drawn between the point and the red line, so that the dashed line becomes perpendicular to the red line and their meeting point should be marked with a cross. As long as no cards ends up at the exact same place on the red line, the place on the red line could be used to distinguish the cards. The crosses should then be named in alphabetical order starting in the down-right corner and continuing through the red line. This way the cards becomes pre-sorted. It is of importance to consider if some cards should have another position, especially if there crosses on the red line ends up really close to each other since that can affect the letter they get named.

When analysing the result it is then possible to either just sorting the cards with their alphabetical letter or, if their letter just seems random to the results, compare the result with the original sorting in the black box and find out if either the x-axle or the y-axle is affecting the result.

Crossings & Intersections

The cards showing crossings or intersections where chosen so they represented different kinds of mainly crossings, but also some intersections. The cards were representing the following:

- Intersection with only walkers and bikers
- Crossings with motor vehicles that were grade separated (tunnel, bridge)
- Crossings with motor vehicles that were integrated (passage - without and with traffic signal)
- Intersection while biking along car road (car-road junction and crossing bicycle road)
- Integrated intersections with both unprotected road users and motor vehicles at the same time (without traffic signal, with traffic signal and circulation).

The different types of crossings & intersections are chosen so they represent different levels on a scale from easier to understand environment that are mainly for unprotected road users (card A) to more complex environments where both different walkers' path, biking paths and motorized traffic needs to be considered at the same time (card K).

4.2.4 Traffic environment (Parents)

The parents got to answer about the traffic environment in two different scenarios.

School trips

The first scenario was about the school trip and the parents were asked to grade how well they agreed on some statements from 1 (totally agreed) to 4 (totally disagreed). It was also possible to choose that they did not know or did not wanted to answer.

- Scenario 1: Your child is going to bike from your home to the school a usual morning. My child's possibilities to bike to school are good since…

Free time trips

The second scenario were about the free time trips and the parents were asked to describe how they perceived the traffic environment their child bike in at their free time. They got to give a free text answer with at least 25 characters. Since free time trips are not only done on a given distance the parents got to answer this scenario as a free time text to make it easier to interpret the answers.

Before they should answer they got some questions to ponder and if they answered with less than 25 characters, they were told to reread those questions. The question to ponder were: "Can you see any differences in biking on the free time and biking to the school?", "Do you feel more, less or the same level of secure when your child bikes on the free time as when your child bikes to the school?" and "Is the environment your child bikes in at the free time suitable for a biking 11-year old?"

- Scenario 2: Your child comes home from the school, eats a snack, and then goes out with the bike. How do you perceive the environment your child bikes in at the free time?

4.2.5 External factors (Children & Parents)

This theme was discussed to different extent based on time with the children. The topics children were asked about was: rules, weather conditions (winter, darkness and rain), load and bike helmet. The external factor cards contained a word or a phrase and a picture describing what was written. The parents got to answer if they agreed or disagreed to some statements about different weather conditions (rain, winter, darkness). They got one question about distance and as a last question the parents were also asked what would be needed to make their child bike more.

4.3 Result of focus interview and questionnaire

In total there were 28 parents responding the questionnaire.

4.3.1 Context

Question: How often does your child bike? (Parents)

89% of the parents claimed that their child bikes daily.
4% of the parents claimed that their child bikes sometimes every week.
7% of the parents claimed that their child bikes sometimes every month.
None of the parents answered that their child bikes more seldom or never.

Question: In what context do you/your child use to take the bike? (Children & Parents)

Table 6. Showing the result on the interview/questionnaire question: In what context do you/your child use to take the bike?

	Children: I usually bike when I am…	Parents: My child usually bike when my child is…	Percentual average (Parents and children weighted equal)
Going to the school	15/16	27/28	95%
Going to a leisure time activity	12/16	14/28	63%
Visiting a friend's house	16/16	22/28	89%
Meeting a friend outside or in the city	7/8	2/28	47%
Going to the store.	5/8	11/28	51%
Going to a relative or to the other parent's home.	3/16	6/28	20%

- **15 of 16 children usually bikes to the school.**

In both interviewed groups all children claimed that they used to bike to school, except from one boy who lived next to the school building and used to walk because it was too close to be worth taking out the bike. One girl said that she uses to bike, but her locker is broken and therefore she cannot bike at the moment.

- **12 of 16 children usually bike to a leisure time activity.**

All children in group 1 had a leisure time activity they regularly biked to. Two boys that play handball use to bike to the activity together, one girl says that she uses to bike to the stable when she goes by her own or with a friend, but when she goes with her grandma she got driven because her grandma is too old to bike. Two children in different sports said that they use to bike to the training or match, but if they have away match, they get driven. One girl says that if it is really cold or slippery, she got driven. One child bikes to the handball but walks to the basketball. Else it seemed to be the rule that the children bike to their leisure time activity. Other activities that was mentioned in the group are Thai boxing, football, basketball and archery.

In group 2 half of the children had a leisure time activity they used to bike to. One boy bike both to the school of arts and to the badminton, one child bike to the football training and one child bike to an activity in the city centre. One child has three activities and use to bike to the handball but take

bus to the dance class and car to the school of arts. The children who did not bike to a leisure time activity was one child who got driven to the handball both to the neighbour village Stångby and to the city centre, one girl gets driven to the gymnastic trainings that are at two different locations in the city, one girl take the bus to her dance class in the city centre and one boy got driven in a car-share to the handball training and he often got driven to the school of arts. He says that it gets stressful when he is not driven and that he is more often driven in the winter.

The differences between the answers in the different groups is that in group 1 most children have one leisure time activity only, while in group 2 it is common to have more leisure time activities. In group 1 all children usually bike to their leisure time activity, while in group 2 taking the bus or getting driven is common as well. It was most common to have one leisure time activity and bike to it, but some children bike even though they have two activities, while some children use other transport modes even if they only have one activity.

- **16 of 16 children usually bike when visiting a friend's house.**

When the children are visiting a friend's house, the children from both groups claim that they are most often biking. In both groups it is also mentioned that it is common to walk if the friend lives close. In group 1 it is discussed that it is the fastest transport mode that is used. Since it takes time to take the helmet, take the bike, lock-up and park the bike it is faster to walk if the friend lives nearby. In group 1 there are some children telling that they are driven if they are visiting a friend living far away.

- **7 of 8 children usually bike when they are meeting a friend in the city or outside.**

In group 1 the children used to meet more often at their friend's house than meeting in the city. Some children claimed that they use to take the bus if the destination is far away, especially if it is in the evening. It is a bit unclear if the children understood the question right since they seemed to only be focusing on meeting at a destination far away, wherefore the question was clarified to the next group that it could be meeting a friend anywhere outside or in the city. In group 2 most of the children used to bike when they are meeting a friend in the city or outside. One child says that the vital factor is whether their friend have a bike or not. If the destination is far away or if it is cold or dark some children use other modal choice. One child answer that if it is cold you can take a jacket and another child mention that if it is dark you should have lamps on your bike.

- **5 of 8 children usually bike to their closest food store.**

When going to the store the children use to bike or walk when they are visiting their closest food store. When the children in group 1 was asked if they used to bike to the store all children agreed at first, but then 3 of them commented that they used to walk when going their nearby food store, because it is really close. In group 2 one girl say that she does not use to visit the food store on her own, but her parents use to drive for grocery shopping and then she can follow the trip to buy things if she wants something. When buying clothes most children go to the local shopping centre (Nova). In both groups most children are visiting the shopping centre with their families and driven in cars. In group 1 some children say that they use to bike or take the bus when shopping clothes. Some children say that they use to bike to the city centre. There are different opinions whether the shopping centre Nova is far away or not. One child in group 1 point out that the shopping centre Nova is not that far away and that he has walked to it ones, but in group 2 one child say that the shopping centre is far away, and that car is needed.

Fact: According to Google Maps (2019-12-02) it is 4,8km (21min) to bike from the shopping centre (Nova) to the asked children's school (Fäladsskolan).

- **3 of 16 children usually bike to a relative.**

In both groups most of the children only had relatives far away. In group 1 there was one kid that used to bike to the grandparents. In group 2 one girl uses to bike to her grandfather and one boy

sometimes bike to his relatives in the city. For the rest of the children in group 2 biking to relatives was not an option since they only had relatives in other parts of the country or in other countries. None of the children participating in the interview had parents living at different places.

4.3.2 Importance of safety

Question: What is of most importance when biking? (Children & Parents)

In group 1 the children first agree on that safety is the most important. They rank having a cool bike as the most unimportant and just before that comes having fun. One child say that it is unimportant having fun, because that is possible to have at the target point. After the interviewer asked if coolness really is unimportant the children answer that it does not matter. Two children describe how ugly their bikes look like but that it does not matter. One child tells that comfort and function of the bike is much more important than having a cool bike. The children are unsure about whether it is most important to move and get exercise or getting fast to reach the target point, wherefore they end up giving them the same rank.

In group 2 the children first agree on that having a cool bike is the most unimportant. Then they decide that the safe traffic environment should be on top. The children agree on that having fun is not so important, it is more important that it goes fast. A discussion appears about having fun and going fast. The children find out that those are of different importance depending on when and where you are going. Arguments used among the children:

- When in hurry it is more important that it goes fast. It is of importance that it goes fast when going to: the school, the leisure time activity or to the store just before it closes.
- It is important that it goes fast when going to an activity.
- It is unimportant that it goes fast when going home because then there is no hurry.
- If having a dinner time to pass, it is also important that it goes fast when biking home.
- It is unimportant that it goes fast when biking home from school and being supposed to do the home work. Then it can be worth biking detours just for fun.

Exercise gets ranked second. The only noted motivation for this is that everything is important, except for having a cool bike. One child question whether the traffic safety always should be on the top and say that sometimes it could be of more importance that it goes fast to reach the target point. But another child answer that when you have died the rest does not matter.

When asked to rank the options as their parents would have done both child groups place “having fun” higher and “reach the target point fast” lower. Motivations according to group 2 the leads up to their result:

- A safe traffic environment is important according to the parents.
- Having fun is more important than reaching the destination fast according to their parents.
- Having a beautiful bike and having fun while biking is approximately the same level of importance according to parents.
- The parents start to worry when biking fast.
- The family use to bike slowly. For instance, one girl tells that she is the fastest biker in the family and especially when her younger sister is joining the trip, she reaches the destination long before the rest of the family.

The ranking done by the children could be seen in table 7 on next page. The children have been ranking the cards from 1 to 5.

Table 7. The ranking of safety according to the children.

Factor to measure	The texts given to children and parents	Rank child group 1	Rank child group 2	**Total rank children**	Rank child group 1 according to their parents	Rank child group 2 according to their parents	**Total rank children according to their parents**
Traffic safety	That the traffic environment is safe	1	1	**1**	1	1	**1**
Exercise	That I move and get exercise	2.5	2	**2**	2	2	**2**
Directness	That it goes fast to reach the target point	2.5	3	**3**	4	5	**4.5**
Fun	That I have fun	4	4	**4**	3	3	**3**
Status	That I have a cool bike	5	5	**5**	5	4	**4.5**

The parents were asked individually in the questionnaire to rank the same options from 1 (most important) to 5 (most unimportant). And the answers on the left side in table 8 were given. Since almost half of the parents have answered that they find “having a cool bike” more important than that “the traffic environment is safe”, which seems very unlikely, it is assumed that they missed the note that they should rank the most important 1 and have turned the scale upside down (see results marked in red in table 8). Therefore, the results from the parents that have answered that “having a cool bike” is the most important or “that the traffic environment is safe” is the least important, have been reranked in the different order and marked in green on the right side of table 8.

Table 8. Parent's result on the importance of safety question. Original results to the left and reranked results to the right.

	Fun	Directness	Safety	Status	Exercise		Fun	Directness	Safety	Status	Exercise
	4	2	1	5	3		4	2	1	5	3
	4	3	1	5	2		4	3	1	5	2
	2	4	5	1	3		4	2	1	5	3
	4	3	2	5	1		4	3	2	5	1
	2	4	5	1	3		4	2	1	5	3
	4	2	1	5	3		4	2	1	5	3
	3	1	5	2	4		2	5	1	3	4
	2	3	5	1	4		4	3	1	5	2
	2	3	5	1	4		4	3	1	5	2
	4	2	1	5	3		4	2	1	5	3
	4	3	1	5	2		4	3	1	5	2
	3	4	1	5	2		3	4	1	5	2
	3	4	1	5	2		3	4	1	5	2
	1	2	5	3	4		5	4	1	3	2
	4	2	1	5	3		4	2	1	5	3
	2	3	5	1	4		4	3	1	5	2
	4	3	1	5	2		4	3	1	5	2
	1	3	5	2	4		5	3	1	4	2
	2	4	1	5	3		2	4	1	5	3
	5	3	1	4	2		5	3	1	4	2
	3	2	4	1	5		3	4	2	5	1
	4	3	1	5	2		4	3	1	5	2
	2	3	5	1	4		4	3	1	5	2
	4	3	1	5	2		4	3	1	5	2
	4	3	1	5	2		4	3	1	5	2
	2	3	5	1	4		4	3	1	5	2
	2	4	5	1	3		4	2	1	5	3
	1	4	3	5	2		1	4	3	5	2
Average	2,93	2,96	2,79	3,39	2,93	Average	3,75	3,04	1,14	4,79	2,29

The final parents rank and the total rank when considering both the parents' opinions and the children's own opinions can be seen in table 6 below.

Table 9. The ranking of safety according to the parents and total rank when combining children's and parent's answers.

