Thesis 189

Comparative Traffic Safety Analysis of Two Types of Bicycle Crossings at Signalised Intersections

A Case Study in Lund

Ferdinand Anon Bayu Aji

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Keywords:
Bicycle crossings, signalised intersection, traffic safety analysis, head movement, giving priority to cyclists

Abstract:
Since the interest of this study is interaction between turning right driver and cyclist crossing from the same direction with driver at signalised intersections, the two types of bicycle crossings facility at signalised intersections were compared in term of traffic safety. The first type is bicycle facility at signalised intersection with bicycle box (Type A) and the second is bicycle facility with bicycle path and own signal for bicycle when they want to cross the intersections (Type B).

For the comparison, field observations were conducted as speed measurements, behavioural studies, conflict studies and interview with cyclists. There is no dominant result that showed whether one of the types is better than the other type. The result of each study did not support each other, such as speed measurements and give priority observation, head movement observation and give priority observation. However, from the result of conflict studies, there is indication that the bicycle crossing type A seems to be safer for cyclists.

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Preface

After finishing two trimester in my home university (Gadjah Mada University) and one semester joined Traffic Safety Science Course in Lund University, I decided to continue with master thesis. Because of all efforts from my supervisor, Prof. András Várhelyi, finally the academic gave me opportunity to defend my thesis in Lund.

Therefore, I would like to thank to Prof. András for his extraordinary assistance and support during my study in Lund, Dr. Thomas Jonsson for the explanation about signalised intersection in Lund and STRADA, Prof. Siti Malkhamah from Master of Transport System and Engineering Gadjah Mada University, to Ministry of Transportation Republic of Indonesia for the scholarship and to all my fellow student in Lund University for all the supports.

Finally, I'm so glad to get new experience and learn different method in Lund University with basic knowledge from my home university. I hope it can enrich my knowledge.

Lund, June 2009

Ferdinand Anon Bayu Aji

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Summary

Since 1998, the city of Lund has improved conditions for cyclists: more bike paths, higher standards for bike paths, better lighting, safer crossings, improved parking facilities, and a variety of different activities to promote cycling and to support the Swedish ”Vision Zero” traffic safety philosophy.

In line with that, bicycle crossings at signalised intersection became the interest of this study due to the interaction between turning right driver and cyclist crossing from the same direction with the driver. For investigation, two types of bicycle crossings at signalised intersection were compared in terms of traffic safety. First type is bicycle crossing with bicycle lane before the intersection and bicycle box for bicycle when waiting for the green light (Type A) and the second type is bicycle crossing with bicycle path before the intersection. This type has crossing marked and own signal for bicycle (Type B). This investigation has the aim to answer the question: which one of the two bicycle crossing types (Type A or B) at signalised intersection in Lund is safer for cyclist?

To gain the understanding of the interest of study, literature review was carried out, concerning bicycle facilities and giving priority regulation. After satisfying that, hypotheses were formulated and were continued with empirical study.

Site selection was conducted based on the motor vehicle and bicycle volume. Before that, with the consideration of the bicycle volume, two of signalised intersections (type A and B) in Lund that has large volume of bicycle are chosen, they are Tornavägen-Tunavägen intersection (Type A) and Tornavägen-Getingevägen- Svenshögsvägen. Further step is comparing the traffic volumes of turning right motor vehicles, turning left motor vehicles from the opposite direction and bicycle volumes in each leg in order to find the similarity of the volumes. This comparison is used the result of traffic counting during peak hours. A pair of leg considered comparable are selected to be investigated. In this study, the selected sites are the east leg of Tornavägen-Tunavägen intersection (Type A) and the south leg of Tornavägen-Getingevägen-Svenshögsvägen intersection (Type B).

Accident data from STRADA for a six year period (2003-2008) at both intersections was analysed. Since the accident data was considered too scarce, this analysis only describe the situation of the selected intersection in general.

The field observations that were conducted to test the hypotheses were speed measurement, behavioural studies, conflict studies and interview with cyclist.

Speed measurement was carried out with radar gun to measure the speed of the turning right car by shooting the rear of the car. The basic idea of speed measurement is the lower the speed, the more the driver give priority to the cyclist. The measured car must be turns right when the green light, free from obstacles in front and not in queue behind of the other car. Seventy five cars were measured at both sites. The result showed that mean speed at site type A is 18.13 km/hour, which is higher than site type B (16.79 km/hour), even though the differences was judged to be less than two km/hour.

The behavioural studies concerned head movement observation and give priority observation. Head movement observation was carried out to investigate the driver behaviour when approached the intersection and wanted to turn right, whether the drivers have the will to observe the situation at intersection facing the cyclist on the right side of the car. Give priority observation was carried out when there is interaction between the car that wanted to turn right and the bicycle that intended to cross the intersection from the same direction. The result showed that the driver did head movement more often at site type B (28%) than at site type A (21%). On the other observation, the result showed that drivers at site type A give more often priority in good time with 81% of interaction with cyclists, whilst at site B the percentage of drivers that did the same things was 79%. From the result, each observation was tested with chi square, in which showed that the behaviour of driver in head movement was affected by the type of intersection while giving priority behaviour was not affected by the type of intersection.

Conflict studies in this study were conducted by using the Swedish conflict technique, carried out totally 6-7 hours per day during five week days. Interaction of drivers and cyclists in the site of study is the focus of the observation. The result showed that at site type B more serious conflicts occured with various types (18 serious conflicts, four types of conflicts) than site type A (11 serious conflicts, two types of conflicts).

Interviews with cyclist were conducted after the cyclists crossed the site of the study. Fifty cyclists were interviewed at each sites. Four standard questions were given. The result showed that most of the interviewees at both sites crossed the site of study daily. About the knowledge of giving priority, most of them have good understanding that the cyclist has priority to cross the intersection in case there is a car wanted to turn right from the same direction. At both sites, the felt safe when crossing the intersection. The design of signalised intersection type B was the one most chosen as safe for cyclists.

Considering the result of field observations, there is no dominant result that showed whether one of the types is better than the other type. The results of the different studies did not support each other, such as speed measurements and give priority observation, head movement observation and give priority observation. Feeling safe when cyclist crossed the intersection type B was not supported by the result of conflict studies. However, from the result of conflict studies, there is indication that the bicycle crossing at signalised intersection type A seems to be safer for cyclists.

1. Introduction

In Lund Municipality, people that travels by bicycling realize aproximetely 25,000 persons every day (Åklundh, 2006). Hence, Lund is one of the municipalities in Sweden with a very high number of cyclists, about half of all the journeys in the densely built up areas are by cycle or on foot. The goal of Lund municipality is to get as many people as possible to cycle rather than drive. The expectation of the increasing of bicycle in Lund is 70% in 2020 (Lunds Kommun, 2004).

On the other hand, since bicycle became popular transport mode in Lund Municipality, the improvement of bicycle facilities is carried out to support the safety for cyclist. Since 1998, the city of Lund has improved conditions for cyclists: more bike paths, higher standards for bike paths, better lighting, safer crossings, improved parking facilities, and a variety of different activities to promote cycling with investing close to 80 million Swedish kronor. (Lunds Kommun, 2005).

Bicycle crossing at intersection is one of facilities that provided in order to guide cyclist when crossing the intersection safely. The improvement of bicycle facilities was provided to support the Swedish ”Vision Zero” traffic safety philosophy that established in 1997. Vision zero in road traffic system is the image of a future in which no one will be killed or seriously injured in the road traffic system (Vägverket, 2006).

1.1 Background

Based on combination statistics from the hospital and police in 2007, there were 373 injured vulnerable road users in Lund. Of these, 229 were cyclists, 119 were pedestrians and 25 were moped. Most of them are the typical of single accidents (60%), and followed by collision between bicycles and motor vehicles (22%), bicycles and bicycles (15%), bicycles and pedestrian (2%) and 1% of them is others (Lunds Kommun, 2008).

Related to bicycle and car collision, Summala et al confirm that from several types of collision between car and bicycle, the most frequent accident type among collisions between cyclists and cars at bicycle crossings was a driver turning right and a bicycle coming from the driver’s right (Summala, et al, 1996). In further study found that from 37% of collisions, neither driver nor cyclist realized the

danger or had time to yield. In the remaining collisions, the driver (27%), the cyclist (24%) or both (12%) did something to avert the accident (Räsänen & Summala, 1997). Both studies were conducted at unsignalised intersections.

Although those studies were conducted at unsignalised intersections, in line with that, the investigation of signalised intersections should be a concern. At signalised intersections, interaction between car and bicycle usually occur when cyclist want to cross the intersection while car from same direction wants to turn right or a car from opposite direction wants to turn left (Figure 1).

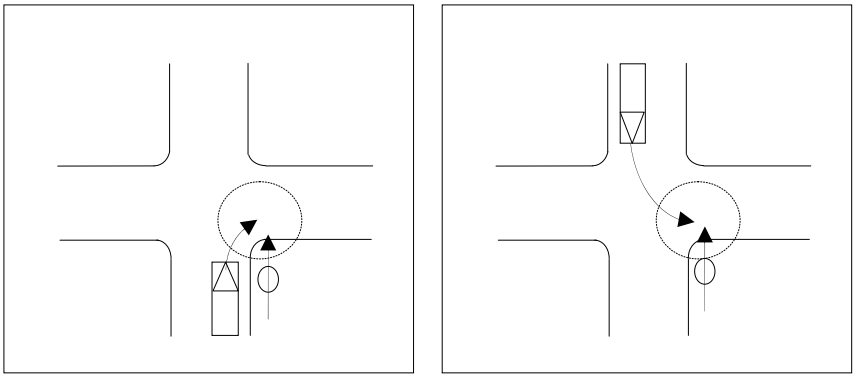

Figure 1: The typical interaction types between car-bicycle that should be investigated

Those types should be considered for investigation due to when the green light on (for both car and bicycle), the driver that wants to turn right sometimes does not consider the position of the cyclist on the right side from the same direction which moving straight to cross the intersection. The conflict between them often occur in this situation. In addition, car driver more alert to the car from the opposite direction at the time than cyclist in the right side of the oncoming car.

Considering the description above, this study concern of conflict between turning right car driver and crossing cyclist.

Related to the design of signalised intersection, there are various ways to design bicycle crossings facilities at signalised intersection (see figure 2). The first is type is mixed traffic bicycle facility (Type A). At intersection with this type there is bicycle lane on the link between intersections, between the carriage way and the pedestrian walk. Bicycle lane is the extension of bicycle path on the pavement that 20-30 m before approach the intersection, the path merge with traffic. This path also called as curtailed path (Kronborg and Ekman, 1995). In this type, there is painted areas and also there is ‘bicycle box’ where the cyclist should take position when merge in mixed traffic. Bicycle box is located in front of the vehicle stops.

Bicycle box functions as the bicycle stops in it, so that it can be seen by the drivers. The sign to cross the intersection is together with other vehicles. In this type, there is no special lane or marking in the middle of intersection.

The second types is signalised bicycle crossing (Type B) which is the type of crossing where bicycle have its own path on pavement. When cyclist wants to cross the intersection, they must make a slight turn to right before crossing and afterwards crossing through the lane that have been marked with the adjacent zebra cross for pedestrians. Signal light for bicycle are available in this intersection.

The third type is signalised intersection with bicycle crossing marked in the middle of the intersection (Type C). In this intersection, before approach the intersection, bicycle has own lane (combination with Type A).

The fourth type is signalised intersecton with painted bicycle crossing (Type D). Similar with Type C but the crossing facility is painted with blue coloured. This type is used in Copenhagen an Malmö.

The fifth type is the mix of type A and type B. The intersection has two kind of bicycle crossing facilities, first with marking road and bicycle signal (two legs) combined with bicycle box in another legs.

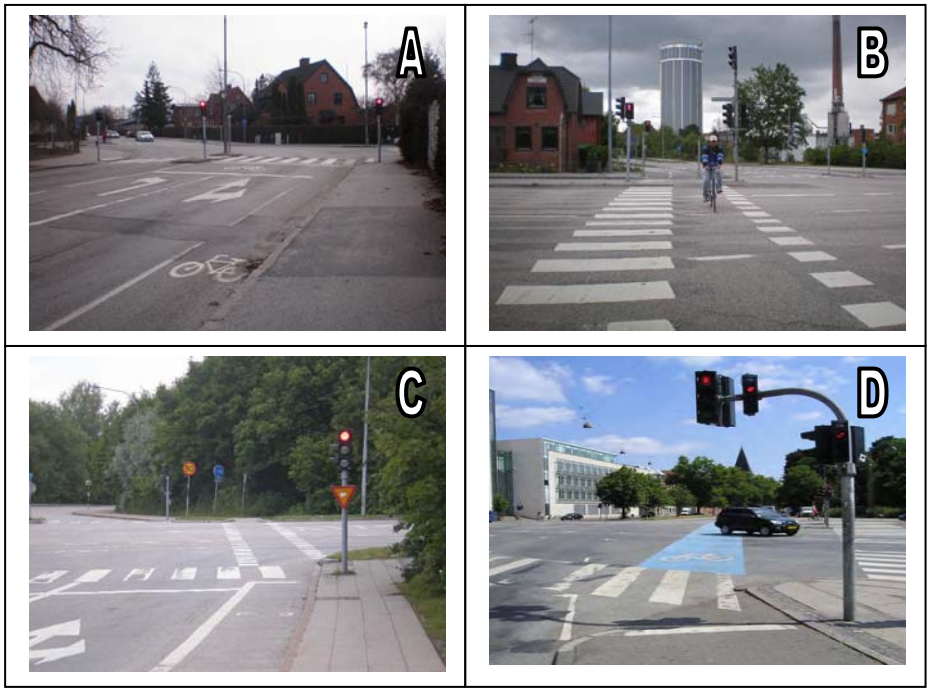

Figure 2: The design types of bicycle crossing facilities

1.2 Aim of thesis

The aim of this thesis is to analyse two types of design bicycle crossings at signalised intersection and compare them in terms of traffic safety. The comparasion of the crossing types for bicycle will answer the question: Which one of the two bicycle crossing types (Type A or B) at signalised intersection in Lund is safer for cyclist?

2. Method and material

This project is completed in three phases, the first is literature review, the second is empirical study and the third is discussion. Literature review focus on the regulation of priority in the traffic for driver and cyclist, especially bicycle crossing at intersection. Based on the findings from the literature review, hypotheses were formulated in order to compare the two types of bicycle crossings.

Empirical study concerning in site selection, accident data analysis of site selected and field observations. Traffic counting is conducted as a consideration to select the site of study. Field observations contain speed measurement, behavioural studies, conflict studies and interview with cyclist. Field observation are conducted to collect data in order to test the hypotheses. Two types of bicycle crossing facilities at signalised intersections is compared, each type is represented one leg in the intersection that compared with another type (*See site selection*). The third fase discusses the results of the literature review and empirical studies.

3. Literature Review

3.1. Lund City and Bicycle in Lund

Lund, situated in the centre of the attractive and expansive Öresund region in southern Sweden, is one of the oldest cities in Sweden with a history more than one thousand years old. The city of Lund covers 442.7 km2, of which 22.9 km2 is densely populated. The city of Lund is the twelfth largest municipality in Sweden with 106 000 inhabitans. The age group 20-29 (21%) is remarkably larger than the national average (13%), due largely to the students at the university (Lunds Kommun, 2008a).

Figure 3: City of Lund

Regarding to transportation modes that used in Lund Municipality, one of favourite transportation mode in Lund is bicycle with 26% of all modes, that only less than car (Trivector Traffic AB, 2008). The number of bicycle increased by the year. In line with that facts, Lund municipality has agenda that called LundaMaTs, which has program to create the bicycle friendly town (Lunds Kommun, 2004).

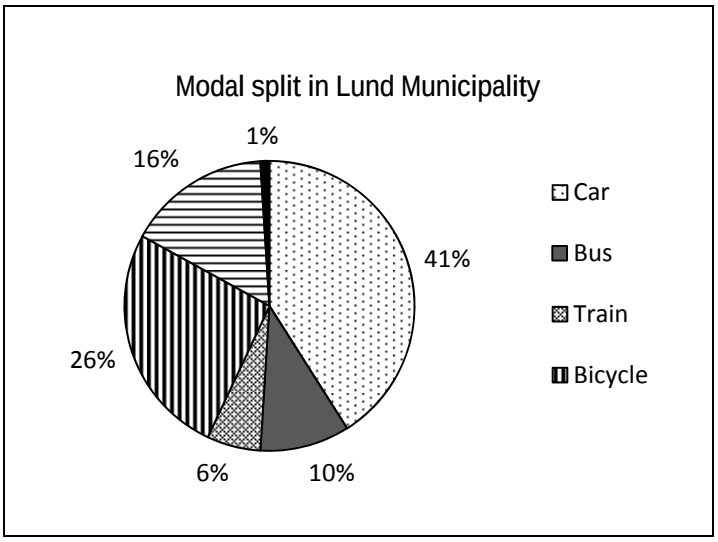

Figure 4: Modal split in Lund Municipality
(Source: Trivector Traffic AB, 2008)

3.2. Bicycle facilities at intersections

Bicycle facilities that will be discussed are bicycle path, bicycle lane, cycle box, bicycle signal and bicycle sign. Bicycle facility itself defined as that defined a general term denoting improvements and provisions made by public agencies to accommodate or encourage bicycling, including parking and storage facilities, and shared roadways not specifically designated for bicycle use (AASHTO, 1999).

a. Bicycle lane

American Association of State Highway and Transportation Officials (AASHTO) defined bicycle lane or bike lane as portion of a roadway which has been designated by striping, signing and pavement markings for the preferential or exclusive use of bicyclists. Bike lanes are established with appropriate pavement markings and signing along streets in corridors where there is significant bicycle demand and where there are distinct needs that can be served by them (AASHTO, 1999, pp 2-8).

Hudson confirm that cycle lane consists of a strip of roadway designed primarily for the use. It is similar to a bus lane but maybe narrower and could be provided on any typ of road (Hudson, 1978, p 69).

Figure 5: Example of bicycle lane

b. Bicycle path

Bicycle path that also called shared use path is a bikeway physically separated from motorized vehicular traffic by an open space or barrier and either within the highway right-of-way or within an independent right-of-way. Shared use paths may also be used by pedestrians, skaters, wheelchair users, joggers and other non-motorized users (AASHTO, 1999, p 2). The width of bicycle path is 1.4 m-1.75 m, depend on the volume of bicycle on that road (Lunds Kommun, 2007).

Figure 6: One way (left) and two way (right) bicycle path

c. Bicycle box

Linderholm (1992) confirmed that at signalised intersections, cyclists in mix street traffic often stand close to cars while waiting for the green light. The cyclists are then exposed to relatively high pollution counts from car exhaust. This may be very annoying, one possibility for improving the conditions of these waiting cyclists is pull back the stop line for the motor vehicles a few meters, while the cyclists still stop at old line. It is prefereble if a bike lane is created next to the curb at the same time, so that the cyclists can easily reach their waiting position.

