Thesis 124

Effects on travel time of an active accelerator pedal. City of Lund

Extended analysis from data logged in LundaISA

David Hernando
2004

LUNDS UNIVERSITET

Lund Institute of Technology
Department of Technology and Society
Traffic Engineering

Effects on travel time of an active accelerator pedal. City of Lund

Extended analysis from data logged in LundaISA

David Hernando

Examensarbete CODEN:LUTVDG/(TVTT-5091)1-81/2004

Thesis / Lunds Tekniska Högskola, ISSN 1653-1922
Instutionen för Teknik och samhälle,
Trafik och väg, 124

David Hernando

Effects on travel time of an active accelerator pedal. City of Lund - Extended analysis from data logged in LundaISA

2004

Keywords:
Active Accelerator Pedal (AAP), Lund, Travel time, Delay, Before/After AAP period.

Abstract:
The effects on speed were studied in a large scale field trial with an in-car system for speed adaptation in Lund, Sweden. The Active Accelerator Pedal was installed in 284 vehicles and it produced a counterforce at the speed limit in the accelerator pedal. All driving information was stored in LundaISA. This study has compared the driving behaviour and travel time before the Active Accelerator Pedal was activated and seven months later, in different street types. The results showed a.small but statistical significant increases on travel time in streets with high speed level, and unchanged travel times in streets with lower speed limit and more interferences of road users. Besides, delays have decreased when they drive along an intersection's influence area, without excessive interferences, and with an intermediate speed limit which allows driving in a more specific way. For central streets, the traffic conditions and the design at intersections are over the effects of the Active Accelerator Pedal.

Citation:
Hernando, David. Effects on travel time of an active accelerator pedal. City of Lund - extended analysis from data logged in LundaISA. Lunds Tekniska Högskola, Institutionen för Teknik och samhälle. Trafikteknik 2004. Thesis 124

Institutionen för Teknik och samhälle
Lunds Tekniska Högskola
Avdelning Trafikteknik
Box 118, 221 00 LUND, Sverige

Department of Technology and Society
Lund Institute of Technology
Traffic Engineering
Box 118, SE-221 00 Lund, Sweden

Acknowledgement

I owe a debt of gratitude to Professor András Várhelyi, who has been my great supervisor and for helping me since the beginning, for his clear guidance, comprehension and fantastic behaviour. Thank you for your patience with my language errors.

I am also indebted to Professor Christer Hydén, my other supervisor, who gave me the opportunity for working in the LTH, when I had problems with the international office he opened me the doors of the department.

I owe a great deal to Hanna Axelsson, who assisted me in a difficult world for me as the Swedish language, for extracting me part of the data and for sharing a very good company. Thanks to Magnus Hjälmdahl, who gave me his data, for his casual and important idea within the analysis.

Thanks to Inger Myhrén for her help in administrative problems, Birgitta Åkerud for her guidance in the library. I also want to thank all those at the Department of Transport Planning and Engineering, who has always had good feelings despite to have different cultures.

A big thank you to my Spanish neighbours in Sparta International corridor, especially Roger Sant Miquel who was my “mentor student” within the department.

I dedicate this work with love to my mother Mª Teresa and my father J. Carlos, because without their help it would be impossible to live an experience like that. Of course, do not forget Anna who encouraged me always. She will be the big love of my life that paid the worst consequences of this thesis.

Barcelona, October 2004

David Hernando

Contents

Appendices

Summary

There is a clear relationship between excess speed and accidents on roads. Due to high driving speeds there are excessive accidents victims, for that reason, to improve this statistics have become a priority for governments. Speed limiters have been studied since 20 ago with excellent results on traffic safety, following this line, the effects of an Active Accelerator Pedal were tested in the city of Lund (Sweden) during seven months. Within the trials were found a significant decrease of maximum driving speeds, among others findings, despite travel time remained unchanged, apparently a paradox.

This study aims to go deeply into this paradox, this way, it has been analysed the effects on travel time during the trials, as well as to improve the knowledge both of how travel time and driver behaviour is influenced by the device. The study is centred in three possible situations, a decrease on delay time due to intersections, a smoother speed distribution and a decrease on stop time before them.

Inside of ISA Project, 284 vehicles were equipped with an AAP in the city of Lund. All the data was logged in a database (LundaISA), which was used for earlier studies within the traffic engineering division of the Lunds Tekniska Högskola, Lund University (Sweden). This study has selected a number of streets from the data stored, where was made a driving speed profile of each one for the two interesting periods of time. Streets have been classified by speed limit and street type in order to test in a more specific way the hypotheses.