Factor to measure	The texts given to children and parents	Total rank parents	**Total rank parents and children together**
Traffic safety	The traffic environment is safe	1	**1**
Exercise	That the child moves and get exercise	2	**2**
Directness	That it goes fast to reach the target point	3	**3**
Fun	That the child has fun	4	**4**
Status	Having a cool bike	5	**5**

The parents were also told to mention if there were anything more, they considered important when their children were biking. The factors that was mentioned of more than one parent was:

- Having a helmet
- Caring about the climate
- Having lights on the bike

4.3.3 Traffic environment

For this chapter the children got to place out the cards showing different road types (see cards in appendix B.1) and different crossings & intersections (see cards in appendix B.2) on a line and were supposed to sort them after how they ranked them from 1=best place for biking to 10/11=worst place for biking. The cards were given out one by one in a randomized order to different children and the child who got the card were supposed to place out that card with help from its class mates. First the road cards were ranked and then the process was repeated with the crossing & intersection cards. The cards with photos have been placed in the appendix to make it possible for the reader to see them beside each other and compare the cards but can with benefit get teared out and watched while reading the following results.

4.3.3.1 Road types (Children)

Table 10. Ranking of different road types according to the interviewed 5th graders, where 1 is the best road to bike on.

Road type	Card number	Rank group 1	Rank group 2	Total rank
Pedestrian zone	A	10	8	9
Mixed greenway	B	3	4	3.5
Separated greenway	C	2	2	2
Separated greenway with one-directional cycle line	D	1	1	1
Mixed cycle-pedestrian track	E	5	5	5
Separated cycle-pedestrian track	F	4	3	3.5
Cycle lane	G	7	9	8
Residential street	H	6	6	6
Country road	J	8.5	7	7
City street with many cars	K	11	11	11
Cycle track suddenly ended by construction work	L	8.5	10	10

The mean value of the two group ranks have been calculated and then a total rank based on the mean value have been calculated which is shown to the right in the table above. The total rank is not a mean value but a rank from 1 to 11 just as the group ranks are. In the following text the cards are sorted after the total rank they were given, with the arguments that the children used when ranking them as bulleted.

The separated greenway with one-directional cycle lane (D) get the highest score according to both child groups. One child argue that it is the best road since you do not even risk to crash with other bikers and one child in the other group mention that it is super great that the road is split in different directions. Children in both groups agree on:

- It is good that the bicycle road is split in different directions

On 2nd place comes the separated greenway (C) and children in both groups thought it was a good road to bike on because of the absence of cars. One argument used:

- It's a bicycle road, no car road and that feels safe

One child recognized the road and commented that it has biked on that road and it is good. One child is critical and comment that walkers often walk over the bicycle road showed on this card.

On 3rd place comes the mixed greenway (B). The children commented that it is a road shared between bikers and walkers, but not for cars. One child commented on that the road is pretty wide and another that it is pretty empty.

The separated cycle-pedestrian track (F) comes on shared 3rd place. Group 1 first place the card higher than the mixed greenway with the argument that it is good that they split, but later change by placing the mixed greenway higher. Group 1 discuss whether this or the mixed cycle-pedestrian track (E) is the best and conclude:

- This is the best because it is safer than card E

In group 2 one child shows and describes that there are no walkers or animals on the bicycle road. It was interpreted by the interviewer that she thought of that bikers have their own lane separated from walkers and walkers with dogs. The argument used by one child in group 2 before placing out the card was that:

- There is a walking space, which is good

On 5ht place comes the mixed cycle-pedestrian track (E). The children in group 2 discus that it is a road for both bikers and walkers. Children in both groups mention that:

- There are cars on this card, which makes it worse than the other bicycle roads.

One child in group 1 adds that you will notice if you start to bike on the car road and therefore it is good that they are separated.

On 6th place comes the residential street (H). Some of the children in group 2 are at first unsure were to bike, but there are some child telling the others that you bike on the road. One child tells that the path walk is small therefore you bike on the road. Children in group 2 also discuss that it is between the houses, which is good, and it is good that the cars drive slowly. In group 1 it was mentioned that there is only little traffic. In group 1 this card at first gets a worse rank, after the cycle lane (G), but are later moved forward with an argument also used by a child in the other group:

- There are almost no cars

On 7th place comes the country road (J).

In group 2 the children notice that it is a country road and argument that there are not so much traffic and it is seldom there are cars, while one child comment it is a pretty big road. In group 1 this card at first gets a lower rank with the motivation country roads are bad to bike on, while one child says that there are only a few cars which makes it okay. Children in both groups agree on that:

- There are not so many cars
- It is a big or bad road to bike on

Later there is a hot-heated discussion in group 1 between two children about whether this road (card J) or the cycle track suddenly ended by construction work (L) is the worst road, which needs to be stopped by telling the children that they both could be right because they see different perspectives and the interviewer decide they get the same rank.

On 8th place comes the cycle lane (G). It is noticeable that this is one of few road cards that the groups place pretty differently, since it gets ranked 7 by group 1 and 9 by group 2. In group 1 the children find out that it is a bicycle road with a car road next to it and notice that there is only a line

between the car road and the bicycle road. In group 2 the children discuss the intersection in front of the road, which is likely to have affected that they give it a lower rank. It is mentioned by one child that it is a small bicycle road and another child adds that it is in car environment, which makes it dangerous.

On 9th place comes the pedestrian zone (A). This card also gets different ranks between the different groups. It was ranked 8 by group 2 and 10 by group 1. In group 1 many of the children agree on the following statement:

- This is worse than all other roads where there is a bicycle road

The interviewer has interpreted it as that the word bicycle road= road made only for unprotected road users in this context. One child in group 1 dispute and claims that you can jump of the bike and walk here and that makes it safer. Group 2 discuss that this is in the middle of the city, this one is worse than the residential street (H) because here is a lot of traffic and that it is easy to drive in to people here since you can drive in to people that moves slowly. One child in group 2 argues that the country road has no traffic, and this is in the city, but the country road (J) is safer because it has no traffic.

On 10th place comes the cycle track suddenly ended by construction work (L). Both groups notice that. The cycling infrastructure ends further on, but that there is a zebra crossing where you can cross the car road. Children in both groups also comment that:

- You must jump of the bike and walk over the zebra crossing.

The card gets a better rank in group 1. The argument it is bad to bike here is used, but not all in the group agree to the same extent (See comment under country road). One child in group 2 notice that the cycle lane (G) has no zebra crossing, but that this one has. Though in the end the group decide to give the suddenly ended cycle track a lower rank.

The city street with many cars (K) gets the worst ranking. Both groups start with commenting that:

- This is the worst

In group 1 one child tells that it is because there are many cars on the picture and group 2 arguments that there are cars and people everywhere. There are no walkers visible in the picture though. In group 2 one child asks the interviewer whether it is okay or not to bike on the path walk here but after the interviewer asked, “Where would you bike?” one other child say that it is not allowed, you must bike with the cars.

4.3.3.2 Crossings & Intersections (Children)

Unlucky some data disappeared and the ranking for group 1 is later reconstructed based on the notes that were made during the interview. The rankings in parentheses are unsure based on the notes made during the interview and were placed out based on the interviewer's memory.

Table 11. Ranking of different crossings & intersections according to the interviewed 5th graders, where 1 is the best road to bike on.

Crossings & Intersections	Card number	Rank group 1	Rank group 2	Total rank
4-road greenway intersection	A	3	4	3.5
Greenway tunnel	B	1	2	2
Greenway bridge	C	(2)	1	1
Greenway crossing car road (with signals)	D	4	3	3.5
Greenway crossing car road (without signals)	E	5	6	5
Cycle lane crossing greenway	F	6	8	7.5
3-road intersection at residential street	G	(9)	9	9
Cycle track crossing car road retracted from car intersection (without signals)	H	(7)	7	7.5
Cycle track crossing car road retracted from car intersection (with signals)	J	8	5	6
Cycle lane leads in to roundabout	K	10	10	10

The mean value of the two group ranks have been calculated and then a total rank based on the mean value have been calculated which is shown to the right in the table above. The total rank is not a mean value but a rank from 1 to 10 just as the group ranks are. In the following text the cards are sorted after the total rank they were given, with the arguments that the children used when ranking them as bulleted.

The greenway bridge and the greenway tunnel get the highest rank according to the children in both groups. The main argument for describing the <u>greenway bridge (C):</u>

- It feels safe because and you can see what happens.

Other arguments used about the greenway bridge is that

- The fence makes it safe.
- The stair and the lamp make it safe.
- It is good that it is separated from the cars and that there is a fence.

The greenway tunnel (B) gets its rank according to group 1 with the argument that:

- It is really good that you don't need to cross the car road.

One boy is worried that it could be dangerous if a car falls of the road, but other children tells him that it never happens, and one child conclude that normally it is not that dangerous. Group 2 also place the tunnel card high, at first in the top, but after asked by the interviewer if there is nothing bad with tunnels, one girl comment that:

- The tunnel on the card is a good one because there you easily see, but they can be scary if they are dark and long.

The other children comment about tunnels in general. One child claims that if you have lights on the bike it is okay even if they are dark and long. Another child comment that it is divided between the different directions for bikers in the tunnel. Many children agree on that it is problematic that people walk on the cycle track in the tunnel, arguments that was used:

- Sometimes you have to stop dead in the tunnel because people walk on the cycle track.
- If people just do as they should a tunnel works well.

The worries seem to have a specific reason. One boy tells that once when he was biking with some friends he was going to bike under a tunnel, but because of people walking on the cycle track in the tunnel he had to dead stop on the way down, used the hand brake, felled of his bike with the head first and ended up at the hospital with a concussion and now he is sceptical to tunnels. However, all children did not worry for tunnels, one girl ads:

- I bike under tunnels every day and that works well.

The children also discuss that the view after the tunnel can be bad. One girl tells that there is a tunnel where she bikes daily to the school and just after the tunnel there is a crossing bicycle road:

- The bikers can pass really fast after the tunnel and it is impossible to see them.

When comparing the bridge and the tunnel one of the groups' first places the bridge lower than the tunnel with the argument that the walkers and the bikers share the space here, but later change it when a girl adds that the bridge is better because you do not have to ride downwards. In group 2 one child concludes that the bridge is better than the tunnel because you see what happens.

On shared 3rd place comes the greenway crossing car road (with signals) and the 4-road greenway intersection. One argument used for the 4-road greenway intersection (A) is that:

- It is good that there are no cars, but it is a bit dangerous anyway.

One child comment that there are lamps, while another child answer you need to have lamps on the bike, so it doesn't matter if there are lamps or not. In the other group the main argument used are:

- You can crash with other bikers, you think it will go well, but sometimes they turn up

However, one child comment that this still is a good place since it is worse to crash with a car than with a bike. One boy says that he once fell of the bike in an intersection who look like this one but does not seem worried. One girl says that her school road is pretty straight, but there is one intersection where you can't see because of the trees which makes it unsafe to cross.

On shared 3rd place also comes the greenway crossing car road (with signals) (D). Both groups notice that it is a zebra crossing with lamps. Children in both groups use the argument:

- Card D must be safer than card E because of the traffic light

In group 2 the discussion continues. One argument used is that:

- There are a lot of bikers and walkers on card D, there is probably much more traffic than on card E

The used argument points out the high number of walkers and bikers and conclude that there must be much traffic. The cars do not seem to worry all the children to the same amount as the bikers and the walkers. One argument used is that:

- Well but car drivers are looking on unprotected road users that stand beside the road

One child argues that the lights are in front of the car and that there is not so much time to see the bikers beside the car, which make it dangerous. The argument for ranking card D higher than card A in group 2 is that one child uses the argument that it is worse to crash with a car than with a bike.

On 5th place comes the card Greenway crossing car road (without signals) (E). Here the different groups use different arguments. Both groups find out that this is a zebra crossing. Group 1 place out the card quit fast with the argument that this is pretty okay. One child in group 2 arguments that:

- It looks to be a pretty big road, you do not really know how to bike here

Other children argue that this is bad, it is unclear and that if you have a bike here it gets problematic. Those arguments were pointed out after one child commented that you do not really know how to bike here. Therefore, it is likely that the groups have interpreted the card differently. While group 1 are likely to see it as a crossing and only have analysed the option of biking straight over, group 2 are likely to have seen it as an intersection and analysed the possibilities to bike in another direction. The girl in group 2 that first mention that you do not really know how to bike here is the same girl as later on card F mention that it is complicated if you are going to turn here, which makes it more likely that at least she analysed that perspective on this card as well.

On 6th place comes the card cycle track crossing car road retracted from car intersection (with signals) (J). This card gets a much better rank by group 2 than group 1.

Group 1 figure out that this is a zebra crossing with a traffic light. The children argument that:

- There are cars from many directions, which makes it more unsafe than if there would only be cars from one direction.

Group 2 use the arguments that this is just a car road, nothing else, you are supposed to drive straight over and that if you see there is red you do not bike and that makes it safe. However, one child in group 2 commented on one thing that was not supposed to be considered and could have affected the groups result:

- It is close to help, this is just beside the hospital

On 7th place comes the card cycle lane crossing greenway (F). Group 1 rank this card higher than group 2. Group 1 argues that it is the amount of traffic that gives this rank:

- Less traffic than at these cards, but more traffic than at those cards.

Just as on card (E) group 2 takes into consideration the risks about doing a turn in the crossing:

- This is not so good, it looks like there are many cars here. If you are going to turn over the road here it gets hard
- You must do a heavy turn here and that is dangerous

On shared 7th place comes the cycle track crossing car road retracted from car intersection (without signals) (H), which gets the same rank by both groups.