Kronbog & Ekman (1995) also confirmed that bicycle box is a box that created from double stop lines of motor vehicle at intersection whereas cyclists can stop in front of the cars a bit away from exhausts, the cyclists can easily move to the left, preparing for left turn and the cyclists can start ahead of the cars when there is green light.

Figure 7: The types of bicycle box

d. Bicycle crossing

Bicycle lanes leading to intersections can be one-way or two-way. It is cheaper to build one two-way bicycle lane compared with bicycle lane on both sides of the road. The cyclists seem to prefer to have all bicycle lanes two way from a comfort point of view. From the safety aspect one way lanes are strongly prefered for several reason (Kronborg & Ekman, 1995).

Another type of bicycle crossing is paiting bicycle crossings. The edge of bicycle crossings are in all countries marked with white squares. In the Netherlands the squares are always painted on both sides of the bicycles crossing increasing visibility, while in other countries they are normaly painted only one side of bicycle crossing when there is a zebra pedestrian crossing painted on the other side (Kronborg & Ekman, 1995).

Related to painting bicycle crossings, blue cycle crossing applied in some place like Copenhagen (Denmark) and Malmö (Sweden). This kind of crossing was invented by Municipality of Copenhagen and marked for the first time in 1981. The basic idea of this design is to mark the area of conflict between motor vehicles and cyclists so road users pay more attention of this conflict and cyclists have a lane marking through the junction area (Jensen, 2008).

Figure 8: Bicycle crossings

e. Bicycle signals

Bicycle signals are common in the Netherlands and Sweden. They are not used as frequently in Denmark as the bicycle crossing is normally controlled by the car signals. The rules in Denmark stipulate that bicycle signals are allowed only if the green period is different for bicycles and for parallel car signal groups. Bicycle signals are rare in Finland as cyclists are supposed to follow the pedestrian signals. In Norway bicycle signals are avoided as the cyclists have to give way for turning traffic. Therefore bicycle signals are not used in Norway if there is a secondary conflict (Kronborg & Ekman, 1995).

Bicycle signals have the same shape as normal vehicle signals, but have smaller lenses (10 cm instead of 20 cm), in Denmark, Finland, Norway and Sweden. They have also a smal bicycle symbol above the red light. In the Netherlands normal signals heads are used for bicycle signal groups, but with bicycle symbols on lenses. The small bicycle signals differ more from other signals than Dutch signals and might therefore be observed better by motorists as well as cyclists (Kronborg & Ekman, 1995).

Figure 9: Bicycle signal at intersection

3.4. Give priority regulation

Basically, there is regulation to regulate the act of road user when approach the intersection. Regulation that is used in this study based on Trafikförordning (1998:1276). In general, a bicycle is classified as a vehicle and being under the competence of Swedish Road Traffic Act and Regulations. Related to the regulation of how to behave in traffic that is used in this study, in section 5 stated that driver of a motor vehicle having the obligation to yield, must slow down and show his/her intention to yield and if necessary yield or stop his/her vehicle.

In chapter Traffic in an intersection, etc., section 20 stated that when a driver is approaching or driving into an intersection, driving behavior must be adapted in order to avoid unnecessary obstacle to the traffic on the intersecting road, if the vehicle is forced to stay in the intersection.

Moreover, section 61 regulate that all drivers, when approaching a pedestrian-or bicycle crossing shall reduce speed and give way to pedestrians and cyclists, when they have entered the crossing on their way to the other side of the road.

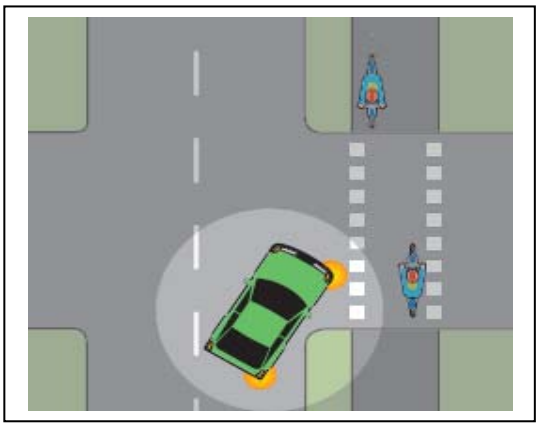

Figure 10: Ilustration of give priority between car and bicycle (Vägverket, 2009)

Considering the regulation above, it can be concluded that basically car when approach the intersection must adapt the speed. If there is bicycle from the same direction with the car, then the driver must be give priority to the cyclists to cross the intersection. Give priority means car should slow down in good time or stop if necessary. Even though the driver must give priority, to increase the safety, both drivers and cyclists must pay attention to each other (Vägverket, 2004).

4. Hypotheses formulation

Based on the findings in the literatures, the following hypotheses are formulated:

1. *Driver gives priority more often at bicycle crossing Type A than Type B*
   The situation in bicycle crossing Type A make cyclist more visible by drivers. This is the reason that the driver easily to identify cyclist and more alert of them. In this case, the driver gives priority more often for cyclist. On the other hand, in bicycle crossing Type B, when cyclists intend to cross the intersection, they must turn right slightly before continuing straight because of the design of intersection. In this situation, driver confuse and guess that the cyclist will make right turning, not to cross the intersection in straight direction.

2. *There are fewer conflicts between driver and cyclist at bicycle crossing Type A than Type B*
   The exposure of cyclists in bicycle crossing Type A are more obvious than in type B. In this intersection, cyclist situated in the same level of pavement with the other vehicle even though they have cycle path. Consequently, the driver easier to see the position of cyclist due to the distance of vehicle lane and bicycle lane at bicycle crossing Type A is closer than Type B, which make driver more alert in Type A.

3. *Cyclists feel safer at bicycle crossing Type B than Type A*
   Riding bicycle in separate path with special crossing marking and special signal make cyclist feel more comfortable and more confident. The concern of compete with cars on the road to faded due to separated path and different level of pavement.

5. Empirical Study

5.1. Site selection

In determining the location of study, the very first step is to describe the type of bicycle crossing at intersections in Lund. In this step, with the basic knowledge about interaction and conflict between driver and cyclist, the type of bicycle crossing is decided.

To select the candidate intersections, the preliminary data used to compare are number of arms, number of lanes, regulation as speed limit, vehicle volume and bicycle volume. The intersections types chosen for the study is four leg signalised intersection. The number of lanes in each leg is two, one lane for motor vehicles to turn right and one lane is for motor vehicles that want to go straight and turn left. The speed limit is 50 km/h. The preliminary data about the bicycle volumes is taken from signalised intersection that considered have large volume of bicycle.

After satisfying the preliminary requirements, two signalised intersections candidates are chosen, that called bicycle crossing Type A and Type B. Because the interest of study is the interaction between driver and cyclist, therefore volume of motor vehicle and bicycle in each intersections chosen must be compared. In this case, the consideration of motor vehicles volumes are turning right motor vehicle and turning left motor vehiles from the opposite direction, whilst for bicycle, is taken from the bicycle volume in the same leg with the right turning motor vehicles. This consideration is used because of the assumption that when a car wants to turn right, the driver needs more effort to be alert because of the position of cyclist that maybe unseen to go straight when crossing the intersection.

The data of motor vehicles and bicycles volume is taken from traffic counting in peak hours, in the morning and afternoon. Based on the data of traffic counting, the intersections are compared in terms of volume of motor vehicle and bicycle traffic to find the similarity of each leg in two kind of bicycle crossing types. From the similarity, a pair of arms is selected to be site of the study.

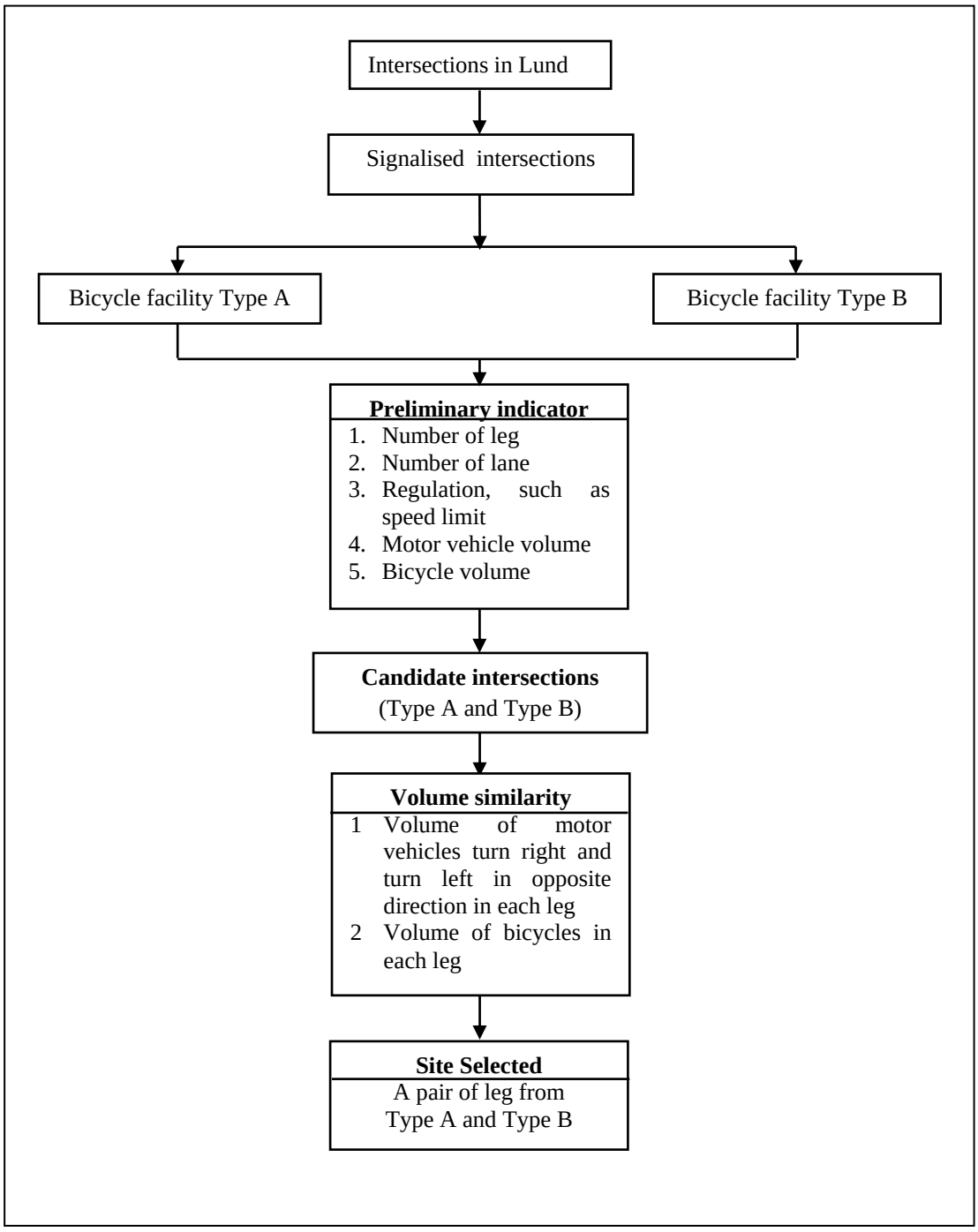

Figure 11: The scheme of site selection

Traffic volumes for the chosen site

As mentioned on Figure 11, trafic volume in the intersection to be the main consideration in selecting a similar leg. Therefore, the preliminary data of the bicycle volume used to select intersection. Bicycle volume data is taken from Fotgängare-och cykeltrafikmängder i Lund 2008 (Lund Kommun, 2009), the two

signalised intersection from two types of study is chosen with a large volume of bicycle. The signalised intersection chosen are Tornavägen-Tunavägen (Site 1 - Type A) and Tornavägen-Getingevägen-Svenshögsvägen (Site 2 - Type B). The data of bicycle volume can be seen in figure below.

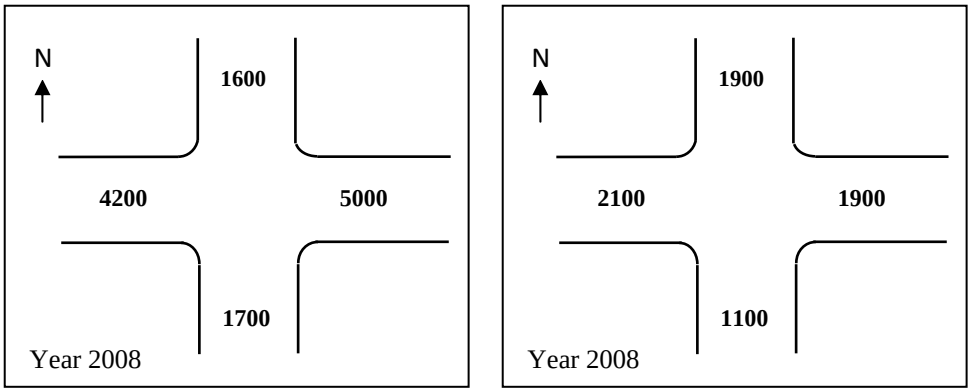

Figure 12: Preliminary data of bicycle volumes at the two selected site of intersections. Source: Lunds Kommun, 2009

After the two signalised intersections are chosen, the further step is to consider the comparison between volume of motor vehicle and volume of bicycle that passing through the intersections. This comparison is obtained from the result of traffic counting in peak hours, with composition of volume as Figure 13.

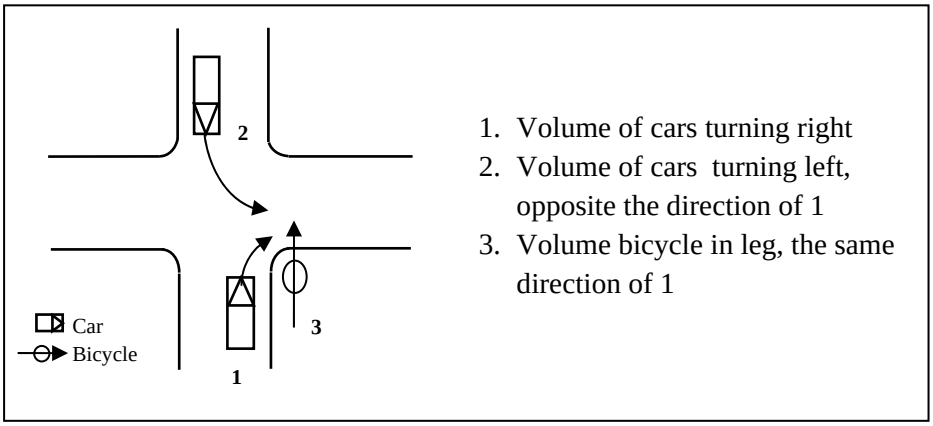

Figure 13: The traffic volume scheme that considered for site selection

Traffic counting conducted at morning peak hours and afternoon peak hours at both site chosen. Traffic counting at site type A was conducted in 2 and 3 April 2009 whilst data from site type B is taken from previous study in 2008. Based on the scheme of volume in Figure 13, the volumes of motor vehicles and bicycles can be seen in figure 14.

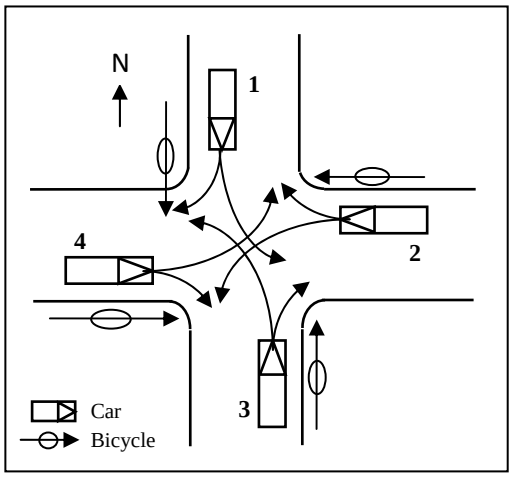

Figure 14: The scheme of moving motor vehicle and bicycle

On the leg 1, the consideration is taken from the turning right motor vehicles volumes of leg 1, the turning left motor vehicles volumes from leg number 3 and the volumes of bicycles from leg 1. Whilst on the leg 2, the consideration is taken from the turning right motor vehicles volumes on leg 2, the turning left motor vehicles from leg 4 and the volumes of bicycles from leg 2. On the leg 3, the consideration is taken from the turning right motor vehicles volumes on leg 3, the turning left motor vehicles volumes from leg 1 and the volumes of bicycles from leg 3. At the last leg, the consideration is taken from the turning right motor vehicles volumes on leg 4, the turning left motor vehicles volume from leg number 2 and the volumes of bicycles of leg number 4. The result of comparison can be seen in table below.

Table 1: The comparison of motor vehicle and bicycle at two signalised intersection (Type A and Type B)

Site 1 (Type A)						**Site 2 (Type B)**					
No.	Motor vehicle volume				Bicycle volume	No	Motor vehicle volume				Bicycle volume
	Leg No.	↱	↳	Total			Leg No.	↱	↳	Total	
1A	1	61	38	99	74	1B	1	262	97	359	257
2A	***2***	***175***	***35***	***210***	***234***	2B	2	51	201	252	329
3A	3	325	202	527	103	***3B***	***3***	***146***	***88***	***234***	***186***
4A	4	21	251	272	230	4B	4	68	123	191	393

From table 1, it can be read that in all legs in two signalised intersections compared, number 2A and 3B can be considered most comparable. The volume of turning right motor vehicles and the volume of bicycle are judged quite similar.

Figure 15: A pair of intersection chosen. Arrows show the location of study. Left is Type A (Tornavägen-Tunavägen) and Right is Type B (Tornavägen-Getingavägen-Svenshögsvägen)

5.2. Description of sites selected

The selected legs of signalised intersection are east leg of Tornavägen-Tunavägen intersection (Type A) and south leg of Tornavägen-Getingevägen-Svenshögsvägen intersection (Type B).

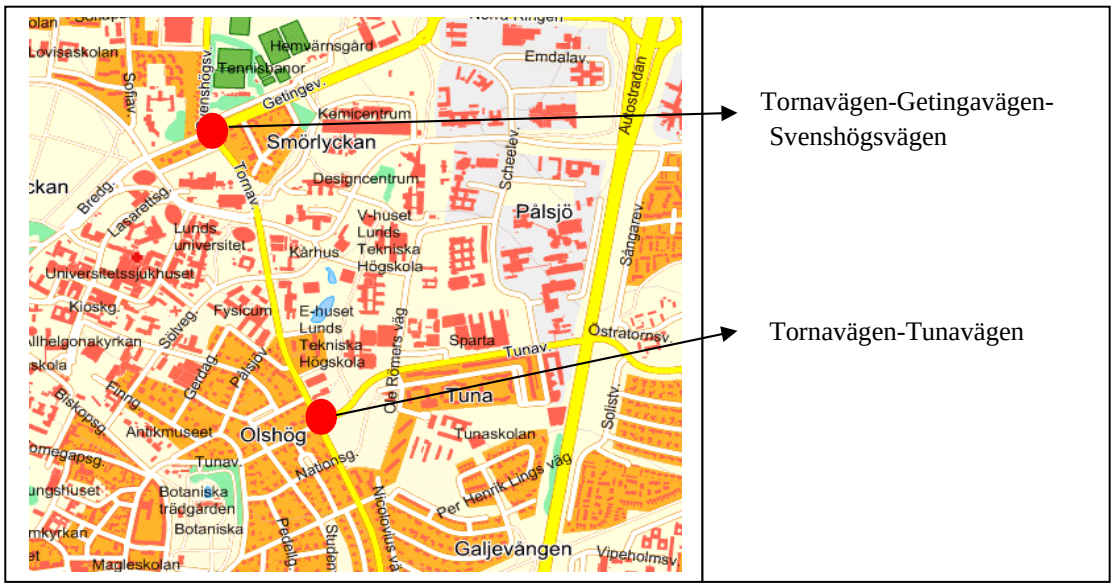

Figure 16: The location of sites selected

5.2.1. Site Type A

The first selected site in this study is Type A bicycle crossing facility at four leg signalised intersection in Tornavägen-Tunavägen, focusing in east leg of Tunavägen. This site located in surounding of Lund University, the surroundings of the intersection are mainly resident area. The dominant traffic road users in this intersection is motor vehicles. Bicycles and pedestrians are placed on separate lanes next to the motor vehicle lanes.