Hypotheses have required a severe study and classification in tables of every stretch, both driving in a free one and driving across an intersection's influence area. It was necessary to identify all the physical intersections, as well as to classify the points, where car drivers were affected, with the distance, main driving speed and main travel time. The points have been fixed at the beginning or at the end of the influence, and for the point with the lowest speed, generally just before the intersection.

The negative effects on travel time decrease after long time use when increase the interferences with others road users, and when decrease the prevailing speed limit. Travel time remain unchanged only in central streets, while there is an increase in arterial roads, higher in arterial roads than in main streets. Delays on travel time and decelerations within the intersection's influence area decrease only for main streets with an intermediate speed limit (50km/h), while accelerations remain unchanged. Otherwise there is no influence after long time use both on delay time and in accelerations/decelerations, in streets with a high (70km/h) or low (30km/h) speed limit. Besides, the stopped cars related to all the passing cars along a whole street remain unchanged for central streets; otherwise there is a decrease for the rest of streets.

For central streets, the prevailing traffic conditions and the street design are upon the effects of an AAP after long time use, due to driving speeds are already controlled despite lower maximum speeds. **For arterial streets**, it is not possible to recover part of the travel time missed due to the effects of the AAP for security reason with the intersection's influence are, because drivers may not neither to drive faster across them nor to brake looser before them, as well as they do not need to accelerate stronger in normal driving conditions. **Main streets allow it,** this way, car drivers may recover part of the travel time at intersections due to the decrease the maximum speeds when they were able to drive above

the prevailing speed limit. Besides, within main streets, the decrease on stopped cars, related to all the passing cars, show that the AAP allows to car drivers find out that there is no use driving fast because they will lose time once the car arrives at the next intersection.

It would be able to seem that an increase on travel time is not positive, but the effects are not as negative as it seems, because if the contagion effects were high the travel time missed would be minimized, keeping on the traffic safety. Following this line, a further research is highly needed in order to improve the knowledge on speed adaptation, once the device has been assimilated.

1. Background:

Many studies have already shown the relationship between excess speed and accidents on different roads. Small speed level reductions decrease significantly the number of accidents (Nilsson 1982; Finch et al. 1994). Currently, there are around 42,000 fatalities accident victims and 1.6 million injuries a year in the European Union, normally for inappropriate speed (IEE., 2004). To improve the safety systems of cars is the scope where the automotive industry has centred their efforts during the last years. Intelligent speed adaptation is another solution to decrease injuries.

In order to improve this statistics, many governments are applying sanction measures to decrease speed with good results, for example France, where automatic radars have obtained a reduction of 20,8% in fatal accidents in 2003 (Diario del consumidor, Consumer.es. 2004). However, a further development on speed adaptation may be highly necessary to give other alternatives to the drivers and the institutions.

The potential safety effects of a speed limiter have been an interesting theme since almost 20 years ago (Várhelyi, A., 1996). The effects of the system on safety has been shown in previous studies, however, subjective safety is difficult to quantify without a study after long time usage of the system. According to Várhelyi, 1996, all drivers who drive over the speed limit would drive at the speed limit, and those who drive below the speed limit would increase their speeds, as they do not have to worry about exceeding the limit. This way, highest speeds would improve safety on the roads, and the average speed might increase compensating for the effects of the speed limiter on travel time.

The Swedish National Road Administration during the period 1999-2002, conducted large-scale trials involving Intelligent Speed Adaptation (ISA) in urban areas. Approximately 5000 vehicles were equipped in four cities of Sweden, Borlänge, Lidköping, Lund and Umeå, with different kinds of devices. The majority, around 4000, were tested in Umeå only including the in-car warning system via a beep sound when the car reached the maximum speed. In Lund, the system tested is the Active Accelerator Pedal (AAP) where a GPS system identifies the exact position of the car in a digital map, including all the speed limits inside the test zone. Besides, it was installed a display showing the current speed limit and an active accelerator pedal which produced a counterforce when the car reached the speed limit. To go faster the driver had to do a counterforce three to five times higher than in a normal situation. The vehicle was also equipped with a data-logger to record speed and position. In Lidköping two systems were tested, 150 cars installed a warning system with a display which showed the prevailing speed limit, and 130 used an Active Accelerator Pedal as in Lund, which also displayed the prevailing speed limit. In Borlänge 400 cars installed the informative system with a display which showed the speed limit and with a warning system via beep sound when exceeding the speed limit.