There are both negative and positive arguments used though. The positives are that here are lights and that it is good that there is distance between the car road and the bicycle road. The negative arguments are that it is dangerous with cars crossings and that it looks pretty busy.

One child is critical to the other's arguments though and argues that this crossing is better than the intersection in card E, with the argument that here come the cars from left and right. It was the same child that firstly mentioned the problematic in turning as a biker in some of the showed cards,

wherefore it is likely that the child argued that this card was better because here is not the problematic in turning and watch out for the cars at the same time.

On 9th place comes the 3-road intersection at residential street (G). Both groups rank this card the same.

In group 1 the arguments used are that the cars can drive out from the road from the right and that you drive on the car road close to the path walk. Some children also discuss that they are unsure when biking with the cars. In group 2 one child uses the following argument:

- Here you can crash with both bikers and cars and that is dangerous.

The cycle lane leads in to roundabout (K) gets the worst rank by both groups of children. The car actually showed a roundabout that you are supposed to bike in but children in both groups argued as if it was a roundabout you are not allowed to bike in, which is the most common type in Sweden. One child mention that roundabouts means many zebra crossings where you need to pass the road and one other tell that you should not drive in to a roundabout with your bike. The main argument in group 1 that many children agreed on was:

- Roundabouts are bad compared to traffic lights

In both groups arguments was used that described that the things they did not like with roundabouts was the cars:

- It is unpleasant when there is a lot of cars all the time
- It is complicated to notice where all the cars are in roundabouts

4.3.3.3 School trips (Parents)

The parents were able to grade their answer from 1 to 4 on the different statements were 1 means agree totally and 4 means disagree totally. There were three parents who answered that they do not know on the last question and their answers have been ignored when calculating the average.

Statement: My child's possibilities to bike to school are good since…

Table 12. The parent's grade on suggested statements about their child's school trip.

Factor to measure	End of statement	Grade
Obstructions	*…my child does not need to jump of the bike because of obstructions along the road.*	1.4
Crossings	*…crossings with other traffic is possible to pass in a safe way.*	1.6
Visibility	*…my child has the possibility to discover hazards since the visibility is good.*	1.7
Space	*…it isn't narrow and there is plenty of space for my child to bike.*	1.7
Maintenance	*…the standard of the roads is good and there are no potholes.*	1.8
Winter maintenance	*…the whole distance is de-iced and dashed at winter time.*	2.7

Most of the parents agreed that there were no obstructions for the children when they bike to school. The crossings, visibility, space and maintenance were in general considered good or at least okay. The winter maintenance was considered less good among most of the parents.

4.3.3.4 *Free time trips (Parents)*

This question was answered as an open text answer and only the general opinions will be concluded. It was obligatory to answer, which means that all 28 parents have at least answered something. But since it was an open question it cannot be said whether the parents who did not wrote the most common words agreed with them or not.

Question: How do you perceive the environment your child bikes in at the free time?

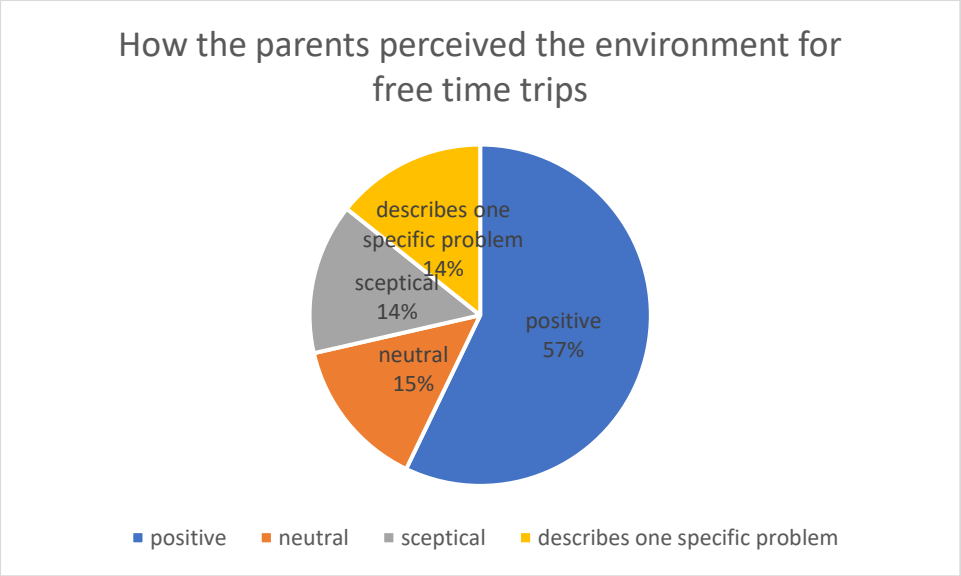


Figure 14. Parent's result on the question: How do you perceive the environment your child bikes in at the free time?

Among the parents that used positive words in general to describe the environment their children bike in on their free time 9 used the word good as one of their first words in their answers or described it as in general good, 3 of them described it as safe and 1 did not really answered the question but mentioned that the children have fun. 3 parents said it was the same as for the school trips and all of them answered positive on the school trips statements, with average between 1.3-1.5 when considering all the questions. The parents that used in general neutral words described it as suitable, safe enough, fairly good or quite safe. Among the parents that seemed a bit sceptical two of them described it as okay, but that it was problematic that there were not enough lights in the evening. Two of them commented car traffic as negatively, one wrote it was pretty okay but wished that no car crossings existed, and one only allowed the child to bike in car traffic together with an adult. Four of the parents participating only describes one specific problem wherefore it is hard to say whether they are positive or negative in general to their children's free time trips. Two of them described the traffic environment in the city centre as problematic. One described the unsafeness during the darkness as problematic and one describe it as problematic that there are many different kinds of bike vehicles on the bicycle roads in rush hour.

Many of the parents mention that there are mostly greenways in the area and that they find it good. But some parents also mention the car roads. There are different opinions though whether the cars drive slowly or fast: two parents mention that the cars drive slowly, one parent that all except of currier vans drive slowly and one parent mention that they drive fast especially on their own street. Even though some specific problems were noted it seems that there are no general problems with fast driving cars in their area. Fast and surprising unprotected road users seem to be a more common appearing problem for the biking children though: one parent mention average old men that bikes fast on the greenways, one parent mention walkers in the pedestrian zone in the city centre that surprisingly walks out in the cycle lane and one parent mention that it is problematic with many type of vehicles on the greenways, especially smaller children on balance bikes that surprise. The traffic environment in the city centre is described somehow problematic according to

four parents. Two parents describe the city environment as not so good or unsuitable for biking 11-year olds. Two other parents describe the traffic or the infrastructure as problematic: both the parent mentioning the walkers in the city centre and one parent that describes that the cycle track ends near the train station and after that there is no good cycling infrastructure for children going to the swimming hall.

4.3.4 External factors

4.3.4.1 Rules (Children)

In both group 1 and group 2 the children were asked about *rules* they had to follow when they bike. In both groups the child starts with mentioning different laws:

- stop by red light
- that it is good to show sign before turning
- that it is necessary to use helmet
- rules about lamps

In group 1 one child first tells that he thinks it is the police or the municipality that decide the rules, and in group 2 one child tells that a rule is very common before finding out that it is a law.

But both groups managed to find out that it is the parliament or Sweden that decide on those rules that are laws (they were helped that it was a law decided by the parliament if they find out it was Sweden).

Other laws that one of the groups mentioned are:

- stop by stop sign
- there are rules about that you are not allowed to drive other people on your bike based on the age (the children are a bit unsure about which ages the rule is applied to though)
- cars most not stop for bikers on zebra crossings except if there are a bike sign as well

No one mention that it is necessary to use bike bell and reflexes according to Swedish law.

First when the children are asked if there are other people deciding rules than the parliament, both groups mention:

- parents can decide rules

Other rules that one of the groups mentions are:

- Parents decide that helmet is needed.
- The school decide that the pupils need to use a specific road while going to the school's sport hall to be able to use a tunnel, instead of going the shortest road and pass over the bigger car road.
- The municipality decide rules at specific zebra crossings.

4.3.4.2 Weather conditions (Children & Parents)

Group 1 was asked about biking under the conditions: darkness, winter and rain.

- Darkness: Many of the children think it is okay to bike in darkness if they have lamps and reflexes, but some do not like to bike in darkness and avoid biking then.
- Winter: Some of the children bike sometimes in the winter. They mention that there is a risk to fall of the bike and it is importance to stay warm. Some children mention that they walk instead in the winter when it is snow and ice, because it is easy to fall of the bike then.
- Rain: Many of the children mention that it is important to use rain jacket. But except of that they claim not having any trouble about biking in rain.

The parents got to click in boxes whether they agreed to the statements or not considering the factors darkness, rain and winter, which was the same factors as the children discussed.

Statement: If it is darkness/winter/rain when my child is going to bike…

Table 13. Parents answers on statement. The numbers show how many parents out of 28 that agree on the statement.

	Darkness	Winter	Rain
…the child bikes alone anyway.	22	23	28
…I bike together with the child.	16	4	1
…I drive my child in the car.	8	12	10
…the child stays at home.	1	0	1
…my child doesn't want to bike.	3	1	4
…I do not allow my child to bike.	3	10	0

The parents also got possibility to comment their answers on the darkness, winter and rain questions. Some parents claimed that they used to bike with their children in darkness and the comments about the darkness were in general about company. There were also some comments about that the child only biked shorter distances in darkness:

> "Depending on time of the day I make her company."

Most children used to bike in the winter according to the parents, but to different extent. Many of the parents chose to comment to what limit their child use to bike in the winter:

> "If ice and snow lays in snowdrifts who hasn't been de-iced – namely, if there is a risk for sliding the daughter got driven in car."

> "Minus degrees with dry road are okay to bike. If slippery state of the road he has to walk. If snow it depends on the amount of snow."

There were not that many parents choosing to comment about the rain, but the ones who did mentioned to what extent it rained or how far the distance is.

> "Pouring rain when the daughter is going to her activities far away=got driven in car. Else she always bikes to the school despite rain."

The children and the parents sometimes agree and sometimes disagree about how they perceive it when the children bike under different weather conditions. Most of the children though it was okay to bike in the darkness, but some of them did not like to bike then and only a few parents agreed that their child did not want to bike in darkness. According to the children some of them used to bike in the winter, but according to the parents the most children did. Some children mentioned that they walk instead of bike in the winter and no one mentioned that they got driven. But over 40% of the parents claimed that they used to drive their children instead of letting them bike in the winter. When the children were asked, they did not seem to have any problem biking in rain if they had a jacket, but when the parents were asked rain was the weather condition that the children were most negatively to bike in. Even thought that all parents agreed that their child bikes when it rains and the most of them also when it is darkness or winter. It was most common to forbid the child biking in the winter, some also forbid them to bike in the darkness but none in the rain. In the darkness it was more common that the parents decided to bike with the child than to drive the child. But in rain and winter it was more common that the parent decided to drive the children, especially in the rain almost no parent chose to bike with their child. Almost no child stays at home because of weather conditions according to the parents.

4.3.4.3 Load (Children)

Group 2 was asked about bringing load on the bike. Following is conclusions they found out after discussion with each other:

- It is not a problem to carry two bags while biking. But what kind of bag you need to bring is of importance.
- If you have both basket and luggage carrier it is possible to carry quite a lot of bags. It is also possible to carry a backpack and bring carrier bags on the handlebars.
- If you are going to carry loads at all those places at the same time it is heavy to bike and with a lot of load it can be necessary, that the parents drive you.
- It is of importance to bring the load in the right way, in other case laces from the gym bag for instance can get stocked in the wheel which can be dangerous.
- Ungainly load, such as a duvet, is unsuited load to carry on the bike.
- Not all bikes have luggage carriers, but if you do not have any a friend can help you.

4.3.4.4 Bike helmet (Children)

Both groups were asked if they used a bike helmet. In group 1 some children confess that they do not always use helmet. In group 2 everyone says yes at first, but afterwards some of them tell about situations where they did not use a bike helmet:

- One child says that he always uses helmet, after he crashed with his bike and got a concussion.
- One child claims that when she leaves the home, she always has a helmet. But sometimes she forgets the helmet when she is at a friend's house, and then she uses to bike back to get it.
- One girl tells that if it is really cold and she use her hat with a ball on, she rather bikes without helmet than without hat and get a cold.
- One boy tells that he once forgot the helmet in the summer because he used a hat and did not noticed until he was in school and a teacher asked him where his helmet was. He claims that it both feels the same on the head and looks the same from the eyes, no matter if you wear a helmet or a hat. One other boy tells that he was close to do the same mistake once, but that his dad noticed and stopped him before he started to bike.

The most children agree in that their parents tell them to wear a helmet and two of the children also comment on the consequences if they do not:

- If I don't wear a helmet, my parents become angry.
- I must wear a helmet, or my parents will take away the bike.

4.3.4.5 Distance (Parents)

When asked how far away from the home the parents are okay with that their child bike on their own the answers differ a lot. The shortest distance a parent was okay with was only 500m and the longest was 8km. The most common answer was 5km even though most parents were not okay with that children biked that far.