Figure 17: Site Type A at Tunavägen East, signalised intersection of Tornavägen-Tunavägen (left) and bicycle box for waiting bicycle during red light (right)

This leg has 14 m width, divided into two directions. One (for the motor vehicle entering the leg from north, south and west legs) has 6 m width. The other direction (for the motor vehicle going out of east leg) has 8 m width, divided into two lanes, one is for vehicle turning left and the other is sharing for right turning and straight motor vehicles. Each lane has 3.5 m width. The rest portion of road is for bicycle lane.

Bicycle lane is the extension of bicycle path that 60 m before stop line at intersection merge with motor vehicles lane in the same level. This lane has grey coloured. In front of the car stop, there is bicycle box for cyclist waiting during red light. This box has dimension 4x7 m (See figure 17).

Traffic signal in this intersection are applied for all vehicles except for pedestrians, that has own signal when intend to cross the intersection.

5.2.2. Site Type B

The second selected site in this study is Type B bicycle crossing facility at four leg signalised intersection in Tornavägen-Getingevägen-Svenshögsvägen, focusing in south leg of Tornavägen. The surroundings of the intersection are mainly resident area. The dominant traffic road users in this intersection is motor vehicles. Bicycles and pedestrians are placed on separate path next to the motor vehicle lanes.

This leg has 13 m width, divided into two directions. One (for the motor vehicle entering the leg from north, west and east legs) has 5 m width. The other direction (for the motor vehicle going out of south leg) has 8 m width, divided into two lanes, one is for vehicle turning left and the other is sharing for right turning and straight motor vehicles. Each lane has 4 m width.

Figure 18: Site Type B at Tornavägen South, signalised intersection of Tornavägen-Getingevägen- Svenshögsvägen (left) and signal facility for cyclist when crossing (right)

This intersection is controlled by traffic signals for motor vehicle in each legs. The cyclist and pedestrian have shared used path whereas it has different level with motor vehicles lanes. Besides that, bicycles have own signal to cross the intersection. For crossing, bicycle has own lane beside the pedestrian crossing.

5.3. Accident data analysis

General

Based on combination statistics from the hospital and police in 2007, there were 373 injured vulnerable road users in Lund. Of these, 229 were cyclists, 119 were pedestrians and 25 were moped. Most of them are the typical of single accidents (60%), and followed by collision between bicycles and motor vehicles (22%), bicycles and bicycles (15%), bicycles and pedestrian (2%) and 1% of them is others (Lunds Kommun, 2008b, p 25).

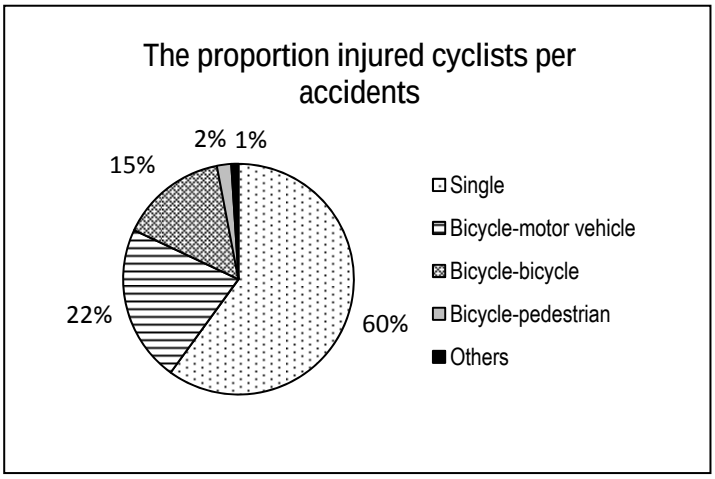

Figure 19: The proportion of injured cyclists per accidents

Accident data at sites selected based on STRADA

The Swedish Traffic Accident Data Acquisition (STRADA) is a traffic accident program that rely on the police and hospitals record. In this study, accident data is taken from STRADA at both sites selected with period time from 1 Januari 2003 until 31 December 2008.

During that period, there were 14 injured and killed person at site type A. From those data, there were four accidents involving bicycles and cars, which is three of them have accident type as the interest of this study. One of them is fatal accident that caused a cyclist died, that occured in 2005 when a truck came on Tornavägen and turn right onto Tunavägen. At the same time, a cyclist in the same direction and when the truck swung got the runner in the truck (Lund Kommun, 2008, p 28).

While at site type B, there were 13 accidents that four of them involving car and bicycle collisions. From those types, only two of them are like the interest of this study, they are the collision between the car that wants turn right and bicycle that want to cross the intersection from the same direction with the car.

5.4. Fields observations

Field observations conducted in order to test the hypotheses as follows: speed measurements, behavioural studies, conflict studies and interview with cyclist. These field observation is conducted approximately for one month observations.

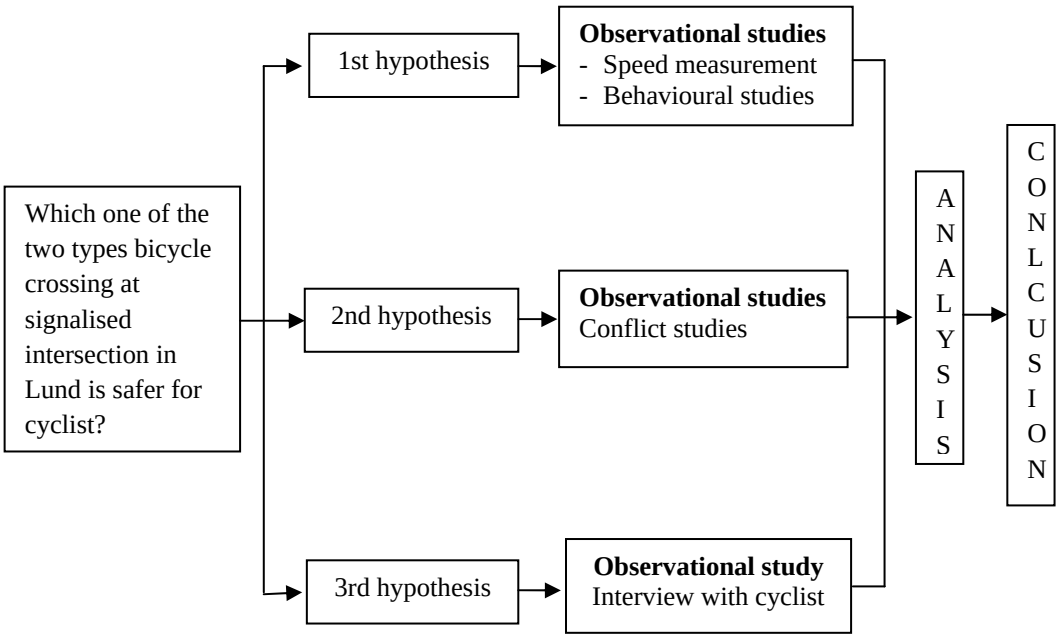

Figure 20: The scheme of observational studies

5.4.1. Speed measurements

Speed measurements is carried out to test the first hypothesis: "*Driver gives priority more often at bicycle crossing Type A than Type B"*. The basic idea of this observation is driver that give priority should be reduce the speed or even stop the car to give way to cyclist to cross the intersection. The focusing of speed measurement is the car that free to right turning because the main interest of study is interaction between turning right drivers with cyclists going straight to cross the intersecation, both are from the same direction. Free position can be assumed that

the car under observation pass the green light without any obstacles in front of them and free from the queue behind another vehicles. In this situation the driver has own speed choice.

Regarding to speed and give priority, Towliat (2001) confirm that low speed and no priority were correlated when it came to motorist's speed and give way behaviour toward unprotected road users at the interaction points, i.e. the lower the speed the better the give way behaviour of motorists.

The speed measurements were carried out at both sites of the study by using radar gun. There are two alternatives to measure the speed of cars (see Figure 21) and in this observation, the first alternative is by shooting the car from the rear and the second alternative is by shooting from in front of the car. Basically, the observer hide the radar gun as much as possible so that the radar gun was not seen by driver. The purpose of this was to prevent the driver change the speed due to realising that he/she was under observation. The target of the number of observation of speed measurements was 100 cars.

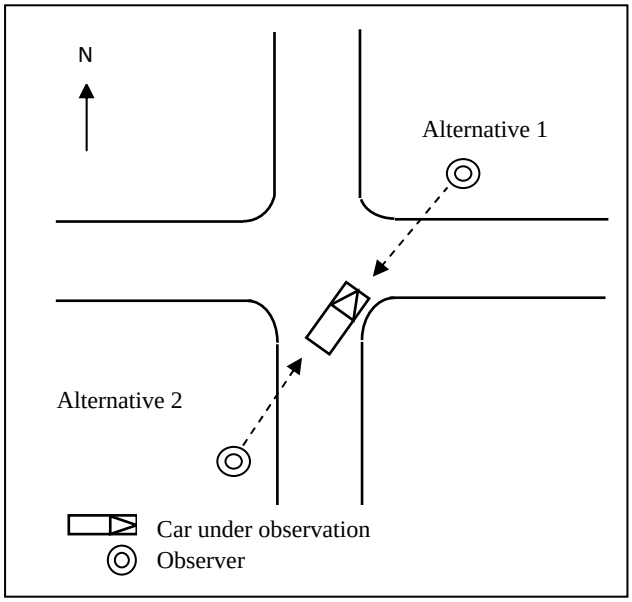

Figure 21: The position of observer in speed measurements, alternative 1 is to measure speed from in front of the car whilst alternative 2 is to measure the speed from the rear of the car

5.4.2. Behavioural studies

Behaviour studies were conducted to test the hypothesis: "*Driver gives priority more often at bicycle crossing Type A than Type B"*. The behavioral studies concerned head movement observation and give priority observation.

a. Head movement observation

The first observation is observation of head movement of driver behaviour when they want to turn right the intersection through the site of study. Head movement observation can be used to study the traffic situation for road users at an intersection, assuming that the visual search strategy of drivers is associated with certain driver behaviour that causes an accident (Herland, 2000).

Head movement observation was carried out to investigate the driver behaviour when there is no cyclist. The aim is to investigate whether the driver has the will to observe the situation at intersection facing the cyclist on the right side of the car. The driver was be observed from ± 20 m before approach the intersection.

b. Give priority observation

The second observation is give priority observation. This observation is carried out when the car intended to turn right and the bicycle intended to cross the intersection from the same direction, they make interaction each other. With other word, interaction in traffic environment is based on communication between the different road users, the quality of the communication is influenced by the perception of the current situation by road users (Engqvist and Palmblad, 2001). Since communication become the basic interaction, interaction between driver and cyclist will occur if one of them reducing the speed or even stopping the car, in this case this action has purpose to give priority to other road users.

The observation is conducted using instrument as observation form and pencil. The interest of this observation is interaction that occured at the time of green light on, the car approaching the intersection, while in the same time the cyclist also intend to cross the intersection. An interaction was registered when there is interaction between a driver and a cyclist or a driver and a group of cyclist. The observation only focus in this interaction with indicators that one of them (driver or cyclist) reduce the speed or even stop the car/bicycle or keep driving/riding. There is no special distance to investigate the car or bicycle position toward the point of meeting and also when they make an action, however, if one of them

realise the presence of others and make an action, it will be registered as one interaction.

The driver behaviour that investigated in this study whether the driver give attention and give priority to cyclist when approach and want to turn right the intersection or just drive the car on. The indicators from this study are driver give priority in good time, driver give priority late and driver drive on.

Giving priority in good time means that drivers really realise of the presence of the cyclists moving at their right side or in front of them, give them priority to cross by reducing the speed or even stopping the car. Whilst to give priority late means the driver give priority to cyclists but the position of car is too close to cyclist or the reaction of driver is late. Sometimes the driver concentrates on the car from opposite direction and suddenly realises the cyclist on the right side. It seems like slight conflict in conflict studies, in line with that interaction studies is a complement to conflict studies (Linderholm, 1992). The last indicator is driver drives on, it means does not give priority for the cyclist to cross the intersection.

Head movement and give priority observation are done in the same wag with the consideration that are two different situation for both observations of driver behaviour: when there is a cyclists and where there is no cyclist.

5.4.3. Conflict studies

Conflict studies is are chosen in this study with the aim to test the second hypothesis: *"There are fewer conflicts between driver and cyclist at bicycle crossing Type A than Type B"*. Conflict studies are nedeed since the accident data are considered too few to be analyzed. This study can be used to evaluate a change for instance in a pre-post-study of reconstruction. Moreover, it can be used to compare different intersections (Herland, 2000).

This study will be conducted using the Swedish traffic conflict technique. This technique assesses the serious conflict whereas serious conflicts indicate a breakdown in the interaction between two road users, i.e. the perceived accident potential is so high that at least one of the road users would not like to be involved in the creation of a similar event deliberately (Hydén, 1987).

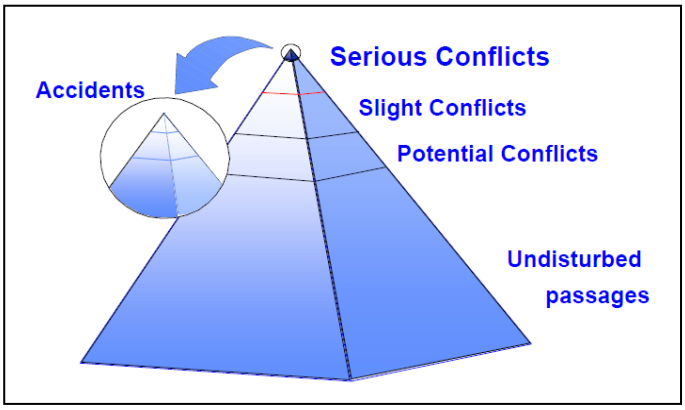

Figure 22: Pyramid of serious conflict (Hydén, 1987)

This technique based on two variables: time to accident (TA) and conflicting speed (CS). TA is the time that remains from the moment one of the road users takes evasive action until a collision would have occured if the speeds and directions of the involved road users had been unchanged. CS is the speed of the road user who take evasive action, just before the evasive action. A serious conflict is defined by certain border values for TA and CS (Departement of Traffic Planning and Engineering, 1992).

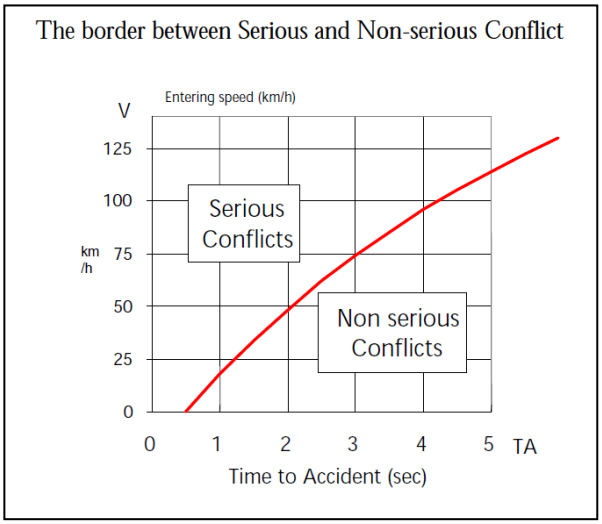

Figure 23: The diagram of serious and non serious conflict (Departement of Traffic Planning and Engineering, 1992)

The observation is conducted in 6-7 hours a day during weekday or 30 hours in total during five weekdays. The time chosen cover the peak hours morning and afternoon, therefore the time chosen are 07.30-09.30, 11.00-13.00, and 15.00-18.00.

The focus of conflict studies is to observe the conflict between cyclist crossing the intersection and car driver going turning right from the same direction and conflict between cyclist crossing the intersection and driver going turning left from opposite direction. In this observation, all conflicts will be registered and then for analysing, only serious conflicts are used.

5.4.4. Interview with cyclists

Interview with cyclist is the best way to test the third hypothesis: *Cyclists feel safer at bicycle crossing Type B than Type A.* This interview has the purpose to know the cyclists perception about their feeling when crossing the site of study, whether they feel safe or not safe. Cyclists are interviewed after they crossed the sites of study. For this evaluation, 50 cyclists at each site of study were interviewed. This interview is conducted using standard questions, that means every cyclists was asked the same questions during interview. The interview was done in English, with form that was prepared before. Another information for the evaluation was gender, age and time of the interview.

The first question given to cyclists after they were stopped was: “How often do you cross the intersection?”. This question is provided to gain insight how often the cyclists crossing the site of study and conclude it how far they accustom with situation of intersection. In first question, three alternative answers were provided: daily, several times in a week and several times in a month.

The second question: “Who has the priority when you cycle straight through the intersection and the car from same direction turns right, the car or the bicycle?”. This question aims to get information of cyclist knowledge about the priority. In this alternative answers are: car, bicycle and no idea. To describe the situation in order to get cyclists figure out, the sktech of interaction was showed for them.

The third question: “How safe do you feel when you cycle through this intersection?”. This question aims to know the feeling of cyclist while crossing the intersection. The scale of answer is provided, they are: Very safe, safe, unsafe and very unsafe.

The fourth question: “Which design of intersection do you consider safer for bicyclist?”. Since this study is comparable analysing between two kind of bicycle crossing facilities, these were showed to cyclists with the purpose that they will choose the design that they thought is safer when they cross it. To help getting

point of this question, two kind of images of intersection (Type A and B) is shown for them. For reasoning, it is also asked why they choose it with free answer.

5.5. Results from the field observations

The field observation is carried out to test the hypotheses that conducted from 23 April 2009 until 25 May 2009. Before that, traffic counting also conducted in order to select the sites, that conducted in 2 and 3 April 2009 in site type A whilst data from site type B is taken from previous study in 2008.

5.5.1. Result from speed measurements

The speed measurements were carried out at both sites of the study. The evaluation of the position of observer was conducted to get the proper measurement with the basic measurement is driver's own choice speed. Driver's own choice speed means that during the green light, driver approached the intersection and turn right without obstacles. Furthermore, the car was not in queue behind the other car. Based on this requirements, the two alternatives of measuring the speed was evaluated (see Figure 21).