The trials were done in the city of Lund, with approximately 27 km^2 and in different types of streets. The speed limits, 30, 50 and 70 km/h were included as well as the street types: arterial, main or central, as well as the number of carriage ways and the volume of pedestrians and cyclists (Hjälmdahl, M., Almqvist, S., Várhelyi, A., 2002). Inside that test area the system was activated automatically and it could not be turned off. Outside the tested area, the driver could activate the system manually and put it on the maximum desired speed.

The AAP was installed in 284 vehicles from November 2000 until May 2001; and uninstalled between November 2001 and January 2002.

The speed in test cars was measured with a datalogg although these cars had the datalogg while the ISA-system was not activated in the beginning of the trials. These saved speeds of test cars were compared with the rest of the cars in Lund, and the speed level did not differ between these two groups of drivers. Once ISA-system was activated, after long-term use, the mean speed of the test vehicles was 2.4 km/h lower than the others drivers. The biggest reductions of speeds were mainly on stretches where the speed level was highest. The reduction of speed was larger at the beginning of the trials than after long-term use (Várhelyi, Hjälmdahl, Hydén and Draskóczy, 2003).

Other results showed something that can be of great importance for the future. After the trials, drivers thought that they should keep the speed limit. Besides, travel times did not increase and many drivers would install the system if it was free (Vägverket, 2002).

Behavioural studies have shown the potential positive effect on traffic safety of in-vehicle speed adaptation system. Drivers become more considerate with other users such as pedestrians and other drivers (Hjälmdahl and Várhelyi, 2003) improving yield behaviour and safety. Although the speed adaptation increased frustration on drivers. On the other hand, the speed variance was smaller when they drive with AAP, with less accelerations and decelerations. Other results: the highest speeds driving with AAP decrease to or below the speed limit. Besides, the travel time is not higher apparently, because of the speed distribution is smoother with AAP, decrease in the highest speeds but increase in the lowest speeds (Várhelyi, et. al. 2003). No increase of time consumption could be verified; however, earlier studies had shown an increase in travel time between 2 and 7% (Almqvist and Nygård 1997, Várhelyi and Mäkinen, 2001).

Another study (Hegeman, 2002) has shown through a microscopic model, where the time gap between cars using ISA could be modelled with a fixed time, that ISA is able to replace traffic lights at intersections. One task of traffic lights is to give traffic from minor roads enough possibilities either to cross or to merge upon the main road. This result will increase the support for Intelligent Speed Adaptation, which was created for safety reasons at the beginning.

2. Aim and hypotheses

The earlier studies of in-vehicle speed adaptation has showed excellent results in traffic safety, however some frustration among drivers may create problems for the implementation of the system.

Further research in this area is needed in order to give more arguments in favour of the speed adaptation to the drivers. Without the compliance of the users and the local administrations the system will not be used, we may not forget that the high number of accidents is a big problem for our society. For many reasons, the device must be installed in cars as ISA Project has already shown in order to improve the safety.

The aim of this work is to analyse the effects on travel time of an active accelerator pedal, as well as to increase the knowledge of how travel time is influenced by the system, which does not change apparently in the large scale study, although it has been showed that maximum speeds are lower than without the system. To find the possible causes of this paradox is the aim of this work.

The best way to show this paradox is through the table and the results below:

Table 1. Decrease of mean spot speed in the mid-block section using AAP, after long time use (Hjälmdahl, et al., 2002)

Street type/ Speed Limit (km/h)	Description	Decrease of speed (km/h)*
		Long-time use (after seven months)
Arterial Road (70)	Dual carriage way	4,9
Arterial Road (50)	Dual carriage way	5
Arterial Road (50)	Single carriage way	3,7
Main street (50)	Low volume of other users	2
Main street (50)	High volume of other users	1
Central street (30)	Mixed traffic	1,7

*= Statistically significant decrease according to the t-test and sign test ($p < 0.05$)

On the other hand, the results of the ISA trial have shown that travel time does not change apparently; in fact they became shorter, although they decreased most on streets with a speed limit of 30 km/h and they increased on streets with speed limits 50 and 70 km/h (Vägverket, 2002). However, it is very important to not forget that earlier trials showed that driving with a speed limiter, during short time periods, increased travel time by 5% (Almqvist and Nygård, 1997) and by 6.6% (Várhelyi and Mäkinen, 1998).

How is it possible? That is the paradox. It has been shown a decrease of highest speeds although the travel time does not change apparently.

A possible explanation of this paradox could be the appearance of a compensatory behaviour on drivers. Earlier references have studied this possible behaviour driving with AAP on different situations in order to show higher speeds at intersections, after long-time use, no statistically significant changes on turning speeds could be verified (Várhelyi, et al. 2003). However, after short-time use of AAP, the results between studies are contradictory; Persson et al. (1993) found an increase on turning speeds driving with a speed limiter. On the other hand, Várhelyi and Mäkinen (2000) found smoother speed distributions with the speed limiter. It means that a speed adaptation system needs time for drivers to get used; this is already known because the speed was lower at the beginning of the trials than after a long-time use.