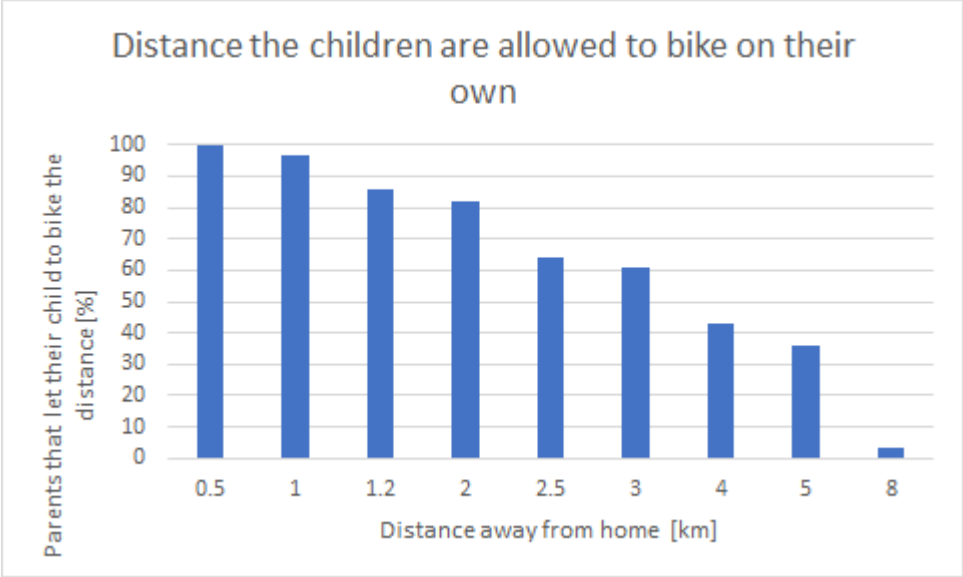


Figure 15. Parents' result about which distance they are okay with letting their child bike on their own.

The parents also had the possibility to comment their answers. 8 of the parents chose to comment and they all somehow commented that it depended on where. Depending on how far away the parents let their child bike on their own they are reasoning different.

What the parents are commenting compared to the distance they are okay with:

- 1km: absolute maximum or only if the exact route choice is decided before.
- 2km: depends on where, how the road looks, traffic, time on day etc., maybe longer if biking with others.
- 2,5km-5km: all three commented that if it is a specific location and the child know where to bike. All three comments also included either that it must be a safe road or that it must be a road especially for bikers.

4.3.4.6 Needed improvements (Parents)

As a final question the parents was asked what would be needed to make their child bike more. The parents were asked it as an open text question that was obligatory to answer. The answers were divided in three different groups.

Question: What would be needed to make your child bike more?

8/28 parents claimed that their child already bikes much.
7/28 parents claimed that they do not know or nothing.
13/28 parents claimed that there was some improvement that needed to be done.

Most of the parents claimed that their child already bikes much or that there do not need to be any improvement. Improvements that was mentioned among more than one parent were:

- better cycling infrastructure in the city centre
- even better safety in general
- better winter maintenance
- better lights along the roads

4.3.4.6.1 Winter maintenance

The winter maintenance was deeper studied after the interview, because it was the area whit most complaints. On Lund municipality (2019) web page it is possible to see how the city prioritize cleaning roads from snow. The main car roads around the district around the school have priority 1 (the highest priority), while the car road leading to the school have priority 2 and other car roads in the dwellings around have priority 3 (Lund municipality 2019). The cycling infrastructure in the area have priority 2 or 3 (Lund municipality 2019). The roads north, east and west around the school have only priority 3 though (Lund municipality 2019). There is one bicycle road south of the school that have priority 1, that leads to the city centre (Lund municipality 2019). Since it is a public school most of the children studying there are likely living in the area and therefore not biking on the bicycle road leading to the city centre. Most of the children must therefore go on a priority 3 bicycle road to be able to bike to the school, while there are a priority 2 car road leading all the way to the school. The car driving infrastructure in the area around the school have accordingly a higher priority than the cycling infrastructure around the school for the winter maintenance.

The Technical Services Department at Lund municipality have been mailed questions the first time at 18th of December about the child perspective in the winter maintenance. Isak Skåre (Mail 2020-01-10) answers that he has developed the winter maintenance maps this and last winter season. He claims that on municipality level the car and bicycle roads have the same priority. When asked about whether and how the child perspective have been considered when the prioritizations have been done Skåre answer that the school roads have been considered when the Traffic and Mobility Unit provided documents for the maps. But he writes that he cannot tell to what grade the school roads were prioritized and if all schools were considered or not though. Skåre cannot answer why the car road has a higher prioritization than the bike roads to an elementary school but wants to know which school that was considered in the question because then he maybe can guess. Skåre describe that a priority 3 road is only de-iced between 7.00-16.00 on weekdays and therefore it is unlikely that the roads are de-iced before the schools start if it has been snowing during the night or in the morning. But the changes are big that the priority 1 and 2 roads have been de-iced at that time according to Skåre. He claims that the Traffic and Mobility Unit has since a while started to become more interested in how the Convention of the Rights of the Child affects their work and the Technical Services Department as a whole. Skåre's mail is answered and he answer with a reference to a college at the same day as the hand in of the essay on 17th of January wherefore there is no time for investigating the issue further.

5 Case study

The case study is done as a complement to the interviews to investigate the environment near the school area where the children are likely to bike. The area is both observed from the bird's eye view on a map and from the street view in the field. In the field it is also possible to study behaviours. It is observed how high percentage of the children that use helmet on their way to the school and eventual incidents occurred during the field work are noted. Some areas that the parents or children have described as problematic or extra good are investigated.

5.1 The area of the school

Fäladsskolan is a school situated in an area build in the 1960's and 1970's (Fastighetsbyrån n.d.) The after a planning tool named SCAFT, which was publicized by the Swedish state in 1968 (Hagson 2004, p. 3). In SCAFT the streets are planned after the following three goals (Hagson 2004, pp. 32-33):

- *Separating* - bikers and walkers are separated from the motorized traffic
- *Differencing* - the streets are differenced based on a scale from high speed way through traffic, down to low speed local traffic
- *Localizing* - the high-speed roads is led outside of the school and dwelling areas and not in the middle of them

The differencing and separating makes SCAFT good for cars to drive fast. It deprioritizes unprotected road users from the main roads, which makes it worse for biking as a transport mode in general to get from point A to B on the shortest road. But because of the localizing SCAFT-areas use to have an expanded road net for unprotected road users in dwelling and school areas, which is good for smaller children that are not used to bike in complicated traffic environments yet. As SCAFT-areas in general, Fäladsskolan also has many dwellings in the nearby area, where the children living can go to the school without having to pass the bigger roads (see figure 16 below). The children living on the other side of the major car roads still needs to cross the bigger roads though, either in tunnels or in crossings. In the crossings both motorized vehicles and unprotected road users are not that prepared for each other, since they are used to be separated.

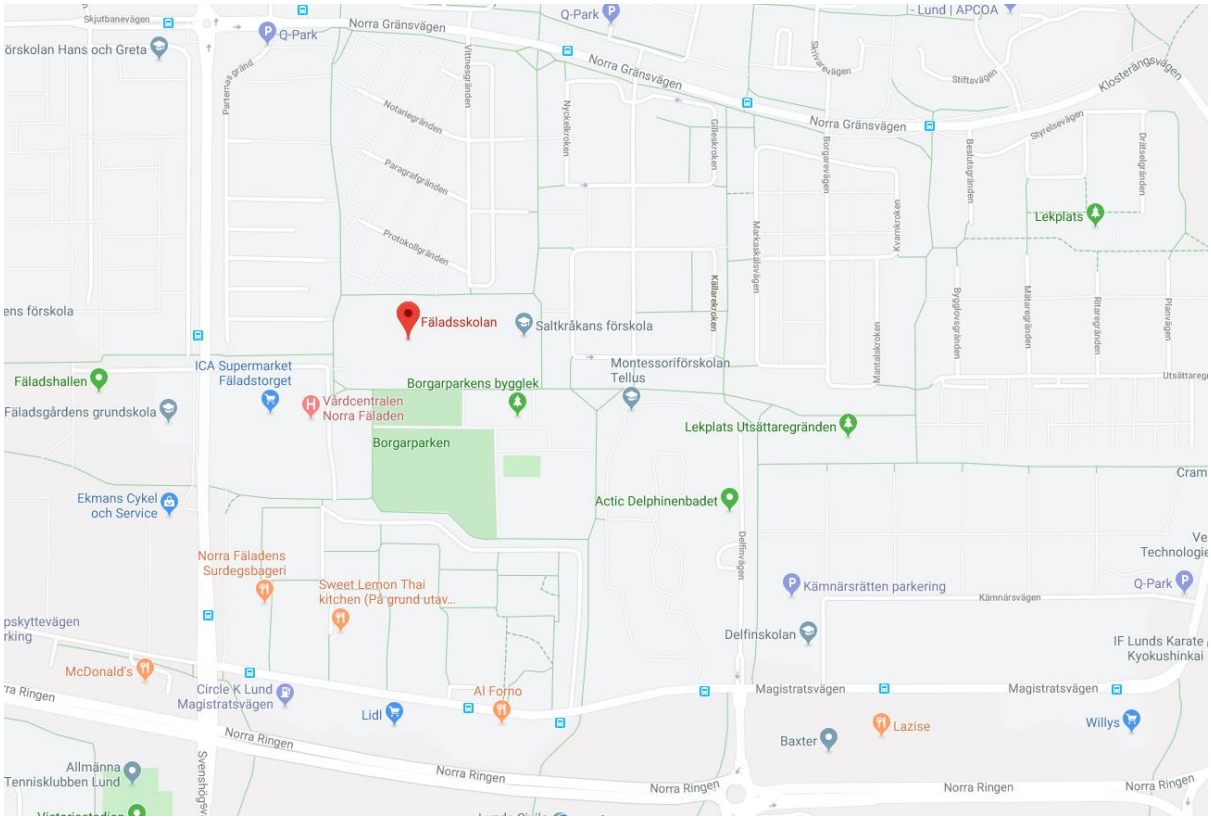


Figure 16. Map over the area close to Fäladsskolan, with the school marked with a red nail. Google Maps (2019-10-14).

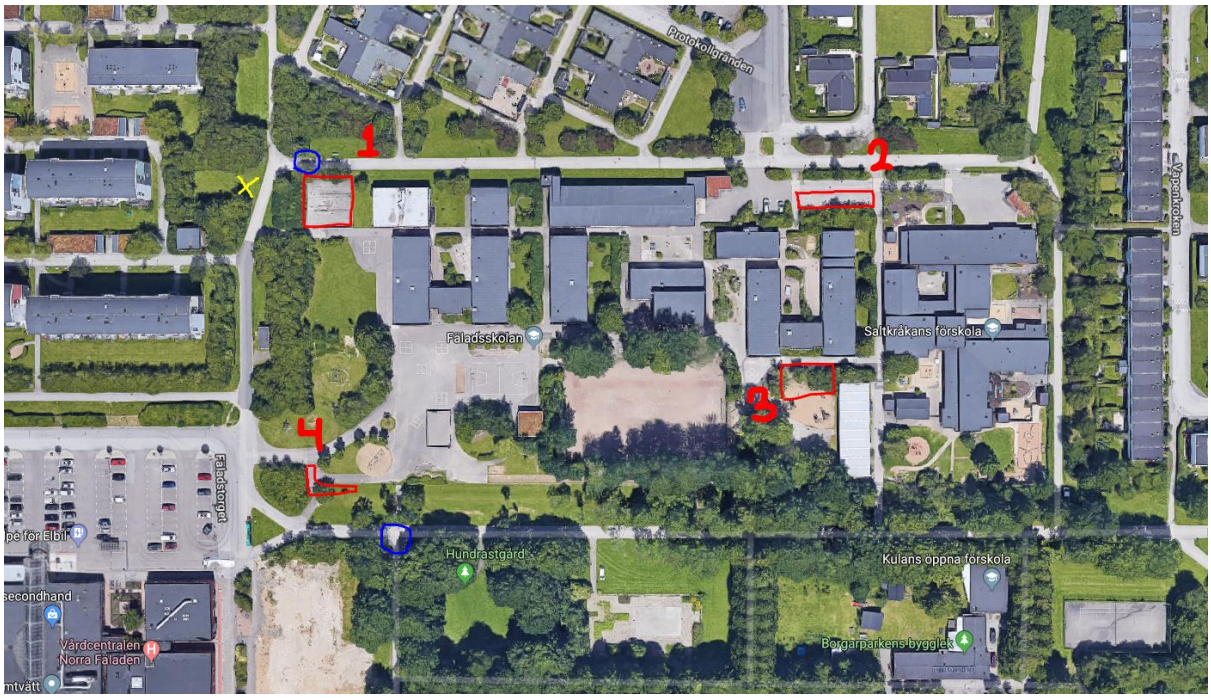


Figure 17. Satellite map over school showing bike parking lots 1-4. Locations for observed incidents are marked with blue circles. Observation place for helmet rates is marked with a yellow cross. Google Maps (2019-11-22). (Red, blue and yellow markings are self-made).

5.1.1 SCAFT differs from modern school areas

In the 1960's and 1970's when the area around Fäladsskolan was built, spatial room for children in the city were high prioritized among Swedish politicians, for instance with standards for playgrounds and possibilities to reach them from the homes (Niska et al. 2017, p. 22). Today children have a lower prioritizing in the city planning. For instance, new schools are established at locations that are far away from the children's home (Niska et al. 2017, pp. 50-51).