Measuring from both alternative basically possible in this observation. However, when the free choice of speed becomes the main goal of this observation, there were more obstacles to use alternative 1, such as the observer could not observe the exact position of the car, whether drivers were using free choice of speed or in queue because of bad visibility. The second reason was that if there were cars in front of the observer, it was difficult to shoot the car. The last things was the observer more exposed if stands up in the position of alternative 1, so the driver possible to know the presence of the observer and change the speed immediately.

Based on alternative 2, the observer took place approximately 40-50 m behind of the passing cars. The observer really know the exact position of the car, able to see if the signal shows green, yellow or red and easier to hide the radar gun. In this position, the observer had a good visibility to investigate the speed of car. Therefore, alternative 2 is chosen in this observation to get proper the data of speed measurement.

Speed of 75 cars was measured at both sites of study since 100 cars could not be achieved considering the difficulties of finding the free cars that make turning right freely in both sites. Data of speed measurements can be seen in Appendix B.

From the 75 cars measured at both sites, the description of result show mean speed in the site Type A is 18.13 km/h while in site type B is 16.79 km/h. The standard deviation of the the site Type A is 3.13 km/h while in the site type B is 3.22. Even though Type B is higher, the differences are judged small. The minimum speed measured in the site Type A is 11 km/h and the maximum is 28 km/h, when in the type B the minimum speed is 10 km/h and the mazimum is 27 km/h. Both sites have range 17 km/h. Furthermore, 85 percentile level in Type A is 21 km/h while in Type B is 20 km/h.

Table 2: The comparison of mean, median, standard deviation and 85 percentile level

	Type A Tornavägen-Tunavägen	**Type B** Tornavägen-Getingavägen-Svenshogsvägen
Mean (km/h)	18.13	16.79
Median (km/h)	18	17
Standard deviation	3.13	3.22
85 percentile level	21	20

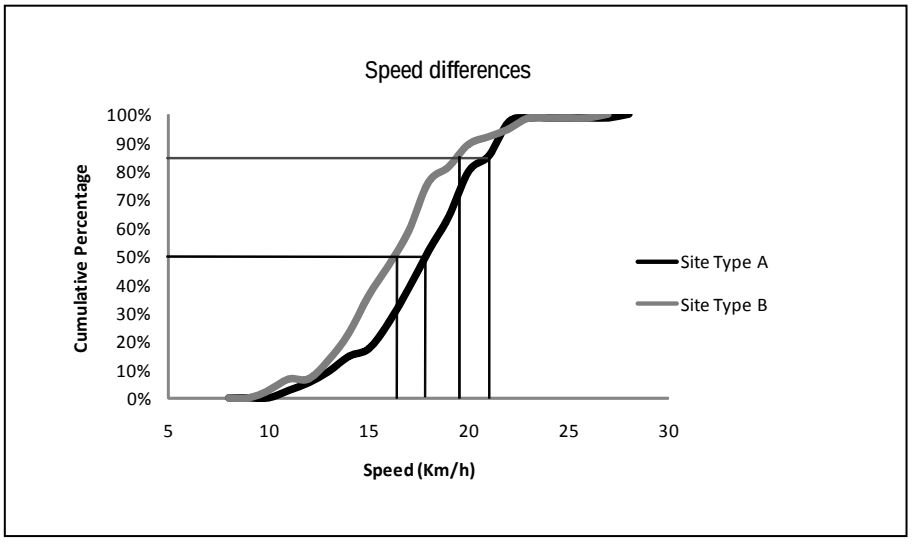

Figure 24: Speed differences of site Type A and Type B

5.5.2. Result from behavioural studies

Head movement and give priority observation were carried out to test the hypothesis: *Driver gives priority more often at bicycle crossing Type A than Type B.* The observasion was conduted from 27 April until 8 May 2009 in both sites of study, with duration observation 10 hours respectively. The result of this studies can be seen in Appendix D, E, F and G.

Observation of head movement and give priority observation was carried out in the same time in each site, using the same form that was made and be tested before. The basic observations are to investigate the driver when on the lane of turning right without any bicycles on the right of them for the driver's head movement observation and to investigate the interaction between driver and cyclist for give priority behaviour, whether the driver give priority to cyclist or not.

a. Head movement observation

In site type A (East Tunavägen of Tornavägen-Tunavägen intersection), 516 drivers were investigated on driver's head movement observation. Based on gender, it can be categorized that 65% (337) of them are male drivers and 35% (179) are female drivers. Whilst in site type B, 579 drivers are under investigation, 60% (350) of them are male drivers and 40% (229) of them are female drivers. From the gender characteristics can be said that between site type A and B has the similarity that most of drivers under investigation are male drivers. From overall result of the investigation, 21% drivers under head movement observation in site type A did head movement to observe situation while approaching and turning right the intersection whilst in site type B is 28%.

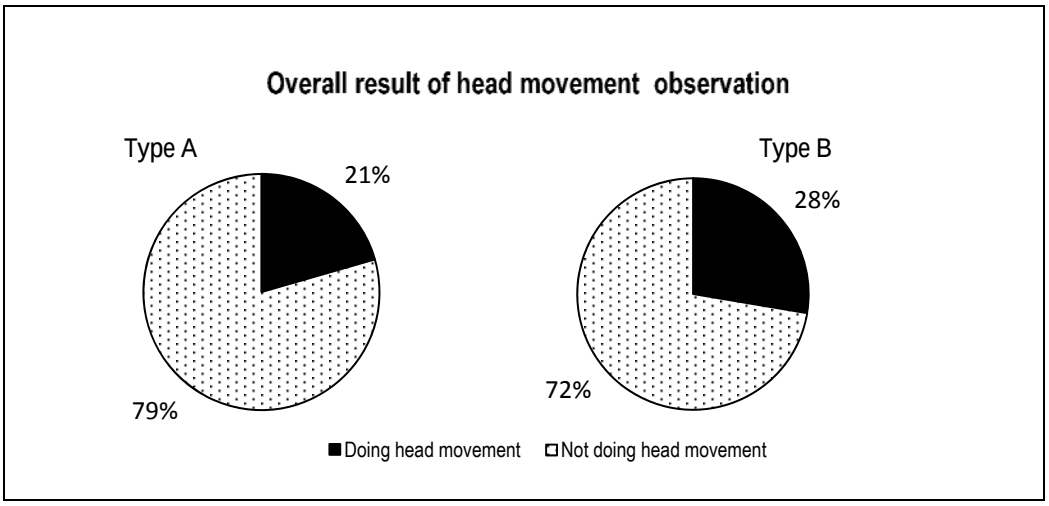

Figure 25: The overall result of head movement observation

For comparing the gender percentage of drivers that did head movement, comparation between number of male or female driver that did head movement and the number of male or female driver under investigation at each site is evaluated. The result showed that in site type A, female driver judged did head movement more often with 0.29 (52/179) than male driver with 0.16 (54/337). Whilst in site type B, female driver also judged did head movement more often with 0.32 (73/229) than male driver with 0.25 (87/350).

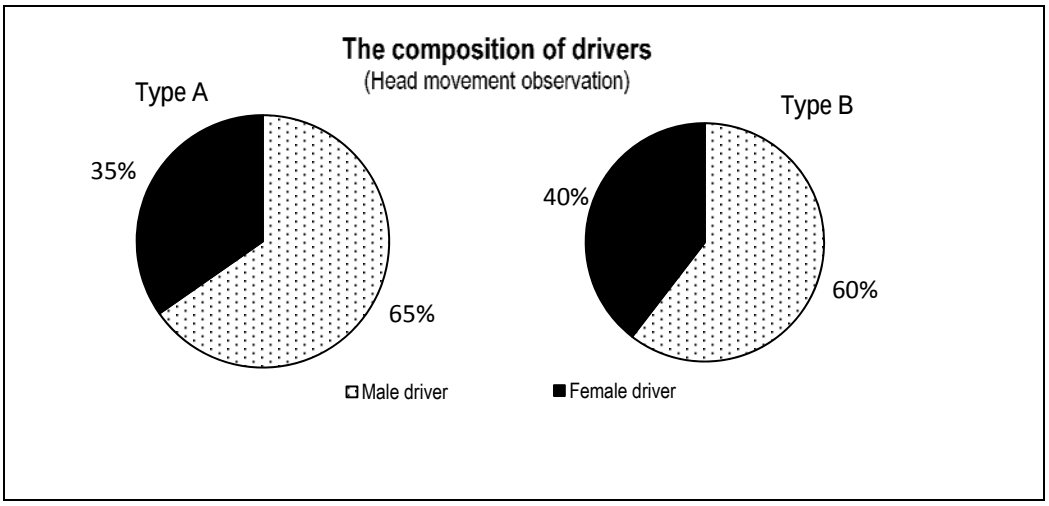

Figure 26: The composition of driver in head movement observation

Based on the result, the percentage of drivers at both sites of study did head movement less than 30%, respectively at site type A was 21% while at site type B was 28%. Chi square test is carried out to test wether the type of site affects the head movement behaviour or not. The result showed that in this case, the type of site affects the behaviour of head movement (Asymp. Sig.= 0.006).

b. Give priority observation

Give priority observation in this study focus on the driver behaviour when approach the intersection and want to turn right, whether they give more often priority to the cyclists or not.

Based on gender composition, in site type A, the drivers under investigation in those interactions 53% (65) of them are male driver whilst female driver are 47% (57). While in site type B, 61% (75) of drivers under observation are male drivers and the rest of it only 39% (48) of them are female drivers.

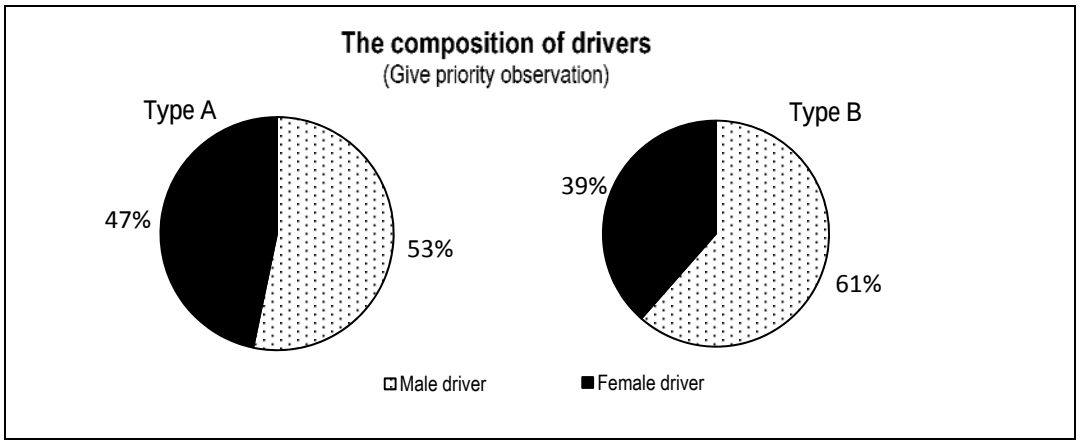

Figure 27: Gender composition of give priority observation

In site type A, 122 interactions are registered. From those interactions, in site type A, 81% (99) of drivers gave more often priority to cyclists in good time, 6% (of 7) drivers gave late priority and 13% (16) of drivers did not give priority and kept drive on. Whils in site type B, from 123 interactions, 78% (96) of drivers under observation gave more often priority in good time to cyclists, 6% (7) gave late priority and 16% (20) of them did not give priority and kept drive on.

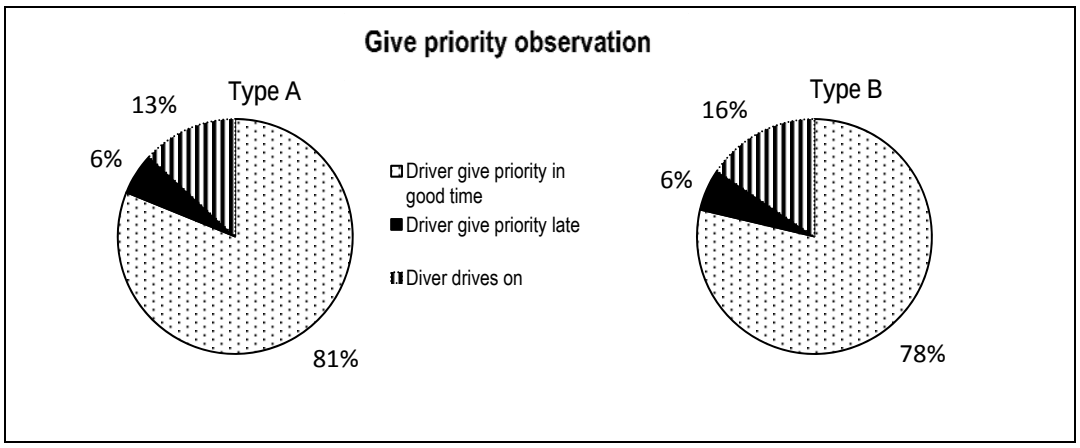

Figure 28: The result of give priority observation

Combining the result between driver give priority in good time and driver give priority late as driver give more often priority, it can be said that 87% (106) of the drivers in site type A give more often priority whilst in site type B is 84% (103).

For comparing the gender percentage of drivers that give more often priority, comparation between number of male or female driver that give priority and the number of male or female driver under investigation at each site is evaluated. The result showed that at site type A, female driver judged gives more often priority with 0.88 (50/57) than male driver with 0.86 (56/65). Whilst site type B, male

drivers judged gives more often priority with 0.85 (64/75) than female driver with 0.81 (39/48).

To test whether the type of site affects the give priority or not, chi square test was conducted with result that the type of site do not affect the behaviour of give priority (Asymp. Sig.= 0.487).

5.5.3. Results from conflict studies

Conflict studies in this study were conducted by using the Swedish conflict technique. This observation is carried out during peak hours in morning, noon and afternoon with extending of that hours, totally 6-7 hours per day during five week days. Interaction of drivers and cyclists in the site of study are interest of observation.

During observation, 11 serious conflict were registered in site Type A. Conflict between turning right drivers and crossing cyclist, that came from the same direction, were the most occured frequent (10 events) while the rest of them is conflict between turning left driver from opposite direction with cyclist crossing (1 event).

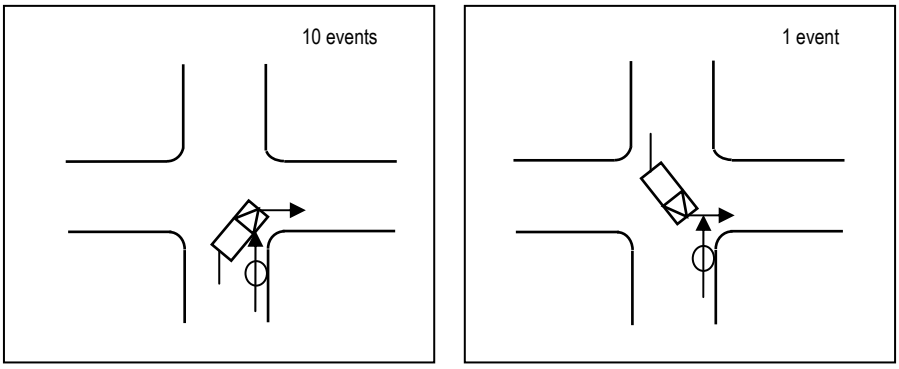

Figure 29: The types of serious conflicts at site Type A

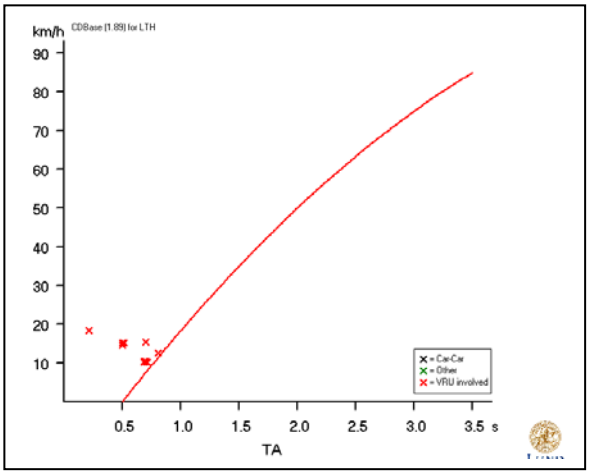

Figure 30: Diagram of serious conflicts at site Type A

At site type B, there were 18 serious conflicts registered with more conflict types than site type A. Conflict between turning right drivers and crossing cyclist that came from the same direction, are become the most occurably in this site (12 events) followed by conflict between turning right driver with cyclist crossing from opposite direction (three events), and then conflict between turning left driver from the opposite site of study with cyclist crossing from the same direction of the car (two events) and conflict between left turning drivers from the opposite of site of study with cyclist crossing from the site of study (one event).

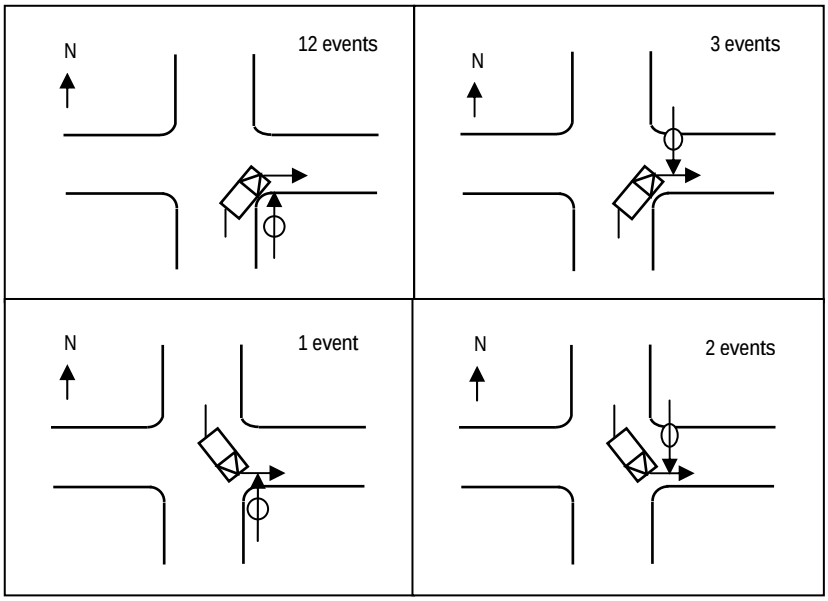

Figure 31: The types of serious conflicts in site Type B

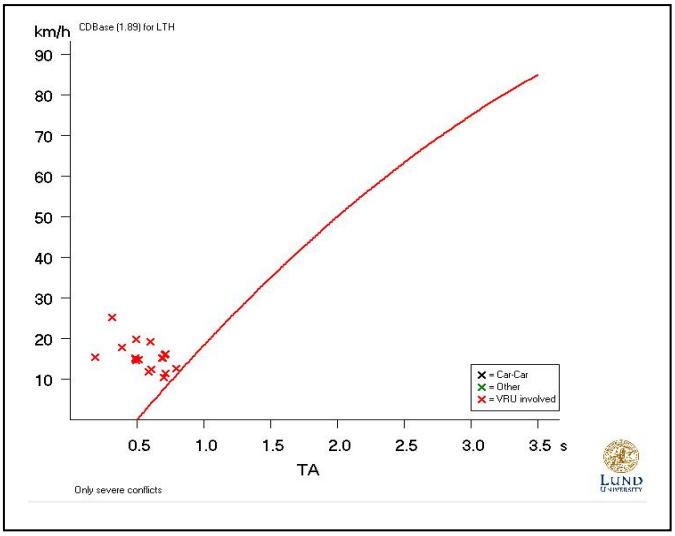

Figure 32: Diagram of serious conflicts at site Type B

Concerning the conflict studies, it can be concluded that site type B has more serious conflicts than site type A. Moreover, the types of serious conflict at site type B is more varied than site type A.