Inside the high number of possibilities, this study has been centred in three different situations, where a car with the AAP installed might recuperate part of the increase in travel time, because of the actuation of the device when the driver reach the prevailing speed limit. These situations have defined the hypotheses below.

The first situation might be when the delay created for an intersection is smaller driving with AAP. The second possibility studies whether the speed distribution is smoother, with lower maximum speeds but with less differences between maximum and minimum speeds, in order to improve the average speed in the whole stretch. And finally, to study whether the ratio of stopped cars is lower, in order to decrease the travel time at intersections.

The main hypotheses for this study were as follows: (1) Travel times in urban areas remain unchanged despite lower driving speeds. (2) Delays at signalised intersections decrease. (3) Less accelerations and decelerations. (4) Stopped cars decrease related to all the passing cars.

3. Method

3.1. Driver selection, test site, data-logged and data-saved.

Inside the ISA project, test drivers were selected on a randomised sample of vehicles owners in Lund. 284 vehicles were equipped with AAP; thirty-eight vehicles of the sample were company cars.

All the data was logged in each test car and after it was saved in a database and analysis program, LundaISA. Within the database, it is possible to find information about date, time, position, speed limit, direction and speed among others, as well as the speed profile of a car. All this information needed for the analysis was logged and classified in links. The stretches of a street between two intersections were called links.

Seven months were the average time that the vehicles used the AAP. During this time, the logged data was analysed for three different periods referred to as: *without AAP,* at the beginning of field trials with the device turned off; *Short-time use*, after the first month with the device turned on; and finally, *Long-time use*, six months later than the first analysis with the APP turned on.

With all the data saved during the trails, the Traffic Engineering Department of Lunds Tekniska Högskola (University of Lund, Sweden) has made many reports inside of ISA Project. In the *"delrapport 13 LundaISA"* (Hjälmdahl, M., Várhelyi, A., Almqvist, S., 2002), there is an analysis point-by-point averages of driving speed, for many streets of Lund, separated by speed limits and street types among others categories.

Inside of this analysis, it is possible to find the average speed profile for each street and for each direction. The length of the whole street was separated in sections of 5 metres; in each section was done a t-test analysis to calculate the average speed, as well as the standard deviation and the confidence interval of this speed valour, of all the cars passed for that section during the seven months of the trials. The result is a double profile made by average speeds of all the cars passed vs. street distance, before the device was turned on (*without ISA*) and after seven months with the device on (*long-time use*).

Besides, in the original report, there a third profile not showed in the following example, because it was made in the same conditions but only one month after the device was turned on (*short-time use*). This period of time is not interesting for this study, for that reason, it has not been showed in the profiles.

Next to the profile *without ISA*, there are showed others two profiles where is possible to find the confidence interval (95%) of the average speed, section by section of five metres as well. However, this study is made up for average speeds and the values of these driving speeds are not useful.