New private schools in Sweden are established in old buildings where the infrastructure around are not fitted for children to travel on their own according to Niska (et al. 2017, pp. 50-51). The same trend can be seen among new established schools in Germany. According to Wulfhorst (Lecture 2018) the reasons behind this are that the noise levels from schools are too high to be accepted among potential house buyers in new dwelling areas and parents prefer schools in driving friendly areas since they have to drive to work anyway. In Sweden there have been a trend of many new established private schools in the latest years (Heimersson 2018), while Germany has a long tradition of private schools (Heimsoeth 2018). The trend with new established schools in the outer edges of the city at locations far away from the children's home is therefore a modern phenomenon that are not only to be seen in Sweden or cannot only be seen in a country with many new established private schools. Whether the reasons behind the phenomena in Sweden is the same as Wulfhorst describes or there are other reasons would need more investigations to be able to tell.

5.1.2 Bike parking lots

The school have 3 different bike parking lots which are marked in figure 17 above. Bike parking lot 1 is the biggest and was therefore chosen for the observations. Bike parking lot 2 is placed close to a preschool, wherefore it is likely that the bike racks are used by the preschool as well. Both bike parking lot 1 and 2 are built a while ago. In bike parking lot 1 there are settlements in the middle were a big puddle have appaired and therefore all bike racks are not useable. Bike parking lot 3 is placed outside of the pavilion buildings. It only has moveable bike racks and has an occupancy rate on approximately 200%. Bike parking lot 4 does not have any racks, but there are bikes parked there.

Figure 18. Bike parking lot 1. (2019-11-19).

Figure 19. Puddle in the middle of bike parking lot 1 reducing the number of useable bike racks. (2019-11-19).

Figure 20. Bike parking lot 2. (2019-11-19).

Figure 21. Bike parking lot 3. The racks are filled, and many bikes are parked outside of the racks. (2019-11-19).

Figure 22. Bike parking lot 4. (2019-11-19).

5.1.3 Streetviews

The are around the school has a lot of greenways that make a great road net for biking children in the area (See figure 23 and 24). When crossing the bigger car roads around the school area it is sometimes possible to use a tunnel and sometimes possible to use a zebra crossing over the road. Example of a tunnel and zebra crossing in the area are shown in figure 34 and figure 35.

Figure 23. Example of greenway in the area near the school surrounded by trees. (2019-11-19).

Figure 24. Example of greenway in the area near the school near a dwelling area. (2019-11-19).

5.2 Helmet rate

When the children were interviewed the most children claimed that they always used helmet except from a few exceptions. Actual bike helmet rate was calculated by standing outside of the school's biggest bike parking lot in the morning and observing whether the bikers that had the parking lot as their destination did use helmet or not. The principal told that the most classes start at 8.15 in the morning, but that some classes could start later, wherefore the study was chosen to be done from 7.45-8.45 in the morning. The school have pupils from 4th to 6th grade, wherefore all of those are likely to have been observed. Bikers arriving to the parking lot that did not look like pupils from 4th to 6th grade have been calculated separately.

5.2.1 Result of helmet observations

Table 14. Numbers of children using helmet or not that are arriving to parking lot 1.

Time (5-min interval)	Children using helmet	Children not using helmet
7.45-7.49	2	2
7.50-7.54	1	0
7.55-7.59	15	0
8.00-8.04	9	0
8.05-8.09	8	0
8.10-8.14	8	0
8.15-8.19	4	0
8.20-8.24	5	0
8.25-8.29	8	0
8.30-8.34	6	0
8.35-8.39	9	1
8.40-8.44	7	0
Total	82	3
Bike helmet rate children	**96%**	**4%**

The observations were done on 19th of November. The sun raised at 7.53 this day, which means that it was under horizon when the observations began, but that it raised during the observation time. Some children used lamps, but the most did not. Even though the sun was still under horizon when the observation started it was close to rise and therefore it was not completely dark.

At 7.45 there were 2 bikes in the parking lot and at 8.45 there were 91 bikes in the parking lot. Two bikers were noticed to leave the parking lot during the observation time, which means that two bikers in total have been missed while observing bikers arriving to the parking lot.

5.2.2 Analyse of bike helmet rate

As seen in figure 11 the national helmet rate for 6-12 years old biking to the school have been somewhere between 80% and 90% in the years 2011-2017 (except from 2016 when the value was lower). The observed bike helmet rate at Fäladsskolan was 96%, which is remarkable high, still there

was three children on their way to the parking lot that did not used a helmet. Out of the three biking children that did not have any helmet on the head no one of them had a visible helmet whit them, such as on the handlebars for instance. If that would be the case it maybe would not be effective enough if the parents just check that the children have the helmet with them. But since all children that got a helmet with them wear it on the head, the probably most effective solution to rise the helmet rate among 11-year olds biking to the school is that the parents check that the children have a helmet when they leave the home in the morning. It is unknown whether the children that biked without helmet had a parent at home when they left in the morning though.

However, the bike helmet rate is already high among children that are biking to the school at Fäladsskolan. It would be of interest to see whether the children use bike helmet to the same extent for other bike trips than from their home to the school, since then it is less likely that there is a parent that can remind them of using helmet. In the interview there was one girl that said that she more often forgot her helmet on her way home from friends than when she leaves the house (see chapter 4.3.4.4), which point on that there could be a difference. Such a study would be more complicated to do though, since it would require more time to be able to observe the same number of bikers and it is more complicated to categorize after age groups on a road or destination were there most likely are many different age groups that use to bike. One bike helmet use study made by the *Swedish Transport Administration* (Lindholm 2018) have been found that have studied bike helmet rates for different groups for a longer time. Based on data from that study there are no bigger difference in helm use for adults if they are biking to work places or on greenways (table 15 below). No study has been found with data about bike helmet rates for children in the school-age on their spare time.

Table 15. National average of percentage of adults using bike helmet, measured near work places and on greenways (Self-made table based on data from Lindholm 2018, p. 9).

	Bike helmet rates adults 2017 (Work places) [%]	**Bike helmet rates adults 2017 (Greenways) [%]**
2006	18.3	20.6
2007	22	20.8
2008	20.5	23.1
2009	23	20
2010	22	21.1
2011	24.4	25.7
2012	24.4	29.9
2013	29.1	30.5
2014	28.9	31.2
2015	31	32
2016	31.4	27,5
2017	37.4	39
Average	**26.0%**	**26.8%**

Except from children that looked to be in the age from 4th to 6th grade there was 4 adults arriving to the school's parking lot during the observation. None of them arrived together with a child, but one

left again 5 minutes later wherefore it is assumed that three of them were teachers and one was likely a parent leaving something forgotten. One of them wore a helmet and three of them did not. It is noticeable that the helmet rate among adults arriving to Fäladsskolan were not higher than the national average (compare with table 15) even though the bike helmet among children were, but there are way too few observations of adults arriving to the school to be able to draw any conclusions from it.

Since it was only 6°C outside when the study was made and there was one girl in the interview mentioning that it could be problematic to wear a winter hat and helmet at the same time it was noted if the children wore any hat. It was common that the children used a hood or a thinner wind hat, even if not all did it. But many children combined hat and helmet. It could maybe be an issue when it gets colder and the thicker winter hats are used, but it did not seem to be a problem combining helmet and cap when it was 6°C outside.

It is likely that the two missed observations came from the school yard (direction 4 in figure 25), since it was not just one road but had a wide span and was harder to detect from the observation place, especially if there were bikers arriving from other directions at the same time. Some of the children approaching from the school yard were walking with their bike beside them. If they would have walked in with the helmet on the handlebar it would not be able to estimate whether they had their helm on their head when they were biking or not, but all of them had a helmet still on the head, wherefore they were noted as children using helmet.

One thing that was noted during the interview was that in the school's cloakroom the children did not only have personal hooks and shoe rack, but also a shelf where it was possible to put the bike helmet. This both makes it easier to bring the helmet because there is a special place for it in the school and it also makes the helmet more visible both for the class mates and teachers to note if a child would skip the helmet one day.

5.3 Approaching directions

Here follows a map over names of directions and entrances that would be used in the following text.

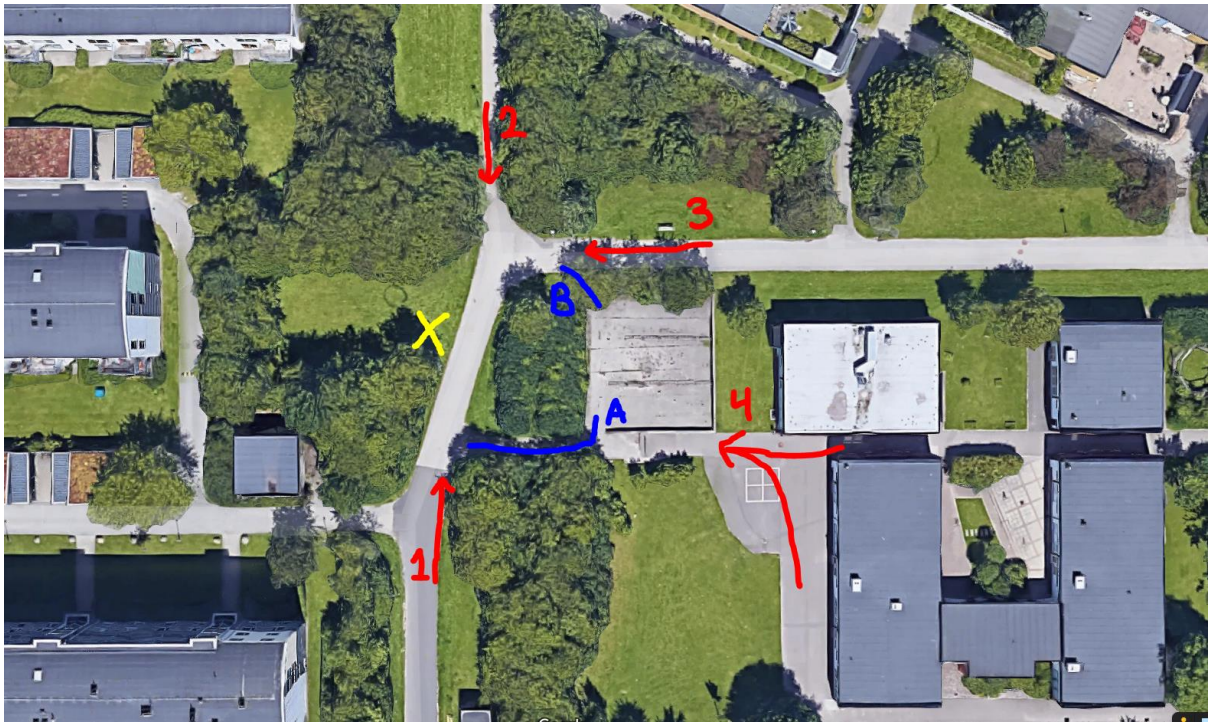


Figure 25. Map over the area near the bike parking lot were the observation was done. Google Maps (2019-11-21). (Red, blue and yellow markings are self-made).

It was observed that the children could approach the parking lot from four different directions (1-4 in the picture above). There were two possible entrances to the parking lot: A, that is a build entrance and B that is a well-trodden path. The yellow cross shows the observation place and the trees between the observation place and the parking lot that are seen in the map above were newly cut down when the observation was done, wherefore there were a great view.

The children approaching from direction 1 were most likely to use entrance A.

The children approaching from direction 2 were most likely to use entrance B.

Among children approaching from direction 3 there were three common ways to enter the parking lot. They could either:

- Bike around the parking lot and enter at A.
- Bike slowly to be able to enter at B.
- Jump of the bike and then walk up on entrance B.

There were some children observed approaching from direction 4, the school yard. They were most likely to enter at A, but one of them parked the bike on the grass above the parking lot.

Figure 26. Photo showing the view while approaching from direction 1. (2019-11-19).

Among biking children approaching from direction 1 it was most common to use the built entrance to the right, before the intersection seen in the front (figure 26).

Figure 27. Photo showing the view while approaching from direction 2. (2019-11-19).

Among biking children approaching from direction 2 it was most common to use the well-trodden path that is seen to the left (in figure 27) for entering the bike parking lot, instead of biking forward and then take left into the built entrance.

Figure 28. Photo showing the view while approaching from direction 3. (2019-11-19).

Among biking children approaching from direction 3 there were two common ways to enter the parking lot. The well-trodden path (B) is seen to the left (in figure 28), which can be reached but with a complicated angle. It is also possible to take left in the main intersection and entering at the built entrance (A).

5.3.1 Analyse of the approaching directions

As seen in chapter 3.4.1 both safety and directness are important factors for bikers. If safety was the most important factor for the biking children here, they would all have used entrance A, which also is what the parking lot is built for. If the most bikers have arrived from direction 1 this would have been a good construction, since it is natural to use entrance A for them.

The reason that the well-trodden path (B) have appeared is probably because the perceived safety was considered high in this intersection, but the directness to the parking lot bad, therefore the well-trodden path has appeared, to compensate for the factor not fulfilled among the built environment. It is especially for the bikers approaching from direction 2 since there is a high directness win and not much of a safety loss for them. For the children approaching from direction 3 the directness win is almost the same while choosing the well-trodden path B, but the safety loss is higher, wherefore this path is not a good option for children approaching from direction 3.

If adults would have entered this parking lot from directions 2 or 3, they would most probably have used the build entrance (A). The directness has the same effect for the adults, but the comfort is much worse for adults using entrance (B) since there is very limited space. The adults are also likely to perceive the well-trodden path as more unsafe since they perceive more risks.

The safety risks about biking from direction 3 and turning into entrance B is that:

- The child needs to lose a lot in velocity or stop the bike and walk, which makes the risk for fast bikers behind biking into them higher.
- To be able to turn with that angle the biking child most first start with going out to right, before turning to left, and the bikers behind them maybe not notice the well-trodden path as an entrance, wherefore they do not understand that the child is going to turn left after

having turned right, which makes the risk for bikers behind them biking into them higher, even if they bike more slowly.