5.5.4. Results from interview with cyclists

Interviews with cyclist were conducted by stopping cyclists after they crossed the intersection. The interview was conducted in English, with four standard questions for all interviewees. Each interview took two to 10 minutes. Fifty cyclists in each sites were stopped and interviewed. The background of the cyclists can be explained by gender and age. For analysing range of age are formed by three levels, under 18 years old, between 18 and 60 years old, and over 60 years old. The result of the interview with syclist can be seen in Appendix H and I.

From the composition of gender, the cyclists interviewed at both sites of study have the similarity of number male cyclists and female cyclists. At site type A, from 50 interviewees, 52% of them are male cyclist and 48% of them are female cyclists. On the other site of study, 56% of them are male cyclist, the other of female cyclists 44%.

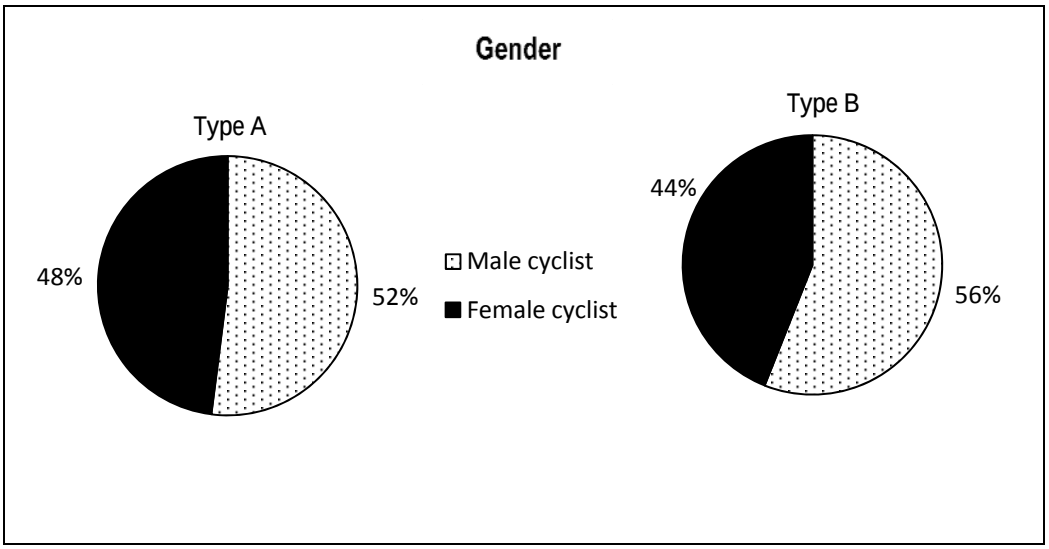

Figure 33: The composition of gender of cyclists at both sites

Based on interviewees' ages, most of interviewees in both sites are between 18 and 60. At site type A, 6% of interviewees are under 18 years old, 88% of them are between 18 and 60 years old and 6% are over 60 years old. At site type B, 2% of interviwees are under 18 years old, 92% are between 18 and 60 years old and 6% are over 60 years old.

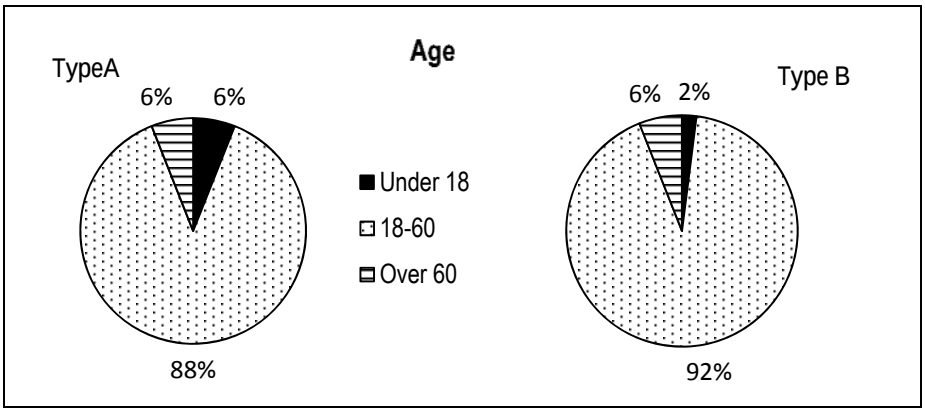

Figure 34: The composition of age of interviewed cyclists at both sites

Question and answer

Question 1: How often do you cross the intersection?

This question has alternative answers: daily, several times in a week and several times in a month. The figure below appears shows that in site Type A most of cyclists are crossing the site of study daily, followed by cyclists crossing the site several times in a week and several times in a month. The same situation in site type B, most of the interviewees crossing the site of study daily also than other

alternatives, followed by interviewees that crossed several times in a week and in several times in a month. It can be concluded that most cyclists that crossed the site of study in both types really know the traffic situation there because accustomed with the condition and environment surroundings.

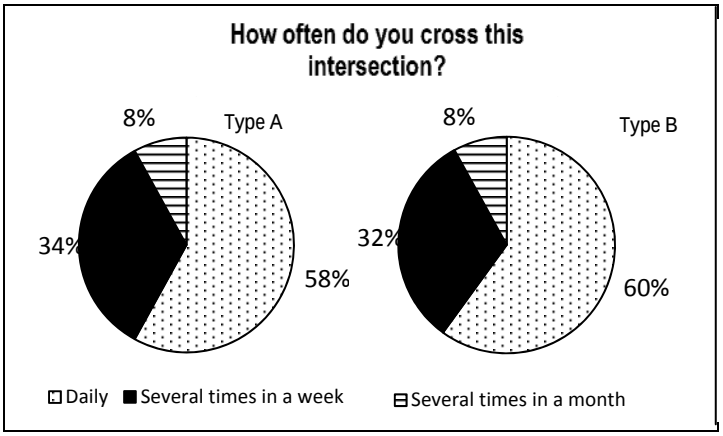

Figure 35: Answers to the first question

Question 2: Who has the priority when you cycle straight through the intersection and the car from the same direction turns right, the car or the bicycle?

Description of question was given to interviewees with a figure, in case there were confusing. The figure given based on the intersest of study (see figure 1). According to the interviewed, in site Type A, most of interviewees gave the correct answer that bicycle has priority to cross the intersection while there is a car want to turn right in the same time from the same direction. On the other hand, based on the same question, in site Type B little bit higher. In site type A the rest of interviewees answered that the car has priority (20%). In this case, all of interviewees gave the answer. Whilst in site Type B, 10% of interviewees gave answer that car has priority, while the rest of them had no idea about this the answer (12%).

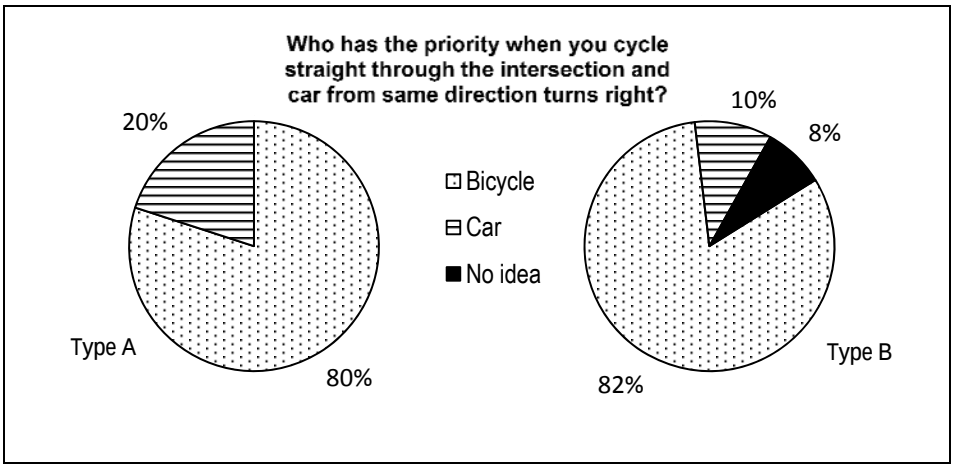

Figure 36: Answers to the second question

Question 3: How safe do you feel when you cycle through this intersection?

This question was given with scale for alternative answers, very safe, safe, unsafe and very unsafe. Based on interviewed, in site Type A, 6% of them feel very safe when crossing the site of study, whilst with the same question 14% of interviewees in site type B feel very save when crossing the intersection site of study. Most of the interviewees in both sites feel safe when crossing in site of study repectively with 62% in site Type A and 64% in site type B. While 26% interviewees in site type A feel unsafe when crossing the intersection, in site type B there are 22% of interviewees are feel the same. For the last alternative, 6% of interviewees in site type A feel very unsafe but none of interviewees in site type B feel very unsafe when crossing the site of study.

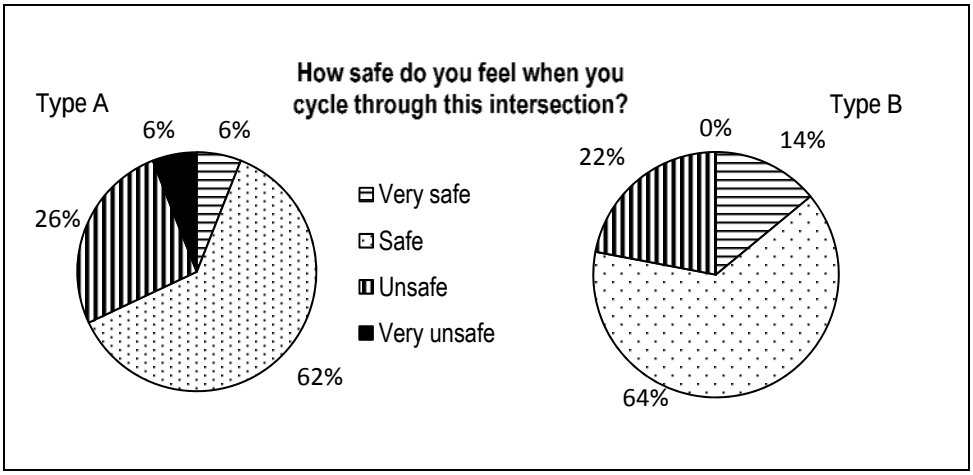

Figure 37: Answers to the third question

Question 4: Which design do you consider safer for cyclists?

This question has alternative answer, that is design type A and type B, represented the site of study. For this question, a pair of images showed to help the interviewees to figure out of the design.

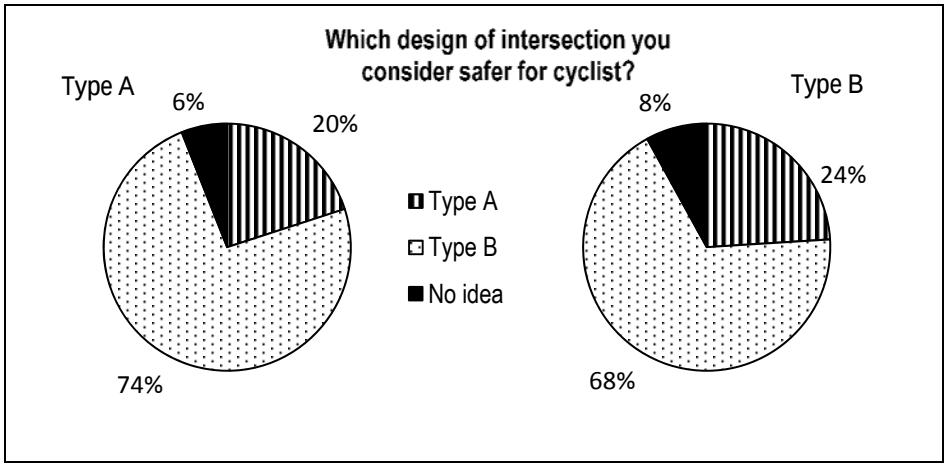

Figure 38: Answers to the fourth question

In this interview, 74% of interviewees in site Type A chose the design of bicycle facility of Type B that safer for cyclist to crossing on, 20% of chose that bicycle facility of the site type B is safer for the cyclist to crossing on and 6% of them have no idea about the design. Whilst in site type B, 68% of interviewees chose the bicycle facility in site B is safer for cyclist to cross on, 24% of them chose site Type A is safer for cyclist and others have no idea about the design.

When asking for the reason, interviwees answered with variety of reasons that describes that the design site type A is chosen as safer for cyclists because the driver can notice the cyclists easily and in this design, cyclist can cross directly, no need tu make slight right turning first before crossing. On the other hand, interviewees consider the design of site type B is safer for cyclists because it has own path that make cyclists separate from motor vehile lanes. The other reason is the presence of signal for cyclists to cross the intersection, the marking of bicycle crossing is drawn clearly and close to pedestrian crossing. It makes the driver more aware in that intersection.

If combined the interviewees in both sites, there are 71% of them chose the design type B as safer for cyclist and 22% of them chose design of type A is safer for cyclist.

6. Discussion and conclusion

Based on the hypotheses formulation, field observation was conducted to test them. Paragraph below will discuss the result of field observation in relation with testing of hypotheses.

6.1. The result of hypotheses test

First hypothesis: Driver gives priority more often at bicycle crossing Type A than Type B

Speed measurement and behavioural studies was carried out to test this hypothesis. From speed measurement result, that shown in site Type A has higher mean speed than site type B. In fact, that basic idea of speed measurement is driver will slow down or reduce the speed when approach the intersection and give priority to cyclist.

From behaviour studies, there are two observations, head movement observation and give priority observation. Basically, the idea of head movement observation is drivers that often do head movement when approch the intersection, they will give more priority to the cyclist that want to cross the intersection from the same direction of the driver. The result showed that the percentage of the head movement in site type B is higher than site type A.

The result of give priority observation showed that the percentage of drivers in site type A give more often priority to cyclist to cross the intersection than drivers from site type B. Moreover, the drivers in site type A less did drive on when approach the intersection and interact with cyclist.

However, based on chi square test, it can be concluded from head movement observation, that the type of site affected the behaviour of drivers. In contrary with that result, from give priority behaviour, the type of site did not affect the behaviour of driver.

Considering above, it can be concluded that first hypothesis is not supported by the results.

Second hypothesis: There are fewer conflicts between driver and cyclist at bicycle crossing Type A than Type B

Since conflict studies were conducted in same number of hours, the result showed that number of serious conflict in site type A are less than site type B. Moreover, the type of serious conflicts in site type B more various than site type A (four different types).

In this case, the hypothesis is supported by the results.

Third hypothesis: Cyclists feel safer at bicycle crossing Type B than Type A

The comparison of interviewees in each sites that feel safe when crossing the intersection actually showed no big difference of percentage between them. How ever, in site type A the percentage of interviewees that feel very safe is less than in site type B. So, if that scale is combined, the cyclists that feel safe and very safe in site type B higher than in site type A. Moreover, most of interviewees in both sites chose design of intersection type B safer for cyclist to cross.

It can be concluded that the hypothesis is supported by the results.

6.2. Discussion

Since this thesis aims to analyse two types of design bicycle crossings at signalised intersection and compare them, some indicators were evaluated in terms of traffic safety.

Based on speed measurement observation, the result of the mean speed in both sites did not show big differences of values. However, mean speed in site type A is higher than site type B. In contrary of that, the result of giving priority behaviour showed that drivers give more often priority in site type A than in site B. Basically, the lower the speed the better the give priority behaviour of driver (Towliat, 2001).

Eventhough the mean speed value and give priority behaviour seemly contradiction, but it can be said that the differences of mean value of the speed in both sites judges small value (18.13 km/hour in site type A and 16.79 km/hour in site type B).

Regarding to head movement behaviour that can be said as indication of give priority of drivers toward cyclist to observe the situation when approach the

intersection, the result of observation showed that drivers in site type B do more often head movement than drivers in site type A. In contrary with that, the result showed that drivers gives more often priority in site type A than site type B. However, chi square test showed that site of study affect the behaviour of driver in head movement, whereas the site of study does not affect the behaviour of driver in give priority to cyclist to cross the intersection.

Related with the the existing regulations, there is no regulation that requires a driver to do the head movement when they want to turn right the intersection. Whilst for giving priority to cyclist, there is regulation of that (see give priority regulation, at chapter 3). From this differences, it can be said that giving priority of drivers to the cyclists is mandatory by the regulation. The consequence of that, give priority become common by the drivers, regardless the location. Since head movement of the drivers when approaching the intersection based only informal rules, the behaviour of drivers is affected by the location and the behaviour of the other road users (Björklund & Åberg, 2005).

Based on accident data from STRADA, the data of accident was only showed that it occured at the intersection. There is no spesific data that showing where in the intersection the accident occured. Hence, accident analysis at both only used to describe the general situation of the intersection.

In conflict studies, the number of serious conflict in site type B is more than site type A. Moreover, the type of conflicts also more various in site type B. If considering the type of serious conflict in site type B, about one third of them are conflict between drivers and cyclists that cross the site of study from the opposite direction or againts the flow.

The design of bicycle crossing in site type B is one way crossing. In this intersection, when the cyclists want to turn left, they have to cross the intersection first and then turn left through the other bicycle crossing. This step sometimes makes the cyclist take the short cut by crossing the wrong way or againts the flow of cyclist. This situation considered that there are some cyclists cross the wrong way in this site, so the emerged of conflict between driver and cyclist that againts the flow is very possible. Since this study want to evaluate the bicycle crossing, so the cyclist that against the bicycle flow in bicycle crossing also be considered to be evaluated.

For other reason, the design of type A make the cyclist uncomfortable when crossing against the traffic flow because the distance of bicycle lane and motor vehicle lane are too close. No marking for crossing at the middle of intersection

also one of the reason that cyclists in this site tend to follow the rules. On the other hand, at site type B, separate path for cyclists, own signal and crossing marked make cyclist more confident. Moreover, the position of bicycle crossing at this type is beside the pedestrian crossing that make cyclist sometimes does not aware of the presence of the car from his/her left side. For driver, since there is two signal (for pedestrian and cyclist), it need effort to more focus on the situation where beside the presence of cyclist and pedestrian, the driver also have to aware of the car from his/her opposite direction that have the same green period. The failure of negosiate with this situation, the conflict even the accident will emerge.

Regarding for the result of interview, the feeling safe of the cyclist when crossing the intersection type B are not followed by actual circumstances. The cyclist perceveid safer at type B because there are more facility for bicycle. In fact, there are more conflicts at site type B.

Considering the result of field observations, there is no dominant result that showed whether one of the types is better than the other type. The result of each observation did not support each other, such as speed measurements and give priority observation, head movement observation and give priority observation. However, from the result of conflict studies, there is indication that the bicycle crossing at signalised intersection type A seems to be safer for cyclists.

Furthermore, further studies with a larger number of sites is needed to get more robust and transferable result.

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Appendix A: Timetable of field observations

Site Tornavägen-Tunavägen (Type A)	Date	Time	Period (hour)	Site Tornavägen-Getingevägen-Svenshögsvägen (Type B)	Date	Time	Period (hour)
1. Speed measurement	23/04/2009	12.00-14.00	2	1. Speed measurement	24/04/2009	08.00-10.00	2
		16.00-19.00	3			12.00-14.00	2
	27/04/2009	10.00-12.00	2			16.00-19.00	3
		18.00-19.00	1		28/04/2009	09.00-10.00	1
	04/05/2009	09.45-11.45	2			14.00-16.00	2
		18.00-20.00	2		29/04/2009	18.00-19.00	1
					07/05/2009	10.00-11.00	1
		Total hour	12			Total hour	12
2. Behavioural studies	27/04/2009	07.30-08.30	1	2. Behaviour studies	28/04/2009	08.00-09.00	1
		12.00-14.00	2			12.00-14.00	2
		16.00-18.00	2			16.00-18.00	2
	04/05/2009	12.00-13.00	1		29/04/2009	16.00-18.00	2
		14.00-18.00	4		08/05/2009	15.00-18.00	3
		Total hour	10			Total hour	10
3. Conflict studies	07/05/2009	14.00-17.00	3	3. Conflict studies	07/05/2009	07.30-09.30	2
	08/05/2009	07.30-09.30	2			12.00-13.00	1
		12.00-13.00	1		08/05/2009	14.00-17.00	3
	15/05/2009	07.30-09.30	2		11/05/2009	07.30-09.30	2
		11.00-13.00	2			11.00-13.00	2
		15.00-18.00	3			15.00-18.00	3
	18/05/2009	07.30-09.30	2		12/05/2009	07.30-09.30	2
		11.00-13.00	2			11.00-13.00	2
		15.00-18.00	3			15.00-18.00	3
	19/05/2009	07.30-09.30	2		13/05/2009	07.30-09.30	2
		11.00-13.00	2			11.00-13.00	2
		15.00-18.00	3			15.00-18.00	3
	25/05/2009	07.30-09.30	2		14/05/2009	07.30-09.30	2
		11.00-13.00	2			11.00-13.00	2
		15.00-18.00	3			15.00-18.00	3
		Total hour	34			Total hour	34
4. Interview with cyclist	22/05/2009	07.30-18.00	7	4. Interview with cyclist	26/05/2009	07.30-09.30	2
	25/05/2009	09.40-10.50	1			11.00-17.00	6
		13.00-13.50	1				
		18.10-20.00	2				
		Total hour	11			Total hour	8

Appendix B: Speed Measurement

Site **Tornavägen-Tunavägen**

Date/Time 23/04/2009 (12.00-14.00)
(16.00-19.00)
27/04/2009 (10.00-12.00)
(18.00-19.00)
04/05/2009 (09.45-11.45)
(18.00-20.00)

Speed				
19	16	20	21	17
22	18	20	14	17
20	13	13	16	20
22	21	19	15	19
16	14	28	16	17
20	22	18	14	17
19	16	20	18	20
22	18	18	18	20
19	12	11	17	22
20	11	20	21	19
17	22	23	20	18
19	21	19	22	17
18	18	16	19	17
20	12	22	16	15
22	17	13	18	14

Site **Tornavägen-Getingavägen-Svenshögsvägen**

Date/Time 24/04/2009 (08.00-10.00)
(12.00-14.00)
(16.00-19.00)
28/04/2009 (09.00-10.00)
(14.00-16.00)
09/04/2009 (18.00-19.00)
07/05/2009 (10.00-11.00)

Speed				
17	10	16	16	17
20	14	17	14	17
10	13	22	16	18
17	18	15	11	18
17	18	18	17	20
14	18	19	16	18
14	15	13	21	19
27	16	16	15	23
18	15	15	18	19
14	21	11	22	18
18	13	20	17	15
18	23	15	13	15
15	20	11	15	20
17	16	20	14	19
23	14	16	13	18

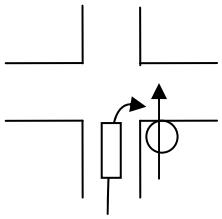
Appendix C: Behaviour studies protocol

Recording sheet of interaction between car driver and cyclist at bicycle crossing

Observer:_____ Date:_____ Time:_____ Number:_____

City:_____

Intersection:_____



Weather: Sunny ☐ Cloudy ☐ Rain ☐

Surface: Dry ☐ Wet ☐

No	No Cyclist	Head Movement	Car Driver				
			Gives priority in good time	Gives priority late	Drives on	Gender	
						Male	Female
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
Total							

Appendix D : Behaviour Studies at Tornavägen-Tunavägen (Type A)

Recording sheet of interaction between car driver and cyclist at bicycle crossings (a)

Date 27/04/2009
Time 07.30 - 08.30
Intersection Tornavägen-Tunavägen (Type A)
Weather Sunny
Surface Dry

No	No Cyclist	Head Movement		Car Driver			Gender		No	No Cyclist	Head Movement		Car Driver			Gender	
				Gives Priority		Drives							Gives Priority		Drives		
		Yes	No	In good time	Late	on	Male	Female			Yes	No	In good time	Late	on	Male	Female
1	√		√				√		51	√		√					√
2	√	√					√		52	√		√				√	
3	√		√					√	53	√	√						√
4	√		√				√		54	√		√				√	
5	√		√					√	55	√		√				√	
6	√		√				√		56	√		√				√	
7				√				√	57	√		√				√	
8	√	√						√	58	√		√				√	
9					√			√	59	√	√						√
10	√	√						√	60	√		√					√
11	√		√				√		61	√		√				√	
12				√			√		62	√		√					√
13	√		√					√	63	√		√				√	
14	√		√					√	64	√		√				√	
15	√		√					√	65	√		√				√	
16	√		√				√		66	√		√				√	
17	√		√				√		67				√				√
18					√			√	68	√		√				√	
19	√		√				√		69				√				√
20	√		√				√		70	√		√				√	
21	√		√					√	71	√		√				√	
22	√		√					√	72				√			√	
23	√	√						√	73				√			√	
24					√			√	74	√	√					√	
25	√		√				√										
26	√		√				√		Total	58	13	45	12	3	1	40	34
27	√	√					√										
28	√		√					√									
29				√			√										
30						√		√									
31				√			√										
32				√				√									
33				√			√										
34	√	√						√									
35	√	√						√									
36	√		√				√										
37				√				√									
38	√	√						√									
39				√				√									
40	√		√				√										
41	√	√						√									
42	√	√						√									
43	√		√				√										
44	√		√				√										
45	√		√					√									
46	√		√				√										
47	√		√					√									
48	√		√					√									
49	√		√				√										
50	√		√				√										
Total	38	10	28	8	3	1	23	27									

Recording sheet of interaction between car driver and cyclist at bicycle crossings (b)

Date 27/04/2009
Time 12.00-14.00
Intersection Tornavägen-Tunavägen (Type A)
Weather Sunny
Surface Dry

No	No Cyclist	Head Movement		Car Driver			Gender		No	No Cyclist	Head Movement		Car Driver			Gender	
				Gives Priority		Drives							Gives Priority		Drives		
		Yes	No	In good time	Late	on	Male	Female			Yes	No	In good time	Late	on	Male	Female
75	√	√					√		125	√		√					√
76				√			√		126	√		√					√
77	√		√				√		127				√			√	
78	√		√					√	128	√		√					√
79	√		√				√		129	√		√					√
80	√		√				√		130	√		√				√	
81	√		√				√		131	√		√				√	
82	√		√				√		132	√		√				√	
83	√		√				√		133	√		√				√	
84	√		√					√	134	√		√				√	
85	√	√						√	135	√		√				√	
86				√			√		136	√		√				√	
87	√		√				√		137	√		√				√	
88	√		√					√	138	√		√				√	
89	√		√				√		139	√		√					√
90	√		√				√		140	√		√					√
91	√		√				√		141	√		√				√	
92				√			√		142						√		√
93	√		√					√	143	√		√					√
94	√		√				√		144	√		√				√	
95	√	√					√		145				√				√
96	√		√				√		146	√	√						√
97	√		√					√	147	√		√				√	
98				√			√		148	√		√				√	
99	√		√					√	149				√			√	
100	√		√				√		150	√		√					√
101	√		√				√		151	√		√					√
102	√		√				√		152	√		√				√	
103	√		√				√		153	√		√					√
104	√		√				√		Total	25	1	24	3	0	1	16	13
105	√		√				√										
106	√		√				√										
107				√				√									
108	√		√				√										
109	√		√				√										
110	√		√					√									
111	√		√				√										
112				√			√										
113	√		√				√										
114	√		√				√										
115	√		√				√										
116				√				√									
117				√			√										
118				√			√										
119	√		√				√										
120				√			√										
121					√		√										
122	√		√				√										
123	√	√						√									
124	√		√				√										
Total	39	4	35	10	1	0	39	11									

Recording sheet of interaction between car driver and cyclist at bicycle crossings (c)

Date 27/04/2009
Time 16.00-18.00
Intersection Tornavägen-Tunavägen (Type A)
Weather Sunny
Surface Dry

No	No Cyclist	Head Movement		Car Driver			Gender		No	No Cyclist	Head Movement		Car Driver			Gender	
		Yes	No	Gives Priority In good time	Late	Drives on	Male	Female			Yes	No	Gives Priority In good time	Late	Drives on	Male	Female
154	√	√					√		204	√		√					√
155	√		√				√		205	√		√					√
156	√		√				√		206	√		√				√	
157	√		√				√		207	√		√				√	
158	√	√						√	208	√		√				√	
159	√		√				√		209	√	√					√	
160	√	√						√	210	√		√				√	
161	√		√				√		211	√		√				√	
162				√				√	212	√	√					√	
163				√			√		213	√		√					√
164	√		√				√		214				√			√	
165	√		√					√	215	√		√				√	
166				√				√	216	√		√					√
167	√		√				√		217	√	√					√	
168	√		√				√		218	√		√				√	
169	√		√				√		219	√	√					√	
170	√		√					√	220				√				√
171	√		√					√	221	√		√					√
172	√		√					√	222	√		√					√
173	√		√				√		223	√		√				√	
174	√		√				√		224	√		√				√	
175	√		√				√		225	√		√					√
176	√	√						√	226	√		√				√	
177				√			√		227	√		√				√	
178	√		√				√		228	√		√				√	
179	√		√				√		229	√	√						√
180	√		√				√		230	√		√					√
181	√		√				√		231	√		√					√
182	√		√				√		232	√		√				√	
183				√			√		233	√	√						√
184				√				√	234	√		√					√
185	√		√					√	235				√				√
186	√	√						√	236	√		√					√
187	√		√				√		237	√		√					√
188	√		√				√		238	√	√						√
189	√	√					√		239	√	√						√
190				√			√		240	√		√				√	
191				√			√		241	√		√				√	
192	√		√				√		242	√		√				√	
193	√		√				√		243	√	√						√
194	√		√				√		244				√				√
195	√		√				√		245				√				√
196	√		√				√		246	√		√				√	
197	√		√				√		247	√		√				√	
198				√				√	248						√	√	
199						√	√		249	√		√				√	
200						√	√		250	√		√				√	
201	√		√				√		251	√		√				√	
202	√		√				√		252	√		√				√	
203	√		√				√		253	√		√				√	
Total	39	6	33	9	0	2	37	13	Total	44	9	35	5	0	1	29	21

Recording sheet of interaction between car driver and cyclist at bicycle crossings (d)

Date 27/04/2009
Time 16.00-18.00
Intersection Tornavägen-Tunavägen (Type A)
Weather Sunny
Surface Dry

No	No Cyclist	Head Movement		Car Driver			Gender		No	No Cyclist	Head Movement		Car Driver			Gender	
		Yes	No	Gives Priority In good time	Late	Drives on	Male	Female			Yes	No	Gives Priority In good time	Late	Drives on	Male	Female
254	√		√				√		304	√		√				√	
255	√		√				√		305	√		√				√	
256	√		√				√		306	√		√				√	
257	√	√						√	307	√		√					√
258	√	√					√		308	√		√				√	
259	√		√				√		309	√		√					√
260	√		√				√		310	√	√					√	
261				√				√	311	√		√				√	
262	√	√					√		312				√				√
263	√		√				√		313				√			√	
264	√		√				√		314	√	√					√	
265	√	√					√		315	√		√					√
266					√		√		316	√		√				√	
267	√		√				√		317	√		√				√	
268	√		√				√		318	√	√					√	
269	√		√				√		319	√		√				√	
270	√		√					√	320	√		√				√	
271	√		√					√	321	√		√				√	
272	√		√					√	322	√		√				√	
273	√		√				√		323	√		√				√	
274	√	√					√		324	√		√					√
275	√		√				√		325	√		√					√
276	√		√					√	326	√		√					√
277				√			√		327	√		√				√	
278	√		√				√		328	√	√					√	
279	√	√					√		329	√		√				√	
280	√		√				√		330	√		√					√
281	√		√					√	331	√		√				√	
282	√	√						√	332	√		√				√	
283	√		√				√		333				√			√	
284	√		√				√		334					√		√	
285						√		√	335					√		√	
286	√		√				√		336	√	√					√	
287	√		√					√	337	√	√						√
288	√	√					√		Total	29	6	23	3	2	0	25	9
289	√	√						√									
290	√		√				√										
291	√		√				√										
292	√		√					√									
293	√		√					√									
294	√		√					√									
295	√	√						√									
296	√		√				√										
297	√		√				√										
298	√	√					√										
299	√		√				√										
300				√				√									
301				√				√									
302				√			√										
303	√	√					√										
Total	43	12	31	5	1	1	33	17									

Recording sheet of interaction between car driver and cyclist at bicycle crossings (e)

Date 04/05/2009
Time 12.00-13.00
Intersection Tornavägen-Tunavägen (Type A)
Weather Cloudy
Surface Wet

No	No Cyclist	Head Movement		Car Driver			Gender		No	No Cyclist	Head Movement		Car Driver			Gender	
		Yes	No	Gives Priority In good time	Gives Priority Late	Drives on	Male	Female			Yes	No	Gives Priority In good time	Gives Priority Late	Drives on	Male	Female
338	√	√					√		388				√				√
339	√	√					√		389				√				√
340	√	√					√		390				√				√
341	√	√						√	391						√	√	
342	√		√					√	392						√		√
343	√		√					√		0	0	0	3	0	2	1	4
344	√		√					√		36	4	32	17	0	2	34	21
345	√		√					√									
346	√		√					√									
347	√		√					√									
348	√		√					√									
349	√		√					√									
350	√		√					√									
351	√		√					√									
352	√		√					√									
353	√		√					√									
354	√		√					√									
355	√		√					√									
356	√		√				√										
357	√		√				√										
358	√		√				√										
359	√		√				√										
360	√		√				√										
361	√		√				√										
362	√		√				√										
363	√		√				√										
364	√		√				√										
365	√		√				√										
366	√		√				√										
367	√		√				√										
368	√		√				√										
369	√		√				√										
370	√		√				√										
371	√		√				√										
372	√		√				√										
373	√		√				√										
374				√			√										
375				√			√										
376				√			√										
377				√			√										
378				√			√										
379				√			√										
380				√			√										
381				√			√										
382				√			√										
383				√			√										
384				√			√										
385				√			√										
386				√				√									
387				√				√									
Total	36	4	32	14	0	0	33	17									

Recording sheet of interaction between car driver and cyclist at bicycle crossings (f)

Date 04/05/2009
Time 14.00-18.00 A
Intersection Tornavägen-Tunavägen (Type A)
Weather Cloudy
Surface Dry

No	No Cyclist	Head Movement		Car Driver			Gender		No	No Cyclist	Head Movement		Car Driver			Gender	
		Yes	No	Gives Priority In good time	Gives Priority Late	Drives on	Male	Female			Yes	No	Gives Priority In good time	Gives Priority Late	Drives on	Male	Female
393				√				√	443	√		√				√	
394				√				√	444	√	√					√	
395	√		√					√	445						√		√
396	√		√				√		446	√		√					√
397	√		√				√		447	√		√				√	
398	√	√					√		448	√	√					√	
399	√		√				√		449				√				√
400	√		√					√	450	√		√				√	
401	√		√				√		451						√		√
402	√		√				√		452	√	√					√	
403	√		√					√	453	√		√				√	
404	√		√					√	454				√			√	
405	√	√						√	455	√		√				√	
406	√		√				√		456	√	√						√
407	√		√				√		457	√		√					√
408	√	√						√	458	√		√					√
409	√		√				√		459	√		√					√
410	√		√				√		460				√				√
411	√	√						√	461	√		√				√	
412	√		√					√	462	√		√				√	
413	√		√				√		463	√		√					√
414	√		√				√		464				√			√	
415	√		√					√	465	√		√					√
416	√		√					√	466	√		√					√
417	√		√				√		467	√		√					√
418	√		√					√	468	√		√				√	
419	√		√				√		469	√		√				√	
420	√		√				√		470	√		√				√	
421	√		√					√	471						√	√	
422	√		√				√		472						√		√
423	√		√				√		473	√		√				√	
424	√	√						√	474	√		√				√	
425	√		√				√		475	√		√				√	
426	√		√				√		476	√	√					√	
427	√		√					√	477				√			√	
428				√				√	478	√	√					√	
429	√		√					√	479	√	√					√	
430	√		√					√	480	√		√				√	
431	√	√						√	481	√		√				√	
432				√				√	482	√		√				√	
433	√		√					√	483				√				√
434	√		√				√		484	√		√					√
435				√			√		485	√		√					√
436	√	√						√	486	√	√						√
437	√		√				√		487	√	√					√	
438	√	√						√	488	√		√					√
439	√		√				√		489	√		√					√
440	√		√				√		490	√		√				√	
441				√			√		491	√	√						√
442	√		√				√		492	√		√				√	
Total	44	8	36	6	0	0	26	24	Total	40	10	30	6	0	4	29	21

Recording sheet of interaction between car driver and cyclist at bicycle crossings (g)

Date 04/05/2009
Time 14.00-18.00 B
Intersection Tornavägen-Tunavägen (Type A)
Weather Cloudy
Surface Dry