- Because of the well-trodden path being so small and rough there is a big risk of falling if wobbling because the velocity is too small.

Figure 29. Photo of the well-trodden path entrance (B). (2019-11-07).

5.3.2 Recommendations for the future

Considering the safety for children approaching from direction 3 it would be better if entrance B did not exist. However, the children approaching from direction 2 would probably bike up the well-trodden path soon if there were grass planted since it feels more natural for them to only go straight forward when they see the parking lot and use entrance B.

It would be good teaching the children that bikes from direction 3 not to use the well-trodden path entrance B. It is not optimal from a safety perspective that the children approaching from direction 2 use this entrance either. When the observation was done there was pretty good visibility in the intersection, but figure 30 shows the view when approaching from direction 1 two weeks before the observation was done, and then entrance B would be seen really late when approaching from direction 1, and there is a risk for a collision with a child using entrance B.

Figure 30. View when approaching from direction 1 before the shrubs were pruned. (2019-11-07).

If the parking lot is going to be reconstructed in the future it would be worth considering if the entrances could be built at other locations, so that the directness become better for as many bikers as possible, without tempting unsafe possibilities to enter. Since the parking lot already have settlements and cannot be used to its full potential it would need to be rebuilt not too far away in the future.

The most important thing to reconsider is the safety for children approaching from direction 3. It would be possible to build an entrance in the northeast corner. However, some children already use the existing built entrance at A, so it is maybe not necessary to build another entrance to make it safe for the children approaching from this direction. The important thing for the children approaching from direction 3 is that the first visible possible entrance is possible to enter in a safe way, no matter if it is a built or well-trodden path entrance, so that the children do not become tempted to use an unsafe entrance.

For children approaching from direction 2 it is optimal arriving on the corner from the directness perspective, but it is not good for the safety with an entrance in the middle of the intersection because of higher collision risks with bikers from many directions. If there should be an entrance at the corner it is necessary to keep the trees and bushes low so the view stands good, and if there should not be any entrance it is necessary to somehow block the possibility to enter the parking lot at the corner, or better lead the flow to another entrance, so that entrance would feel as the most natural to use for the bikers arriving from this direction.

The existing entrance A already has optimal location for children approaching from direction 1.

While considering all bike parking lots it is noticeable that both the built bike parking lots 1 and 2 are placed north of the school building, while the build entrance 1 is placed good only for children biking from south. Therefore it has probably not been considered from which direction the children are biking when the locations for the parking lots and the entrances was decided. Since new bike parking lots have appeared south of the school building and a well-trodden path have appeared where children from north are entering bike parking lot 1, it is likely that children are biking from all kind of directions to an equal extent. To improve the directness that would need to be considered for the locations of bike parking lots and entrances to them.

5.4 Incidents

Two incidents are observed while being in the area. The locations for the incidents are both marked out on the map in figure 17.

The first incident happens in connection to the intersection were the bike helmet rate was observed during the observation time. A boy was biking with his mum from direction 3 (See figure 28). He probably knew that he was supposed to turn left and started to turn left into entrance B before fast object the turn and turning left in the main intersection. When the boy is trying to enter entrance B, he ends up in front of his mum who is almost biking into him and starts to scream: “NO! What are you doing? We are not going to turn here!”. The boy and the mother continued biking and bypassed Fäladsskolan. He looked younger than the pupils at Fäladsskolan and was probably a F to 3rd grader on his way to the school Backaskolan.

The second incident happens in connection to an intersection south of the school (figure 31). Three girls who look to be in the right age for Fäladsskolan are biking from south and one girl first start to turn left, but then suddenly change direction to the right instead wherefore her friends behind her start to scream because they are almost biking into her. The discussion between them later goes: “What was you supposed to do there?”, “I don’t know.” This incident was observed around 10 a clock and all the three girls involved wore a gym bag, wherefore it is likely that they were on their way from the sport hall to Fäladsskolan.

Figure 31. Intersection where the second incident happened. The bikers came from the left road in this intersection and will later turn in the direction towards the photographer. (2019-11-19).

5.4.1 Analyse of the incidents

In the first observed incident the parent and the child are likely to have agreed on that they are going to turn left in the intersection in front of them, and they are at the spot showed in figure 27 above. What the child has in mind is that they are going to turn in to the well-trodden path entrance B (figure 32), but what the parent has in mind is that they are going to turn left where the greenway splits in two other greenways in front of them (figure 33).

Figure 32. The child's view. (2019).

Figure 33. The adult's view. (2019).

During the short time that the case study was done two incidents were observed. It is remarkable that they have a lot in common. Both incidents are observed in connection with an intersection. A group of at least two people were biking together, one child was biking first and unsure about the direction, starts to turn, but then the child suddenly objects the turn while realising that he/she is biking in the wrong direction. The biker/-s behind the first child are biking faster than the child suddenly objecting the turn and are close to bike into the forward biking child, which result in a fast braking and a scream among the backward biker/-s. None of these incidents resulted in a hit or that someone fell of the bike, but it could have happened and maybe does the next time.

5.5 Tunnel or crossing bigger road

5.5.1 The sport hall route

In the interview some children mentioned that they must use the tunnel instead of crossing the bigger car road while going to the sport hall. Since they said “must”, most of them would probably have crossed the car road instead if no one told them what to do. See figure 34 of the red light crossing and figure 35 of the tunnel below.

Figure 34. Photo of the red light crossing the children are not allowed to use while going to the sport hall. (2019-11-19).

Figure 35. Photo of the tunnel the children are supposed to use instead while going to the sport hall. (2019-11-19).

For the children that have morning class in the sport hall or have leisure time activities in the sport hall after the school, the tunnel will be surrounded of darkness at the time of the day the children have to pass it during the winter time.

Figure 36. Photo of the tunnel the children are supposed to use taken 5 minutes before the sun rise. (2020-01-29).

The directness is another important factor. If looking on the map (figure 37), it is easy to see why the children see it as a must having to pass the tunnel. The map below shows the different possible routes between the school and the sport hall. Route 1 is the route were the biker pass the crossing and it is 450 m long in total. Route 2 is the route were the biker pass the tunnel and it is 850 m long.

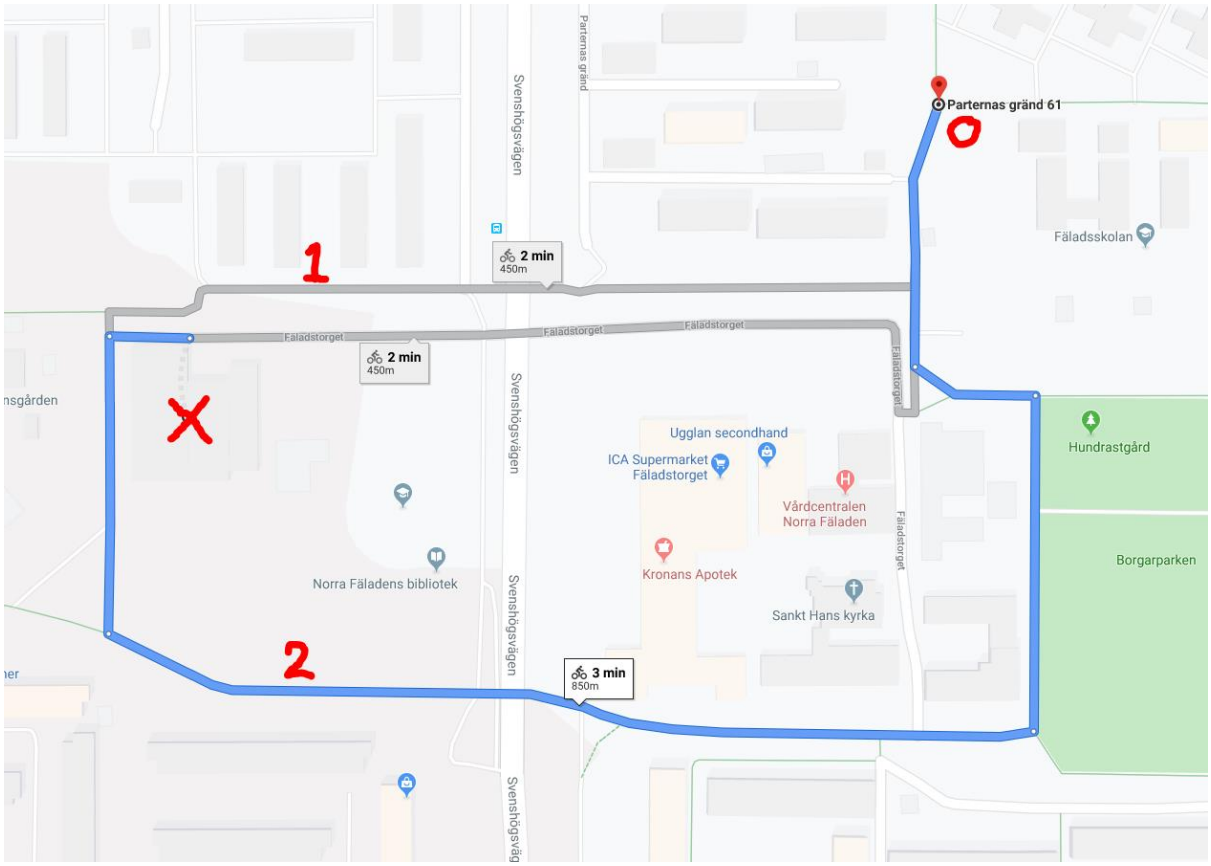


Figure 37. Map showing the possible routes from the school Fäladsskolan where bike parking lot 1 is marked with a ring to the sport hall Fäladshallen which is marked with a cross. Google Maps (2019-11-21). (Red markings are self-made). Route 1 and 2 from the text above is marked. The map also shows another route which is the same as route 1, but while biking on the car road instead of the bicycle road. That road looked less bike friendly in reality and have the same distance as route 1 wherefore it is considered unlikely that the children would use that road.

5.5.2 Analyse of the sport hall route

Even if it is a short distance considering the total route from the school to the sport hall the children will perceive route 2 as a route with bad directness, since it is needed to bike almost the double length than the shortest road to be able to reach the same destination. If just the photos of the red light crossing and the tunnel are studied the tunnel looks safer since it has a grade separation, while the red-light crossing is over a straight road were the cars can drive fast and are maybe not that observant on bikers since they do not have any bikers on their own road. It is totally reasonable that the school have set up the rule that the children should use the tunnel, but the children did not like the alternative road because of the bad directness. A SCAFT-area is in many perspectives good for biking children, but sometimes they must pass the bigger roads which makes confliction with cars that drive fast and are not prepared for bikers. If avoiding this both a lot of high-costing tunnels are needed, and the directness becomes bad because it is still not possible to build tunnels everywhere. Worth to mention here is that the interviewed children, at least in some perspective, preferred bridges for tunnels. But the geographical altitude is often the thing in reality that decide whether a bridge or tunnel is possible.

5.5.3 Observation place

While standing on the observation place for bike helmets it was possible to see bypassing child bikers on the greenway road. Most of the bypassing child bikers were driving towards south and later turned right. There were at least three children that looked to be in the same age as the children at Fäladsskolan, that was bypassing during the observation time and did not used helmet, but their actual age and school is unknown.

5.5.4 Analyse of observation place

The children biking south and later turning right were probably going to visit the area where a school for younger children (F to 3rd grade), a school for older children (7th to 9th grade) and the sport hall is situated. If they were going to visit this area and took right it means that they later must have used the crossing instead of the tunnel, which was the same crossing that children in the interview claimed that they were not allowed to bike in according to their school. As mentioned above this route has a better directness and it is of interest to see that there are many children biking there in the morning traffic. Even if the school do not allow their children to bike here because they consider the route more dangerous, the cars driving here daily in the morning traffic most be used to biking children here since it was noted that many children biked here.

5.5.5 Tunnel with crossing bicycle road afterwards

The interviewed children did not seem to have any worries about the tunnel used on the card in the interview. However, there were other problematic situations mentioned in the interview. One thing that was described as problematic was fast bikers passing on a bicycle road directly after the tunnel. Example of crossing bicycle roads after tunnels could be seen in the field, for instance the one on the photo. It is unclear if it was this tunnel that was spoken about or a similar one because there are many tunnels in the area.

Figure 38. Example photo of tunnel with crossing bicycle road afterwards. (2019-11-07).

6 Discussion

6.1 Question at issue and general thoughts

The question at issue was to investigate what the current safety levels for biking children in Sweden are and what can be done to improve the safety among biking children in Sweden. This question was very open and were not possible to answer completely, especially not within the time limitation of a master thesis, but several examples of safety problems and solutions have been found. There are many good aspects about the bike safety for Swedish children, but there are also improvements that needs to be done. In a longer historical perspective, the safety in Sweden has been approved much both among children and bikers. When studying the injury data for biking children specifically, the injury levels are more stable, and it cannot be seen whether the changes depends only on the yearly variation or not. The levels of slightly injured children have decreased the whole time period 2006-2018, even if it is considered that the levels of biking also have decreased, while the slightly injured levels been alternating, but are almost unchanged in the end of a 12-year period. However, those calculations were based on data only for the months January-August since it was based on the open data from the *Swedish Transport Agency* (Transportstyrelsen 2019d) that was possible to find on the web site that time of the year. The fact that it was only data for a part of the year can of course have affected the yearly variation, but since it is data for a bigger part of the year, it has been estimated that the yearly variation would not be much more than it would have been if comparing data for all of the year.