No	No Cyclist	Head Movement		Car Driver			Gender		No	No Cyclist	Head Movement		Car Driver			Gender	
		Yes	No	In good time	Late	Drives on	Male	Female			Yes	No	In good time	Late	Drives on	Male	Female
493				√			√		543	√		√				√	
494						√	√		544	√		√					√
495	√		√				√		545	√	√					√	
496	√		√				√		546	√		√				√	
497				√				√	547	√		√				√	
498	√		√				√		548	√		√				√	
499	√		√				√		549	√	√					√	
500	√		√					√	550	√	√					√	
501	√		√					√	551				√				√
502						√	√		552	√		√				√	
503				√				√	553	√		√				√	
504	√		√				√		554	√		√				√	
505	√	√						√	555	√		√					√
506	√		√				√		556	√	√					√	
507	√		√				√		557	√	√						√
508	√		√				√		558				√				√
509	√		√					√	559	√		√				√	
510				√			√		560	√		√					√
511	√		√				√		561	√		√					√
512	√		√				√		562	√	√					√	
513	√		√				√		563	√	√					√	
514	√	√						√	564	√	√					√	
515	√		√				√		565	√		√				√	
516	√		√					√	566	√	√						√
517	√	√						√	567	√	√						√
518	√		√				√		568	√		√				√	
519	√		√				√		569	√		√					√
520	√		√					√	570	√	√						√
521	√		√					√	571	√		√				√	
522				√			√		572	√		√				√	
523	√	√					√		573	√	√						√
524	√	√					√		574				√			√	
525	√		√				√		575	√	√					√	
526				√				√	576	√	√						√
527				√				√	577	√		√					√
528	√		√					√	578				√			√	
529	√	√					√		579	√	√					√	
530	√		√				√		580	√		√				√	
531	√		√				√		581	√		√					√
532	√		√				√		582				√			√	
533				√				√	583				√			√	
534	√		√					√	584				√			√	
535	√		√					√	585	√		√				√	
536	√	√					√		586	√		√				√	
537	√		√				√		587	√		√				√	
538	√		√					√	588	√		√				√	
539	√	√					√		589	√		√				√	
540	√		√				√		590	√		√				√	
541	√		√				√		591	√		√				√	
542	√	√						√	592	√		√				√	
Total	40	9	31	8	0	2	31	19	Total	43	15	28	7	0	0	35	15

Recording sheet of interaction between car driver and cyclist at bicycle crossings (h)

Date 04/05/2009
Time 14.00-18.00 C
Intersection Tornavägen-Tunavägen (Type A)
Weather Cloudy
Surface Dry

No	No Cyclist	Head Movement		Car Driver			Gender	
		Yes	No	In good time	Late	Drives on	Male	Female
593	√		√				√	
594	√		√					√
595				√				√
596	√	√						√
597	√		√					√
598				√				√
599				√				√
600						√	√	
601	√	√					√	
602	√		√				√	
603	√		√				√	
604	√		√				√	
605	√	√						√
606	√	√						√
607	√		√				√	
608	√	√					√	
609	√		√					√
610	√		√				√	
611	√		√				√	
612	√		√				√	
613	√		√				√	
614	√		√				√	
615	√		√				√	
616				√			√	
617	√	√						√
618	√		√					√
619				√				√
620				√				√
621	√	√					√	
622	√		√				√	
623	√		√				√	
624	√		√					√
625	√	√					√	
626				√			√	
627	√		√				√	
628	√		√				√	
629	√		√				√	
630						√		√
631	√		√				√	
632	√		√				√	
633	√		√				√	
634	√		√					√
635	√		√				√	
636	√	√					√	
637	√		√					√
638				√				√
Total	36	9	27	8	0	2	28	18

Appendix E : Behaviour Studies at Tornavägen-Getingavägen- Svenshögsvägen (Type B)

Recording sheet of interaction between car driver and cyclist at bicycle crossings (a)

Date 28/04/2009
Time 08.00 - 09.00
Intersection Tornavägen-Getingavägen
Weather Sunny
Surface Dry

No	No Cyclist	Head Movement		Car Driver			Gender	
		Yes	No	In good time	Late	Below 30km/h	Male	Female
1	√		√				√	
2	√		√				√	
3	√	√					√	
4	√		√				√	
5	√		√				√	
6	√	√					√	
7				√			√	
8	√		√				√	
9	√		√				√	
10	√		√				√	
11	√		√				√	
12				√			√	
13	√		√				√	
14				√			√	
15				√				√
16	√	√					√	
17	√		√				√	
18	√		√					√
19	√		√					√
20	√		√				√	
21	√		√				√	
22	√	√					√	
23	√		√				√	
24	√	√					√	
25	√		√				√	
26	√		√				√	
27	√		√				√	
28	√		√					√
29	√		√				√	
30	√		√				√	
31	√		√					√
32	√		√					√
33				√				√
34	√		√				√	
35	√		√				√	
36				√			√	
37	√		√				√	
38	√		√				√	
39	√		√					√
40	√		√				√	
41				√			√	
42	√		√				√	
43	√		√				√	
Total	36	5	31	7	0	0	35	8

Recording sheet of interaction between car driver and cyclist at bicycle crossings (b)

Date 28/04/2009
Time 12.00 - 14.00
Intersection Tornavägen-Getingavägen
Weather Sunny
Surface Dry

No	No Cyclist	Head Movement		Car Driver			Gender	
		Yes	No	In good time	Late	Below 30km/h	Male	Female
44	√		√					√
45	√	√					√	
46	√		√				√	
47	√	√					√	
48	√		√				√	
49	√		√				√	
50				√			√	
51	√		√				√	
52	√		√				√	
53				√			√	
54	√		√				√	
55	√	√					√	
56	√		√					√
57	√	√					√	
58	√	√					√	
59	√	√					√	
60	√	√					√	
61	√	√					√	
62	√	√					√	
63	√		√				√	
64	√		√					√
65	√	√					√	
66	√	√					√	
67	√	√					√	
68	√	√					√	
69	√	√					√	
70				√			√	
71	√	√					√	
72	√		√				√	
73	√		√				√	
74	√		√					√
75	√		√				√	
76	√		√				√	
77	√	√					√	
78	√		√					√
79	√		√				√	
80	√		√				√	
81	√		√				√	
82	√		√				√	
83	√		√				√	
84	√		√				√	
85	√		√				√	
86	√		√				√	
87	√		√				√	
88	√		√				√	
89				√			√	
90	√		√				√	
91	√		√				√	
92	√		√					√
93	√		√				√	
Total	46	16	30	4	0	0	32	18

No	No Cyclist	Head Movement		Car Driver			Gender	
		Yes	No	In good time	Late	Below 30km/h	Male	Female
94	√		√					√
95	√		√				√	
96				√				√
97	√	√						√
98	√		√				√	
99	√		√				√	
100	√		√					√
101				√			√	
102	√		√				√	
103	√	√					√	
104	√		√				√	
105	√		√				√	
106	√		√				√	
107	√		√				√	
108	√		√					√
109						√		√
110						√	√	
111	√		√				√	
112	√	√						√
113	√		√				√	
114	√		√				√	
115				√			√	
116	√		√				√	
117	√	√					√	
118				√				√
119				√			√	
120	√		√					√
121	√	√						√
122				√				√
123				√				√
124				√				√
125				√			√	
126					√			√
Total	21	5	16	9	1	2	19	14

Recording sheet of interaction between car driver and cyclist at bicycle crossings (c)

Date 28/04/2009
Time 16.00 - 18.00
Intersection Tornavägen-Getingavägen
Weather Sunny
Surface Dry

No	No Cyclist	Head Movement		Car Driver			Gender		No	No Cyclist	Head Movement		Car Driver			Gender	
		Yes	No	In good time	Late	Below 30km/h	Male	Female			Yes	No	In good time	Late	Below 30km/h	Male	Female
127	√	√						√	177	√		√					√
128				√			√		178	√	√						√
129	√		√					√	179	√		√					√
130	√		√				√		180	√	√					√	
131	√		√				√		181	√	√						√
132	√		√					√	182	√		√				√	
133	√	√						√	183	√	√					√	
134	√	√					√		184				√			√	
135	√		√					√	185	√		√					√
136	√		√				√		186	√		√					√
137	√		√				√		187	√		√					√
138						√	√		188				√			√	
139	√		√					√	189	√		√				√	
140	√		√					√	190	√		√				√	
141				√			√		191	√		√					√
142	√		√				√		192	√	√						√
143	√		√					√	193	√	√						√
144				√				√	194				√				√
145	√	√						√	195	√	√					√	
146	√	√					√		196				√				√
147	√	√					√		197	√	√					√	
148	√		√					√	198	√	√					√	
149	√	√						√	199	√	√						√
150	√	√						√	200	√		√				√	
151	√		√					√	201				√				√
152	√		√				√		202					√		√	
153	√		√				√		203	√		√					√
154	√		√				√		204	√	√						√
155				√			√		205	√		√				√	
156	√		√				√		206						√	√	
157	√		√				√		207						√	√	
158	√		√				√		208	√	√						√
159	√		√				√		209	√		√					√
160	√	√					√		210	√		√				√	
161	√	√						√	211	√	√					√	
162	√		√					√	212	√		√					√
163	√		√					√	213				√			√	
164				√				√	214	√		√				√	
165					√			√	215	√		√				√	
166	√	√						√	216	√		√				√	
167				√			√		217	√	√						√
168	√		√				√		218				√			√	
169	√		√				√		219				√				√
170				√				√	220	√		√					√
171	√	√						√	221	√	√					√	
172	√	√						√	222	√		√				√	
173	√	√						√	223	√		√				√	
174	√		√				√		224	√		√				√	
175	√		√					√	225				√				√
176	√	√						√	226	√		√				√	
Total	41	15	26	7	1	1	24	26	Total	38	15	23	9	1	2	27	23

Recording sheet of interaction between car driver and cyclist at bicycle crossings (d)

Date 28/04/2009
Time 16.00 - 18.00
Intersection Tornavägen-Getingavägen
Weather Sunny
Surface Dry

No	No Cyclist	Head Movement		Car Driver			Gender		No	No Cyclist	Head Movement		Car Driver			Gender	
		Yes	No	In good time	Late	Below 30km/h	Male	Female			Yes	No	In good time	Late	Below 30km/h	Male	Female
227	√		√				√		277	√		√					√
228	√		√				√		278				√				√
229	√		√					√	279	√		√					√
230	√		√					√	280	√		√					√
231	√		√					√	281	√		√					√
232				√				√	282					√			√
233	√		√					√	283	√		√				√	
234	√	√					√		284	√		√				√	
235	√		√				√		285	√	√					√	
236	√	√						√	286	√	√					√	
237	√		√				√		287	√	√					√	
238	√		√				√		288	√		√				√	
239	√		√				√		289	√		√				√	
240	√		√				√		290	√		√				√	
241	√	√					√		291	√		√				√	
242	√		√				√		292	√		√				√	
243	√		√					√	293	√		√				√	
244	√		√					√	294	√		√				√	
245	√		√				√		295	√	√					√	
246	√	√					√		296						√	√	
247	√	√						√	297	√		√					√
248	√	√						√	298	√	√	√				√	
249	√		√				√		299	√						√	
250	√		√					√	300	√		√					√
251	√		√				√		301	√	√						√
252	√		√				√		302	√		√					√
253				√			√		303	√		√					√
254	√		√					√	304	√		√				√	
255	√		√					√	305	√	√					√	
256	√	√						√	306				√			√	
257	√		√				√		307	√		√				√	
258	√		√				√		308	√		√				√	
259	√	√					√		309	√		√					√
260				√			√		310	√	√					√	
261	√		√				√		311	√	√						√
262				√			√		312				√			√	
263				√			√		313				√			√	
264	√		√				√		314	√		√				√	
265	√		√				√		315	√		√					√
266	√		√					√	316	√		√				√	
267	√		√					√	317				√			√	
268	√	√						√	Total	34	9	25	5	1	1	27	14
269	√	√						√									
270				√				√									
271	√	√					√										
272	√	√					√										
273	√	√					√										
274	√	√					√										
275	√		√					√									
276	√		√					√									
Total	44	14	30	6	0	0	29	21									

Recording sheet of interaction between car driver and cyclist at bicycle crossings (e)

Date 29/04/2009
Time 16.00 - 18.00
Intersection Tornavägen-Getingavägen
Weather Sunny
Surface Dry

No	No Cyclist	Head Movement		Car Driver			Gender		No	No Cyclist	Head Movement		Car Driver			Gender	
		Yes	No	In good time	Late	Below 30km/h	Male	Female			Yes	No	In good time	Late	Below 30km/h	Male	Female
318				√				√	368	√		√					√
319	√		√					√	369	√		√					√
320	√		√					√	370	√		√				√	
321	√		√				√		371	√		√					√
322	√	√						√	372	√		√					√
323				√				√	373	√		√					√
324	√	√						√	374	√	√					√	
325	√		√				√		375				√			√	
326	√		√					√	376	√		√				√	
327	√		√					√	377	√		√				√	
328	√		√				√		378	√		√				√	
329	√		√				√		379	√	√						√
330	√		√				√		380	√		√					√
331	√		√				√		381	√		√					√
332	√		√				√		382	√		√					√
333	√	√						√	383	√		√					√
334	√	√						√	384	√		√				√	
335	√		√				√		385	√		√					√
336	√		√				√		386	√	√						√
337	√	√						√	387				√			√	
338	√		√				√		388	√		√				√	
339				√			√		389	√		√					√
340				√			√		390				√				√
341	√		√				√		391				√				√
342	√	√						√	392	√		√					√
343	√		√				√		393	√	√						√
344	√		√					√	394	√		√				√	
345	√		√					√	395	√		√				√	
346	√		√				√		396	√	√						√
347	√		√					√	397				√			√	
348	√		√				√		398				√			√	
349	√		√				√		399				√				√
350	√	√						√	400	√		√				√	
351				√			√		401	√		√				√	
352	√	√						√	402	√		√					√
353	√	√					√		403	√		√					√
354				√				√	404	√		√					√
355	√		√				√		405	√	√						√
356	√	√					√		406	√	√					√	
357	√		√				√		407	√	√						√
358	√	√					√		408						√		√
359	√		√				√		409	√	√					√	
360	√		√				√		410	√	√						√
361	√		√				√		411	√		√				√	
362	√		√				√		412	√		√				√	
363	√		√				√		413	√	√					√	
364	√		√				√		414				√				√
365	√	√						√	415	√	√					√	
366	√		√					√	416	√		√				√	
367	√		√				√		417	√		√					√
Total	44	12	32	6	0	0	30	20	Total	41	12	29	8	0	1	22	28

Recording sheet of interaction between car driver and cyclist at bicycle crossings (f)

Date 29/04/2009
Time 16.00 - 18.00
Intersection Tornavägen-Getingavägen
Weather Sunny
Surface Dry

No	No Cyclist	Head Movement		Car Driver			Gender	
		Yes	No	In good time	Late	Below 30km/h	Male	Female
418	√		√					√
419	√		√					√
420	√		√				√	
421	√		√				√	
422	√		√				√	
423	√		√				√	
424	√	√						√
425	√		√				√	
426				√			√	
427				√			√	
428	√	√						√
429	√	√					√	
430	√		√				√	
431	√		√					√
432				√			√	
433	√		√				√	
434	√		√				√	
435	√		√				√	
436	√		√				√	
437	√	√					√	
438	√	√					√	
439	√	√					√	
440				√			√	
441						√		√
442	√		√				√	
443	√		√					√
444	√		√				√	
445	√	√					√	
446	√		√				√	
447	√		√				√	
448	√		√				√	
449	√	√					√	
450	√		√				√	
451				√			√	
452	√	√					√	
453	√		√					√
454	√		√				√	
455	√	√					√	
456						√		√
457	√		√				√	
458	√		√					√
459				√				√
460					√		√	
461	√		√				√	
462				√			√	
463				√			√	
464	√	√					√	
465					√			√
466				√			√	
467						√	√	
Total	36	11	25	9	2	3	38	12

Recording sheet of interaction between car driver and cyclist at bicycle crossings (g)

Date 08/05/2009
Time 15.00 - 18.00
Intersection Tornavägen-Getingavägen
Weather Cloudy
Surface Dry

No	No Cyclist	Head Movement		Car Driver			Gender		No	No Cyclist	Head Movement		Car Driver			Gender	
		Yes	No	In good time	Late	Below 30km/h	Male	Female			Yes	No	In good time	Late	Below 30km/h	Male	Female
468	√		√					√	518	√	√						√
469	√		√					√	519	√		√				√	
470	√		√					√	520	√		√					√
471	√		√					√	521	√	√					√	
472	√		√					√	522	√		√					√
473	√		√					√	523	√	√					√	
474				√			√		524	√		√					√
475	√		√				√		525	√		√					√
476	√		√				√		526	√		√					√
477				√				√	527							√	
478	√	√					√		528	√		√				√	
479						√	√		529	√		√				√	
480	√		√					√	530				√			√	
481	√		√				√		531	√		√					√
482	√	√					√		532	√		√					√
483	√		√					√	533	√	√					√	
484	√		√				√		534	√		√					√
485	√		√				√		535	√		√				√	
486	√		√				√		536	√	√					√	
487				√			√		537	√	√					√	
488	√	√						√	538	√		√					√
489	√		√				√		539	√	√					√	
490	√		√					√	540	√	√					√	
491	√	√					√		541	√	√						√
492	√		√				√		542				√				√
493	√		√				√		543	√	√						√
494	√		√					√	544							√	
495	√	√						√	545							√	
496	√		√					√	546	√		√				√	
497				√			√		547	√	√					√	
498	√		√				√		548	√	√					√	
499	√		√				√		549	√		√				√	
500	√		√				√		550	√		√				√	
501	√	√					√		551				√			√	
502	√	√						√	552					√		√	
503	√		√				√		553	√		√					√
504	√	√					√		554	√		√				√	
505	√		√				√		555	√	√						√
506	√		√				√		556	√		√					√
507	√		√				√		557	√		√				√	
508				√				√	558	√		√				√	
509	√		√					√	559	√	√						√
510	√		√					√	560	√		√				√	
511				√				√	561	√		√				√	
512	√	√					√		562	√	√					√	
513	√		√				√		563	√		√					√
514	√		√					√	564	√		√					√
515	√		√					√	565	√	√						√
516	√	√						√	566	√		√				√	
517	√		√				√		567	√		√				√	
Total	43	10	33	6	0	1	28	22	Total	43	16	27	3	1	3	30	20

Recording sheet of interaction between car driver and cyclist at bicycle crossings (h)

Date 08/05/2009
Time 15.00 - 18.00
Intersection Tornavägen-Getingavägen
Weather Cloudy
Surface Dry

No	No Cyclist	Head Movement		Car Driver			Gender		No	No Cyclist	Head Movement		Car Driver			Gender	
		Yes	No	In good time	Late	Below 30km/h	Male	Female			Yes	No	In good time	Late	Below 30km/h	Male	Female
568	√		√				√		618								
569	√	√					√		619	√		√					√
570	√		√					√	620	√	√					√	
571	√		√					√	621	√		√				√	
572	√		√					√	622				√				√
573	√		√				√		623	√		√					√
574	√		√				√		624	√	√						√
575	√		√				√		625	√		√					√
576	√		√				√		626				√				√
577	√		√				√		627	√		√					√
578	√		√				√		628	√		√				√	
579	√		√				√		629	√		√				√	
580	√		√					√	630	√		√				√	
581	√	√						√	631	√	√						√
582	√		√					√	632				√			√	
583	√		√				√		633				√			√	
584	√		√					√	634	√		√					√
585				√			√		635	√		√				√	
586	√		√				√		636	√		√				√	
587	√	√					√		637	√		√				√	
588	√	√						√	638				√				√
589	√		√				√		639	√	√					√	
590	√		√					√	640	√	√						√
591	√		√					√	641	√		√				√	
592	√	√					√		642	√		√				√	
593	√	√						√	643	√		√				√	
594	√		√				√		644	√		√				√	
595	√		√					√	645				√			√	
596	√	√						√	646	√	√					√	
597						√	√		647	√		√				√	
598	√		√				√		648	√		√				√	
599	√		√					√	649	√		√				√	
600	√		√				√		650	√		√				√	
601	√		√				√		651	√	√					√	
602	√		√					√	652	√	√					√	
603	√		√				√		653	√		√				√	
604	√		√				√		654	√		√				√	
605	√		√					√	655	√		√				√	
606	√		√				√		656	√		√				√	
607	√		√				√		657				√				√
608	√		√				√		658	√		√					√
609	√	√					√		659	√		√				√	
610	√		√					√	660				√				√
611				√				√	661	√		√				√	
612	√		√					√	662	√		√				√	
613	√		√					√	663	√		√				√	
614	√		√				√		664	√		√				√	
615	√		√				√		665				√				√
616	√		√					√	666	√		√				√	
617						√	√		667	√		√					√
Total	46	8	38	2	0	2	29	21	Total	40	8	32	9	0	1	34	16

Recording sheet of interaction between car driver and cyclist at bicycle crossings (i)

Date 08/05/2009
Time 15.00 - 18.00
Intersection Tornavägen-Getingavägen
Weather Cloudy
Surface Dry

No	No Cyclist	Head Movement		Car Driver			Gender	
		Yes	No	In good time	Late	Below 30km/h	Male	Female
668	√		√				√	
669	√		√					√
670	√		√					√
671				√			√	
672	√	√					√	
673	√		√				√	
674	√		√				√	
675	√		√				√	
676	√		√					√
677	√	√					√	
678						√	√	
679				√			√	
680	√		√					√
681	√		√				√	
682	√		√					√
683				√			√	
684				√				√
685				√			√	
686	√		√					√
687	√		√				√	
688	√		√					√
689	√		√				√	
690	√		√				√	
691	√		√					√
692	√		√					√
693						√		√
694	√		√				√	
695						√	√	
696	√		√				√	
697	√		√				√	
698	√		√				√	
699				√			√	
700	√		√					√
701	√	√					√	
702	√	√						√
Total	26	4	22	6	0	3	22	13

Appendix F: Resume of behaviour studies

Head movement observation

Site	No. of driver	Head movement observation		Composition of gender	
		Yes	No	Male	Female
Type A	516	106	410	337	179
Type B	579	160	419	350	229

Number of doing head movement driver based on gender

Site	No. of driver	Composition of gender	
		Male	Female
Type A	106	54	52
Type B	160	87	73

Number of not doing head movement driver based on gender

Site	No. of driver	Composition of gender	
		Male	Female
Type A	410	283	127
Type B	419	264	155

Give priority observation

Site	No. of Interaction	Car Driver			Gender Composition	
		Gives Priority		Drives On		
		In good time	Late		Male	Female
Type A	122	99	7	16	65	57
Type B	123	96	7	20	75	48

Give priority in good time drivers based on gender

Site	No. of driver	Composition of gender	
		Male	Female
Type A	99	52	47
Type B	96	61	35

Give priority late drivers based on gender

Site	No. of driver	Composition of gender	
		Male	Female
Type A	7	4	3
Type B	7	3	4

Drives on drivers based on gender

Site	No. of driver	Composition of gender	
		Male	Female
Type A	16	9	7
Type B	20	14	6

Appendix G: Chi square test of behavioural studies

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
HeadMovement * Location	1095	81.7%	245	18.3%	1340	100.0%

HeadMovement * Location Crosstabulation

Count

		Location		Total
		Type A	Type B	
HeadMovement	No	410	419	829
	Yes	106	160	266
Total		516	579	1095

Ho: Location (Type) of intersection does not affect the head movement

H1: Location (Type) of affect affect the head movement

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7.460[a]	1	.006		
Continuity Correction[b]	7.080	1	.008		
Likelihood Ratio	7.510	1	.006		
Fisher's Exact Test				.007	.004
Linear-by-Linear Association	7.453	1	.006		
N of Valid Cases	1095				

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 125,35.

b. Computed only for a 2x2 table

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
CarDriver * Location	245	18.3%	1095	81.7%	1340	100.0%

CarDriver * Location Crosstabulation

Count

		Location		Total
		Type A	Type B	
CarDriver	gives priority	106	103	209
	Drives on	16	20	36
Total		122	123	245

Ho: Location (Type) of intersection does not affect the give priority behaviour of driver

H1: Location (Type) of intersection affect the give priority behaviour of driver

Chi-Square Tests

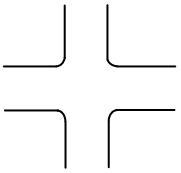
	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.483[a]	1	.487		
Continuity Correction[b]	.265	1	.607		
Likelihood Ratio	.484	1	.486		
Fisher's Exact Test				.589	.304
Linear-by-Linear Association	.481	1	.488		
N of Valid Cases	245				

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 17,93.

b. Computed only for a 2x2 table

Appendix H: Interview protocol

Lund Institute of Technology
Departement of Technology and Society
Traffic and Road



Interview Protocol

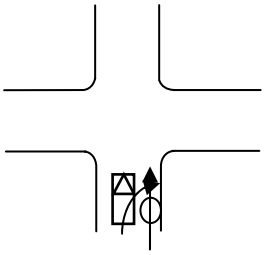
Interviewer: ..... Date ..... Time .....

City: ..... Intersection .....

Gender : ○Male ○Female Age : .....

1. How often do you cross this intersection?
   - ○Daily
   - ○Several times in a week
   - ○Several times in a month

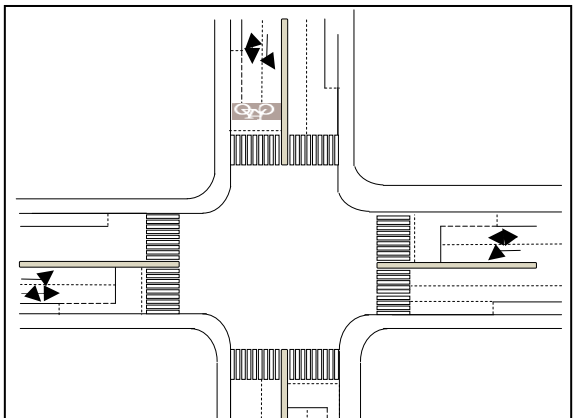
2. Who has the priority when you cycle straight through the intersection and the car from same direction turns right, the car or the bicycle?
   - ○ Car
   - ○ Bicycle
   - ○ No idea



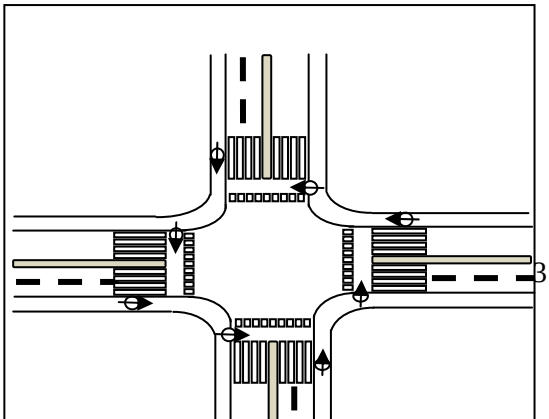
3. How safe do you feel when you cycle through this intersection?
   - ○Very safe
   - ○Safe
   - ○Unsafe
   - ○Very unsafe

4. Which design of intersection do you consider safer for bicyclist?

Type A ○



Type B ○



Appendix I: The result of interview with cyclist at Tornavägen-Tunavägen

(Site type A)

No	Date	Time	Gender	Age	Question 1	Question 2	Question 3	Question 4	
								Type	Reason
1	09/05/22	08:02	Male	63	Daily	Bicycle	Safe	A	That's quite work
2	09/05/22	08:08	Female	54	Daily	Bicycle	Safe	B	Clearer path, marking and signal for bike
3	09/05/22	08:12	Female	37	Several times in a week	Bicycle	Unsafe	B	It has own path and signal for bike
4	09/05/22	08:25	Male	21	Daily	Bicycle	Unsafe	B	It separate from car
5	09/05/22	08:38	Female	52	Daily	Bicycle	Safe	A	Directly crossing, not turn right first
6	09/05/22	08:43	Male	33	Daily	Bicycle	Safe	B	It has separated lane for bike
7	09/05/22	11:34	Female	21	Several times in a week	Bicycle	Safe	B	It has special path and signal for bike
8	09/05/22	11:45	Male	65	Daily	Bicycle	Very unsafe	B	Bicycle expose and can be seen
9	09/05/22	11:58	Female	22	Several times in a week	Bicycle	Very unsafe	B	It has own path
10	09/05/22	12:05	Male	45	Several times in a month	Bicycle	Safe	B	The car doesn't interact directly with bike
11	09/05/22	12:12	Female	24	Several times in a week	Bicycle	Unsafe	B	It has own path
12	09/05/22	12:16	Male	23	Daily	Bicycle	Safe	B	It has very clear sign
13	09/05/22	12:27	Female	45	Several times in a week	Bicycle	Safe	B	It has signal and separated lane
14	09/05/22	12:43	Male	35	Several times in a week	Car	Safe	A	Driver can see cyclist clearly
15	09/05/22	12:59	Female	23	Daily	Bicycle	Unsafe	B	It has separated lane
16	09/05/22	15:07	Female	36	Several times in a month	Bicycle	Safe	No idea	Feel safe for both
17	09/05/22	15:16	Female	72	Daily	Car	Safe	A	Type B must turn right first
18	09/05/22	15:25	Female	38	Several times in a week	Bicycle	Unsafe	B	Thre is specific marking for crossing
19	09/05/22	15:36	Male	27	Daily	Bicycle	Safe	B	There is light for bicycle

20	09/05/22	15:40	Male	26	Several times in a week	Bicycle	Safe	B	It separated
21	09/05/22	15:44	Male	27	Daily	Bicycle	Safe	B	It separated and has own signal for bike
22	09/05/22	15:54	Male	23	Daily	Bicycle	Safe	A	Bike more expose because standing in front of the car
23	09/05/22	15:59	Female	19	Several times in a week	Bicycle	Safe	B	It has special path and signal
24	09/05/22	16:00	Female	19	Several times in a month	Car	Safe	B	It has special path
25	09/05/22	16:07	Female	50	Several times in a week	Car	Very safe	B	No more traffic

No	Date	Time	Gender	Age	Question 1	Question 2	Question 3	Question 4	
								Type	Reason
26	09/05/22	16:27	Male	53	Several times in a week	Bicycle	Safe	No idea	There is no different
27	09/05/22	16:30	Male	22	Several times in a week	Bicycle	Safe	B	There is obvious marking for crossing
28	09/05/22	16:35	Female	23	Daily	Bicycle	Unsafe	B	It has separated lane
29	09/05/22	16:40	Male	56	Daily	Car	Unsafe	B	There is special lane for bike
30	09/05/22	17:39	Male	35	Daily	Bicycle	Very safe	B	Bike has track and driver can observe
31	09/05/25	09:37	Female	17	Daily	Bicycle	Safe	B	There is clear sign
32	09/05/25	09:43	Male	24	Daily	Bicycle	Safe	No idea	
33	09/05/25	09:56	Male	40	Daily	Bicycle	Very unsafe	B	It has separated lane
34	09/05/25	10:05	Female	16	Daily	Bicycle	Very safe	B	It has own light
35	09/05/25	10:24	Male	53	Daily	Bicycle	Safe	B	Not mix traffic
36	09/05/25	10:40	Male	23	Several times in a week	Car	Unsafe	B	It has own crossing
37	09/05/25	10:44	Male	62	Several times in a month	Bicycle	Unsafe	B	No reason
38	09/05/25	10:48	Female	24	Several times in a week	Bicycle	Safe	B	There is special crossing near zebra cross
39	09/05/25	14:30	Male	22	Several times in a week	Car	Safe	B	It has own path
40	09/05/25	14:47	Female	22	Daily	Bicycle	Unsafe	B	It has special path
41	09/05/25	18:12	Male	21	Daily	Car	Safe	B	Cyclist can see the car when crossing
42	09/05/25	18:23	Female	23	Daily	Bicycle	Unsafe	A	Cyclist more expose, driver more aware
43	09/05/25	18:40	Male	20	Daily	Bicycle	Unsafe	B	It has own path
44	09/05/25	18:45	Female	27	Daily	Bicycle	Unsafe	A	Driver can notice cyclist
45	09/05/25	18:49	Female	27	Several times in a week	Bicycle	Safe	B	It has special path
46	09/05/25	18:55	Male	23	Several times in a week	Bicycle	Safe	B	It has special path
47	09/05/25	19:04	Female	20	Daily	Car	Safe	A	

48	09/05/25	19:23	Male	26	Daily	Bicycle	Safe	A	Cyclist more exposed
49	09/05/25	19:44	Female	16	Daily	Bicycle	Safe	B	It has separated lane, Type B more cloose to the car
50	09/05/25	20:00	Male	22	Daily	Bicycle	Safe	B	It has separated lane

Appendix J: Interview with cyclist at Tornavägen-Getingavägen-Svenshögsvägen

(Site type B)

No	Date	Time	Gender	Age	Question 1	Question 2	Question 3	Question 4	
								Type	Reason
1	09/05/26	07:57	Male	51	Daily	Bicycle	Unsafe	B	There is special lane for bike
2	09/05/26	08:02	Male	26	Daily	No idea	Safe	B	It has light
3	09/05/26	08:05	Male	55	Several times in a week	Bicycle	Unsafe	No idea	
4	09/05/26	08:08	Male	25	Several times in a week	Car	Very safe	B	No reason
5	09/05/26	08:13	Male	32	Daily	Bicycle	Safe	A	Driver can notice cyclist
6	09/05/26	08:17	Male	52	Daily	Bicycle	Unsafe	B	No reason
7	09/05/26	08:20	Male	42	Several times in a week	Bicycle	Unsafe	No idea	
8	09/05/26	08:23	Female	52	Daily	Bicycle	Safe	A	Car can notice bike
9	09/05/26	08:28	Male	63	Daily	Bicycle	Very safe	B	Not too close to car
10	09/05/26	08:32	Female	29	Daily	Bicycle	Safe	B	It has special path and not too close to car
11	09/05/26	08:35	Male	43	Daily	Bicycle	Very safe	A	Driver can easily recognise bike
12	09/05/26	08:39	Female	34	Daily	Bicycle	Safe	B	It has special lane
13	09/05/26	08:45	Male	30	Daily	Bicycle	Safe	B	It has marking for crossing
14	09/05/26	08:51	Male	33	Daily	Bicycle	Safe	A	No reason
15	09/05/26	09:00	Female	22	Daily	Bicycle	Very safe	B	The position of car make they aware
16	09/05/26	09:05	Female	44	Several times in a week	Bicycle	Very safe	A	No reason
17	09/05/26	09:09	Male	32	Daily	Bicycle	Very safe	B	There is signal for bike
18	09/05/26	11:50	Female	29	Daily	Bicycle	Safe	A	Can directly straight
19	09/05/26	11:54	Female	86	Several times in a week	Car	Unsafe	B	It has own path
20	09/05/26	11:58	Male	22	Daily	Bicycle	Safe	B	It separated with car

21	09/05/26	12:15	Female	24	Several times in a week	Bicycle	Safe	B	It separated with car
22	09/05/26	12:21	Female	22	Daily	Bicycle	Safe	A	Less conflict among bikes
23	09/05/26	12:31	Male	23	Daily	Car	Safe	B	No reason
24	09/05/26	12:36	Male	21	Several times in a week	Bicycle	Safe	B	It has own signal
25	09/05/26	12:49	Female	49	Several times in a month	Car	Unsafe	A	Long turn, make cyclist frustated
26	09/05/26	12:56	Male	28	Several times in a week	Bicycle	Safe	B	It separated with car
27	09/05/26	13:01	Female	16	Daily	No idea	Safe	B	Look like better
No	Date	Time	Gender	Age	Question 1	Question 2	Question 3	Question 4	
								Type	Reason
28	09/05/26	13:05	Male	19	Daily	Bicycle	Safe	A	Cyclist easily can be seen
29	09/05/26	13:12	Female	22	Daily	Bicycle	Unsafe	B	It separated with car lane
30	09/05/26	13:23	Male	23	Several times in a week	Bicycle	Safe	No idea	Both are same
31	09/05/26	13:29	Male	27	Several times in a week	Bicycle	Very safe	B	It has own path and signal
32	09/05/26	13:44	Female	30	Several times in a month	Bicycle	Safe	A	Cyclist can be seen
33	09/05/26	13:54	Male	23	Several times in a week	Bicycle	Safe	B	It separated with car
34	09/05/26	14:03	Female	24	Daily	Bicycle	Safe	B	It has special light for bike
35	09/05/26	14:21	Female	20	Daily	Bicycle	Safe	A	Cyclist can easily be recognised by car
36	09/05/26	14:24	Male	22	Several times in a month	Bicycle	Safe	B	It has special marking
37	09/05/26	14:35	Female	25	Several times in a month	Bicycle	Unsafe	B	It has own signal
38	09/05/26	14:50	Male	83	Daily	Bicycle	Safe	B	It has special path
39	09/05/26	14:54	Male	38	Several times in a week	Bicycle	Safe	B	It has special path and signal
40	09/05/26	15:02	Male	22	Daily	Bicycle	Safe	B	It has special path
41	09/05/26	15:08	Female	19	Several times in a week	No idea	Safe	B	It has special path and signal
42	09/05/26	15:12	Male	18	Daily	Bicycle	Safe	No idea	
43	09/05/26	15:18	Male	30	Several times in a week	Bicycle	Safe	B	It has special path
44	09/05/26	15:27	Female	56	Daily	Car	Safe	B	It has special path and signal
45	09/05/26	15:38	Female	22	Daily	Bicycle	Safe	B	Not too close to car
46	09/05/26	15:58	Female	32	Daily	No idea	Unsafe	B	It has separated lane
47	09/05/26	16:04	Female	25	Daily	Bicycle	Safe	B	It has special marking for crossing
48	09/05/26	16:10	Male	20	Daily	Bicycle	Safe	B	The path clear for bike

49	09/05/26	16:15	Male	37	Several times in a week	Bicycle	Safe	A	Good vision for driver
50	09/05/26	16:20	Female	28	Several times in a week	Bicycle	Unsafe	B	It has special path