6.2 Result discussion

6.2.1 No separation between bikers and walkers in travel survey data

Calculations were done based on national travel survey data and official data of accidents statistics in chapter 3.2.1. to estimate the risk to get killed or injured with different transport modes. It was not possible to separate bikers from walkers in the national travel survey data and it was not possible to separate public transport in the accident data. Different age groups were used in the accident data and the travel survey data which makes it harder to compare the dataset. An interpolation was done since the age category 15-24 years old was found to use public transport more and car less than the age group 6-14 years old to be able to compare it with the accident data for 0-17 years old. There are no national travel survey data for children younger than 6 years old and it is questionable how much a 6-year-old will remember about their daily trips or if their parent was aware of everything to be able to fill it in properly. Because of those sources of error, the calculated comparable numbers are really rough.

6.2.2 Decreasing levels of biking will lead to safety problems

In an international perspective the safety levels among bikers in Sweden are in general high, but there are countries with higher levels of biking where it is safer to bike. What is alarming though is that the levels of biking among children in Sweden have been found decreasing. That could be seen as another issue, but because of the safety in numbers effect that also affect the safety. No new data based on studies after 2014 have been found about this though and therefore it is unknown whether this trend is continuing. High levels of biking were observed at Fäladsskolan, but safety improvements are still asked for.

6.2.2.1 Long distances reduce the possibility to bike (to a leisure time activity)

Almost all interviewed children were biking daily to the school, but the children were biking to leisure time activities to less extent. The studied children all go to the same school, a school build in an area from the 1960's and 1970's, and most likely lives in that area as well, which can explain that the levels of biking where so high among the children on the studied school. Even though the school's location has not been changed it is likely that the locations for common leisure time

activities have been changed over the years. According to Niska (et al. 2017, p. 9) the distances to the schools and the leisure time activities have increased in Sweden and is one reason children bike less today. While studying the results from the context part it can be seen that the children having leisure time activities in the same area as the school are biking to bigger extent than the children having leisure time activities in other parts of the city.

6.2.3 Safety is considered important among children and parents

In the importance of safety theme of the interview both children and parents are ranking the traffic safety highest among the asked five factors, which shows that this thesis is investigating an issue considered important. The only questions that was asked before this question, was about the context the children use to bike in and how often they bike. Therefore, it is not likely that neither children nor parents gave traffic safety such a high rank because of that it was the issue the interview were mainly focusing on.

6.2.3.1 Safety improvements that the parents asked for

Even though most children biked daily almost half of the parents wished for some sort of improvement to make it possible for their child to bike more. There were four improvements mentioned among several parents, and they could all be safety related somehow: better cycling infrastructure in the city centre, better winter maintenance, better lights along the roads and even better safety in general. This shows that the safety is an important factor for the parents. There are always safety improvements needed to be done, even if the levels of biking already are high, and it is of importance to consider those to keep the levels of biking high. The suggested improvement about even better safety in general shows that the parents consider safety important, but it is to wide spread to be able to draw any conclusions about what needs to be done to improve it since they do not specify what kind of improvements they are looking for. The other improvement suggestions are discussed more thoroughgoing.

6.2.3.1.1 Better cycling infrastructure in the city centre for children

The city centre is perceived less bike friendly for children according to the parents that mention the city centre in their free text answers. However, there are different problems mentioned: absence of cohesion of the cycling infrastructure, walkers suddenly turning up on the bicycle road and environment not suitable for 11-year olds. Because there are different and wide spread problems mentioned there are no quick fix solution that can solve the perceived problems and make the city centre more bike friendly for the children. When planning a city there is a limitation of space, which becomes extra clearly in the city centre were many interests should share the space and therefore there are also risks that some group will get less prioritized. However, it is of importance that the city planners remember the children's interest when planning the city centre and that economical resources are prioritized for this.

6.2.3.1.2 Better winter maintenance for children

In the school trip scenario, the winter maintenance was the factor that the parents were most dissatisfied with. More parents disagreed than agreed on the statement that: *My child's possibilities to bike to school are good since the whole distance is de-iced and dashed at winter time.* 10 of 28 parents did not allow their children to bike in the winter and 12 of 28 parents use to drive their child in car instead of letting them bike in the winter. The parents were more likely to forbid their children to bike or drive their children in car instead because of winter than because of the other asked weather conditions: darkness and rain. Some children claimed that they use to walk in the winter instead of bike.

Many negative comments about children biking in the winter was said and it is of interest to see if there are any traffic planning reasons behind that or if asked children and parents just does not like winter and coldness in general, wherefore the municipalities webpage was studied and the

municipality was contacted (see chapter 4.3.4.6.1.), which was not planned in the beginning of the process. It is worrying that the man in charge only answered that school roads have been prioritized on the question about if and how the child perspective has been considered. Children is a big group of the population since everyone under 18 belongs to that category and they need to be considered when considering people in general. If children in traffic only are considered for school trips it is not that strange that the reduction in bike trips have been bigger for free time trips than for school trips (chapter 3.3.2) and the trend will likely continue if the municipality (and maybe also other municipalities in Sweden) continue to not consider children's free time trips. The mailed municipal official claims that both his unit and department in a whole has for a while started to become more interested in how the Convention of the Rights of the Child affects their work. It is good if units and departments in municipals are interested in new laws, but only that is a very low ambition. They even need to act on them to make a difference.

6.2.3.1.3 Better street lighting for children

Since the case study was done during day time the street lightning have not been checked in field. There were in total 3 parents that commented that they wished for better street lightning. But out of the 28 parents that participated 22 of them had a child who use to bike alone in the darkness and since so many of the children use to bike alone in the darkness but only a few parents comment the lightning as a problem it cannot be a major problem in the area. However, it can still be a local problem on some specific roads. Out of the 3 parents that wished for better lightning only one child uses to bike alone in the darkness, but the parent comment that it is more common that the child bikes with other friends then. All the three parents that wished for better lightning in the darkness usually make company with the child when it is dark. Since it is unknown where the parents who wished for better lighting lives no conclusions can be drawn, but if they were asked again and it turns out they lives in the same area, it could be of interest to improve the lighting there.

6.2.4 Many road users are negative for the biking children

Many road users are seen as negatively for the biking children both according to their parents and according to themselves. It is mainly other unprotected road users that are described as problematic but also cars. The reasons that the unprotected road users are described as more problematic are likely because they are more common appearing on the roads the children use to bike on, not because a pedestrian is more problematic than a car. Out of the 11 road cards the children were going to rank the card with many walkers got ranked 8 and 10 in the different child groups and the card with many cars got ranked 11 in both. Much traffic was seen as a problem among the children no matter if it was cars or other unprotected road users.

6.2.5 How children's and parent's behaviour depend on each other

One thing that was of interest to study from the beginning of the process was if there is any relation between the parents and the children's behaviour. But because of time limitation and some difficulties in finding trustworthy facts about this that part have been skipped for this thesis. But it would be of interest to find more studies in this area. When the weather conditions were studied (chapter 4.3.4.2) it becomes clearly that the children and parents sometimes describe the reality equally and sometimes totally otherwise which can make it complicated to analyse the results. Something that would be of interest to study more is what is the differences between adult and child behaviour in traffic, if the bike habits of an adult is affected of its bike habits as a child and how the adults' bike habits affects the children. It should be remembered thought that in this study it cannot be seen whether the answering parents belongs to the same children that participated or not, only that they are parents to children in the same two classes.

6.3 Method discussion

6.3.1 Different methods for asking children and parents.

The children were interviewed in a group while the parents were answering the questions as a poll study through internet. The different chosen method could have affected that different answers were gotten. This becomes clearly in the context part where some questions could have been differently interpreted. The children's and the parent's answers are mostly similar, but a higher percentage of the children say that they use to bike to a leisure time activity than their parents. A reason for this could be that the children have been counted as that they use to bike to a leisure time activity if they have at least one leisure time activity they use to bike to, but the parents maybe have answered that they do not use to bike to the leisure time activity if they have many activities and are more often going by another transport mode. The children got to answer the context part as one question each, but the parents got to answer the context part as one question where they were able to tick in six different checkboxes. Four parents have only ticked in one of the checkboxes and at least two of them have probably understood it as if they were only supposed to tick in one checkbox. Those two parents claimed that their child usually only bikes to the school, but later could give a detailed description of the environment their child use to bike in at their leisure time. The question about meeting other friends in the city the parents have probably interpreted as meeting friends in the city centre just as the first child group did, which was unclearly asked since it was of interest to see what transport mode the children used while meeting up at any point in the city. Just as many of the children claimed that they never bike down to the city centre, this question probably got only a few agreements by the parents since their child do not use to bike down to the city centre, not because they do not use to bike when meeting outside in the city. A fewer percentage of the parents answered that their child use to bike to the store than their children. Some parents could have interpreted the question just as some child first did and only though about going to the shopping centre (to buy clothes for instance) and not to their local food store (to buy candy for instance) and going to the local food store was the value that was calculated among the children.

6.3.2 Interviewing children in focus group

Using focus groups as interview method is a time effective way to get many opinions. However, there were also some troubles using this method. The children discussed freely and fast which sometimes made it hard to keep control over the discussion, on the other hand this also made it possible for the interviewer to be quiet and listen on what the freely spoken children find important. Some children talked more, and some were more quietly wherefore all children's opinions not get the same value in the discussion. This effect was reduced by sometimes giving the word to a specific child but will still affect the result more than it would have done if the interview was made individually. Since the children know each other well the group dynamic also has a role in which child that usually talks more than another.

One thing that is complicated with interviewing children is to make them stay calm and focused, especially if the interviewer is not used to handle a group of children. There was one occasion when two children stood up and screamed on each other because they got completely different opinions and there was likely some intern conflict behind as well. At one point the other class mates was showed a movie and then the children that was interviewed escaped because they found the movie time more interested than being interviewed.

6.3.3 Recognizable photos

Most of the cards showing photos of roads and crossings & intersections where taken by the author in the same city that the children live. Some children recognized the places on the photos, for instance the road card "separated greenway (C)" and the crossing & intersection card "cycle track crossing car road retracted from car intersection (with signals) (J)" where both recognized by children. It cannot be excluded that the children also recognized other cards and therefore based

their opinions about the photo on the card on other things they know that cannot be seen at the photo. If the study was redone photos from a neighbour city would rather be used, but to get valuable results it is of importance to only use photos showing traffic situations that the children are familiar with.

6.3.4 Questionnaire

One thing that makes questionnaires complicated is the risk that the questions will be misunderstood and that the results will not be useable. The parents were supposed to grade some alternatives from 1 to 5 in the importance of safety section. It is obviously that some parents have interpreted 5 as the most important based on their answers, even though it was clearly stated in the description of the question that they should rank the most important 1 and least important 5. An alternative way to construct this question would have been to write most important instead of 1 and least important instead of 5 among the alternatives. One thing that makes questionnaires through an internet link complicated is that the answerer cannot ask if there is a question that is hard to understand.

6.3.5 Sample choice

There were multiple schools that chose to not participate in the study for different reasons. The studied children have both a principal and a teacher that support a study about biking children. The interviewed children go at a school situated in a SCAFT-area, which is a quite friendly for biking children compared to other school areas, especially the ones around new established schools. Since Fäladsskolan is a public school in the city the most children on the school probably live in the nearby area as well. Therefore, the study will not represent the bike habits of Swedish children in general, the studied children have in general better biking possibilities.

Since it was voluntary both for children and parents to participate that could also have affected the result since both individuals that love biking and hate biking are probably more willing to participate and give their opinions than individuals that do not care about biking. Only 16 children and 28 parents participated in the study in total and the study results should rather be seen as if they are showing a direction rather than definitively results.

6.3.6 Loss in results

Two main factors for losses in results based on what was said in the interview or written in the questionnaire have been found.

6.3.6.1 Losses in results because of collection of data method

The results of the interview were remembered by having one person taking notes during the interview, and the interviewer also wrote down notes the same day after the interview. No recording was made. Taking notes was considered being a more important method to save the result since an audio recording cannot show which card that was mentioned when a child just points on cards and say: I think this one is better than this one. Because of this reason it was of more importance taking notes, but if the study would be redone audio recording would have been done as well, since it in that case would be possible to use citations in the results. There is also one risk of missing information because of that the children speak fast sometimes, and it takes time to write down notes. For this reason, audio recording could also have been used as a complement. However, it also takes more time relisten audio recordings and because of time limitations for the thesis writing fewer questions would have needed to be asked in that case.

6.3.6.2 Losses in results because of language

The focus group interview and the questionnaire were both made in Swedish but the results in the thesis have been written in English. There are always some losses in information when translating from one language to another. For instance, the parents' citations have been translated to the

closest word with the same meaning in English, but it is not always the exact same word exists in two different languages. It was also some difficulties in translating a childish language into a more academic language, which can have resulted in some loss in information depending on what the child wanted to tell. It has also been complicated to translate bike specific terms since there exist more words for different type of cycling infrastructure in the English language than in the Swedish language. For instance, the Swedish word “cykelväg” could mean any type of road for biking when it is used in Swedish everyday speech but have a number of different translations when it will be written in academic English, see for instance the terms for cycling infrastructure used in the rapport *Cycling, Health and Safety* (OECD 2013, pp. 13-16). In most cases it was understandable which road type that was discussed based on the context, but it is possible that it has been translated in the wrong way at some place in this text.

6.4 Suggestions on further studies

6.4.1 National study of alteration in levels of biking

The used fact about that the levels of biking are decreasing among children are based on data from the years 1995 to 2014 (see chapter 3.3.1), which was six years ago. No newer study has been found about the alteration in levels of biking and it would be of interest to see if this trend is continuing, have been flattening or have turned over to be able to make further recommendations. The issue with decreasing levels of biking is another subject but because of the safety in number effect this will have a big impact on the safety as well. The alteration in total numbers of dead, seriously injured and slightly injured bikers are also affected on the levels of biking and therefore it is needed to have updated statistics about the alteration in levels of biking to not draw hasty conclusions about the safety levels based on the number of deaths, seriously injured and slightly injured bikers.

6.4.2 Local study about children biking in the city centre

The children on Fäladsskolan only biked to the city centre to a small extent, even though most of them are biking daily. It is possible that there is a connection between that less perceived safety in the city centre and that the children are only biking to the city centre to a small content. This would need to be studied more though to be able to tell whether the children do not bike to the city centre because it is perceived less bike friendly among the parents or not. To be able to tell more general thoughts about the perceived safety for biking children in the city centre it would be of interest to also study children living closer to the city centre, to make sure that the distance is not the reason that the city centre is avoided. Studying children biking in the city centre could sound more complicated than studying biking children on a specific school. But since the free time trips have been reduced to a bigger extent than the school trips in the national travel study (see chapter 3.3.2) the result from a study about the children’s biking trips in the city centre would be of more interest.

6.4.3 Local and regional/national study about bike friendly locations of leisure time activities

One parent is specifically mentioning that there is no good road for a child biking from the studied area to the swimming hall, while almost all children having leisure time activities in the area around the school. Do the children not bike to other parts of the city because the distances are too far away or are other parts of the city less bike friendly? One thing that could have a major effect on the children’s bike habits is the possibilities to bike to their leisure time activity. It would be of interest to see a study that investigate how bike friendly some common locations of leisure time activities in the city are. All studied children already are biking to the school and the parents’ grade of the school trips are really good, but the studied children bike to less extent on their free time and only a little more than half of the studied parents were positive to the environment their children bike in on their free time. Therefore, a study of the bike environment for children going to a leisure time activity would be of interest, since there are more that could be improved. It would also be of interest to study the locations of leisure time activities in a bigger perspective (regional/national) to

be able to see the connection between the locations of the leisure time activities and the bike free time biking trips among children. As Niska (et al. 2017, p. 9) the distances to the schools and the leisure time activities have increased and is one reason children bike less today. But since the levels of free time trips have been more reduced than the levels of school trips (chapter 3.3.2) there could likely be other reasons as well.

6.4.4 Find out what makes a place bike friendly

The government sees a need of developing the bicycle roads according to Sweden's national bike strategy (Johansson 2017, p. 20). It is also written that the cycling infrastructure net needs to be categorized in the national bike strategy (Johansson 2017, p. 22). To make those ambitions possible it is needed to have knowledge about what makes a place bike friendly. There are 5 important factors mentioned in CROW and some other factors mentioned in the GCM-handbook (see chapter 3.4.1) that describe the biker's needs. In this study it was found that the asked children gave the highest rank to the road type "separated greenway with one-directional cycle line (D)" and the pictures with much traffic got low rank no matter if it were unprotected road users or cars wherefore the flow on the road seems to be an important factor for the children. More studies about what makes a place bike friendly than what was found when writing these teases would be of interest. It is also worth to consider what makes road possible to bike, since the first incident (chapter 5.4) indicates that children and adults could have different opinions about that.

7 Conclusion

Considering a worldwide perspective, the safety for biking children in Sweden is good, but there are nearby countries with lower fatality rates than Sweden. Considering a fifty-year historic perspective, the safety for both children and bikers have been improved a lot in Sweden, but in the last twenty years the risk to get injured as a biking child have been almost unchanged. Decreasing levels of biking is another issue, but it is tightly connected with the safety among bikers and needs to be prioritized to improve the bike safety among children. The alteration in levels of biking also needs to be documented to be able to draw right conclusions about the bike safety levels when studying statistics about road deaths and road injuries. Unlike the bike helmet rates among adults, the bike helmet rates are high among Swedish children, but can still be improved. A local study showed that traffic safety is considered important both among the children and their parents, that the children bike to their leisure time activities to less extent than they bike to the school, that the biking children prefer not having to share the space with neither pedestrians nor cars and that the parents have most complaints about the winter maintenance of the bicycle roads. Challenges are awaiting both in new build school areas and in SCAFT areas but are of various kinds.

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Appendix A. Calculations

The first appendix shows numbers in the different calculation steps that was described in chapter 3.2.1. The numbers in the tables below should be carefully watched and seen as comparable numbers between the different columns rather than actual numbers.

Table 16. Dead children per distance (Self-made table based on data from Transportstyrelsen 2019e and Trafikanalys 2019a & b).

	Biking and walking	**Car drivers and passengers**	**Other modal choices**	**All modal choices**
Dead children 0-17 years old [per year]	5	3	5	13
Average travelled distance for a child 6-17 years old [kilometres per day]	1.2	16	11	28
Dead children per distance	4	0.2	0.4	0.5
Values in row above divided by 4.0	1	0.05	0.11	0.11

Table 17. Seriously injured children per distance (Self-made table based on data from Transportstyrelsen 2019e and Trafikanalys 2019a & b).

	Biking and walking	**Car drivers and passengers**	**Other modal choices**	**All modal choices**
Slightly injured children 0-17 years old [per year]	62	83	84	229
Average travelled distance for a child 6-17 years old [kilometres per day]	1.2	16	11	28
Slightly injured children per distance	53	5	8	8
Values in row above divided by 4.0	13.2	1.3	2.0	2.1

Table 18. Slightly injured children per distance (Self-made table based on data from Transportstyrelsen 2019e and Trafikanalys 2019a &b).

	Biking and walking	**Car drivers and passengers**	**Other modal choices**	**All modal choices**
Slightly injured children 0-17 years old [per year]	430	818	529	1777
Average travelled distance for a child 6-17 years old [kilometres per day]	1.2	16	11	28
Slightly injured children per distance	367	51	49	63
Values in row above divided by 4.0	92	13	12	16

Table 19. Dead all ages per distance (Self-made table based on data from Transportstyrelsen 2019e and Trafikanalys 2019a & b).

	Biking and walking	**Car drivers and passengers**	**Other modal choices**	**All modal choices**
Dead individuals all ages [per year]	58	133	51	242
Average travelled distance for an individual all ages [kilometres per day]	1.5	25	12	38
Dead individuals per distance	39	5	4	6
Values in row above divided by 39	1	0.14	0.11	0.16

Table 20. Seriously injured all ages per distance (Self-made table based on data from Transportstyrelsen 2019e and Trafikanalys 2019a & b).

	Biking and walking	**Car drivers and passengers**	**Other modal choices**	**All modal choices**
Seriously injured individuals all ages [per year]	433	1382	396	2210
Average travelled distance for an individual all ages [kilometres per day]	1.5	25	12	38
Seriously injured individuals per distance	290	56	33	58
Values in row above divided by 39	7.5	1.5	0.8	1.5

Table 21. Slightly injured all ages per distance (Self-made table based on data from Transportstyrelsen 2019e and Trafikanalys 2019a &b).

	Biking and walking	**Car drivers and passengers**	**Other modal choices**	**All modal choices**
Slightly injured individuals all ages [per year]	2332	10953	1454	14740
Average travelled distance for an individual all ages [kilometres per day]	1.5	25	12	38
Slightly injured individuals per distance	1563	444	120	385
Values in row above divided by 39	40	11	3	10

Appendix B. Interview cards

B.1 Traffic environment – road types

The traffic environment cards in appendix B.1 only contained photos when they were given to the children. The text, the ranking and the card letters have been added afterwards.

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Country road

7 **J**

City street with many cars

11 **K**

Cycle track suddenly ended by construction work

10 **L**

B.2 Traffic environment – crossings & intersections

The traffic environment cards in appendix B.2 only contained photos when they were given to the children. The text, the ranking and the card letters have been added afterwards.

Greenway crossing car road (without signals)

Cycle lane crossing greenway

3-road intersection at residental street

Cycle track crossing car road retracted from car intersection (without signals)

Appendix C. Questionnaire

The questions, descriptions and selectable answers have been copied directly from the questionnaire. They are still written in Swedish to make it possible for the reader to check the original questions and are free to use for anyone that would like to repeat the interview.

CYKELVANOR BLAND BARN I ÅRSKURS 5
Hej! Jag heter Sofie och studerar på LTH. Just nu håller jag på att skriva mitt examensarbete som handlar om barns cykelvanor. Jag skulle bli glad om du kan hjälpa mig genom att svara på följande frågor. Enkätundersökningen riktar sig till dig vars barn går i årskurs 5.

Hur ofta cyklar ditt barn?

- Dagligen
- Några gånger i veckan
- Några gånger i månaden
- Mer sällan
- Aldrig

[If answering 'mer sällan' or 'aldrig']
Berätta varför ditt barn inte brukar cykla!

_____

När brukar ditt barn vanligtvis ta cykeln?
Kryssa i de alternativ som stämmer!

- När barnet ska till skolan
- När barnet ska hem till en släkting eller annan förälder
- När barnet ska handla
- När barnet ska till träning eller annan fritidsaktivitet
- När barnet ska hem till en kompis
- När barnet ska träffa kompisar på stan
- Annat:____

Vad tycker DU är viktigast när ditt barn ska cykla?

Rangordna från 1-5 där 1 är viktigast och 5 minst viktigt.

Att barnet har kul __
Att det går snabbt att ta sig till målpunkten __
Att trafikmiljön är säker __
Att barnet har en häftig cykel __
Att barnet rör på sig och får motion __

Finns det något annat du tycker är viktigt när ditt barn ska cykla som inte nämndes i föregående fråga?
Om ja, ange vad

_____

SCENARION
Nu kommer två scenarion. Jag vill veta hur du upplever det att låta ditt barn cykla själv i området där ni bor. I följande scenarion vill jag att du svarar utifrån din generella upplevelse av sträckan där ditt barn cyklar. På sista frågan i enkäten finns det möjlighet att uttrycka sig i textform om du har fler åsikter.

Scenario 1: Skolvägen
Föreställ dig följande:
Ditt barn ska cykla från er bostad till skolan en vanlig morgon.
Mitt barns möjligheter att cykla till skolan är goda eftersom...

Rows
... mitt barn har möjlighet att upptäcka faror då sikten är god.
... det inte är trångt och det finns gott om utrymme för mitt barn att cykla.
... mitt barn inte behöver hoppa av cykeln på grund av hinder längs med sträckan.
... korsningar med övrig trafik kan passeras på ett säkert sätt.
... vägbanans standard är god och det finns inte gropar.
... hela sträckan snöröjes och grusas under vintern.

Columns
1.Håller med helt
2.
3.
4.Håller inte alls med
Vet ej/Vill ej svara

Scenario 2: Fritidsresor
Till fritidsresor räknas samtliga resor som inte sker mellan hemmet och skolan. I detta scenario vill jag veta hur du upplever miljön där ditt barn cyklar på fritiden. För att underlätta för dig att svara kommer här några frågor att fundera över:
– Tycker du att det är någon skillnad mellan att cykla på fritiden och till skolan?
– Känner du dig mer, mindre eller lika trygg när ditt barn cyklar på fritiden som när ditt barn cyklar till och från skolan?
– Är miljön ditt barn cyklar i på fritiden lämplig för en cyklande 11-åring?
Föreställ dig följande:
Ditt barn kommer hem från skolan, äter ett mellanmål och ger sig sedan ut med cykeln.
Vad är din upplevelse av miljön där ditt barn cyklar på fritiden?

_____

ANDRA SAKER
Nu följer några frågor om andra saker som kan påverka ditt barns cykling.

Avstånd
Hur långt från hemmet tycker du det är okej att ditt barn cyklar på egen hand?
Ange ditt svar i kilometer, ex. 1.0 __
Möjlighet att kommentera

_____

Mörker
Avsluta meningen genom att bocka för de alternativ som stämmer. Det är möjligt att välja flera alternativ.
Om det är mörkt när mitt barn ska ge sig ut och cykla så...

- ... cyklar barnet själv trots att det är mörkt ute.
- ... cyklar jag tillsammans med barnet.
- ... skjutsar jag barnet i bil.
- ... stannar barnet hemma.
- ... vill inte barnet cykla.
- ... tillåter jag inte att barnet cyklar.

Möjlighet att kommentera

_____

Regn
Avsluta meningen genom att bocka för de alternativ som stämmer. Det är möjligt att välja flera alternativ.
Om det regnar när mitt barn ska ge sig ut och cykla så...

- ... cyklar barnet själv trots att det regnar.
- ... cyklar jag tillsammans med barnet.
- ... skjutsar jag barnet i bil.
- ... stannar barnet hemma.
- ... vill inte barnet cykla.
- ... tillåter jag inte att barnet cyklar.

Möjlighet att kommentera

_____

Vinter
Avsluta meningen genom att bocka för de alternativ som stämmer. Det är möjligt att välja flera alternativ.
Om det är minusgrader eller snöar när mitt barn ska ge sig ut och cykla så...

- ... cyklar barnet själv trots att det är vinter.
- ... cyklar jag tillsammans med barnet.
- ... skjutsar jag barnet i bil.
- ... stannar barnet hemma.
- ... vill inte barnet cykla.
- ... tillåter jag inte att barnet cyklar.

Möjlighet att kommentera

_____

En sista fråga

Vad skulle krävas för att ditt barn ska kunna eller vilja cykla mer?

_____