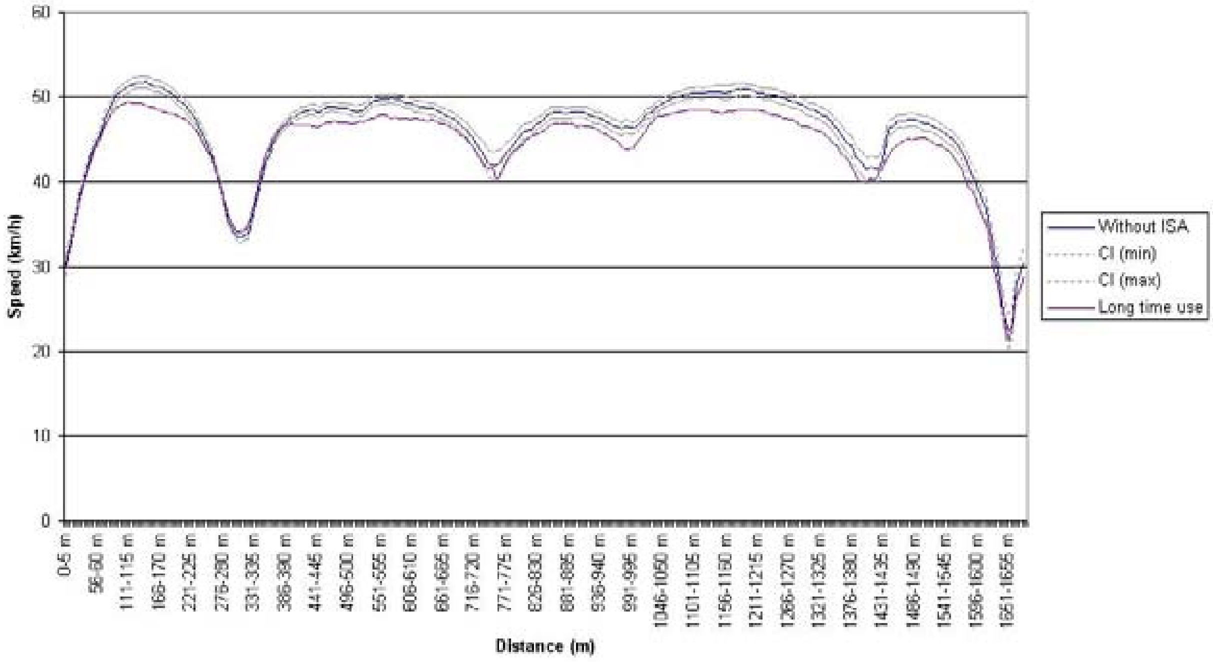


Figure 1. Tornavägen/Solvägen/Södra vägen; South-West direction; Total length: 1688m

3.2. Selection of the streets.

The speed and travel time analyses of this study have been separated in four different groups. All the streets for this study have been selected from *"delrapport 13 LundaISA"* (Hjälmdahl, M., Várhelyi, A., Almqvist, S., 2002), within the streets that represent the street type environment of Lund, with different length and number of stretches. The streets have been classified with regard to speed limit and street type also.

The first group has been made up with arterial roads and with a speed limit of 70km/h.

The second group has been made up of main arterial streets of 50 km/h as speed limit (streets where users may drive above the speed limit of 50 km/h, and the effects on travel time are different in front of other main streets of Lund).

The third group is main streets with 50km/h as speed limit, but where drivers may no reach the speed limit because of the frequent interactions with the rest of road users.

The fourth group has been made up of central streets with a speed limit of 30 km/h and with frequent interactions between different road users.

The criteria to select the streets for each group have been the same that as in the earlier study (Hjälmdahl, M., Várhelyi, A., Almqvist, S., 2002). The selection has been made with consideration to traffic conditions and possible changes, so that the vehicles should not be affected by changes in the street environment, during the seven months when the trials were done.

Another important factor is to know each street of each group in order to do a deep analysis of the situation. It means to know the length of the street and between intersections, kind of intersections, number of intersections… Every kind of intersection has a different variation of speed, regulated for traffic lights, with/without priority… For this reason; it has been necessary to know in each street which kind of intersection had each one of them. This is the best way to separate significant intersections, because of not all the changes of speeds may reflect the influence of an intersection.

4. Analysis

4.1. General analysis.

To increase the knowledge of the effects of an active accelerator pedal on travel time is highly needed, therefore it is very important to analyse the different changes that cars have been suffering, during the period of seven months when the trials were done in Lund.

There are two situations for a car, to drive free along the street where the AAP can intervene, or to cross through the influence of an intersection. For this study is very important to separate that situations, because of earlier studies (Várhelyi, A., et al. 2003; Hjälmdahl, M., Almqvist, S., Várhelyi, A., 2002) has been trying to explain the paradox between travel time (it does not change apparently) and the significant decrease of highest speeds.

The initial analysis aims at obtaining the same kind of information before the AAP was activated and seven months later, about travel time, accelerations and decelerations, stopped cars ratio and delays at intersections. After that, it is necessary to compare the same results in these two periods, from the difference of these two mean values.

The analysis finishes with a sign test, between the different values of each hypothesis during the two periods, it is just about on how many of the stretches is the change positive or negative. For all the hypothesis, the statistical analysis has been done with a confidence level of 95%, and with the same initial assumption (H0), the median value of the distribution is $m=0$, it means that there is no difference, initially, between the mean values of both periods. This way, whether the great majority has gone to one direction, then the probability is large and the study may say that there is a real change in that direction. Equally, the possible differences have been explained verbally in order to show whether the initial hypotheses can be verified or not.

The sign test has been done directly from the web page of the Institute of Phonetic Sciences (IFA), where the probability (p-value) is given directly only introducing the number of positive (n+) and negative (n-) values, without exceed the limit (n+ + n- <= 100). In order to reject the initial assumption, the p-value has to be lower than 0.05.

All the information for testing the four hypotheses had been obtained from two different sources.

First one, from *"delrapport 13 LundaISA"* (Hjälmdahl, M., Várhelyi, A., Almqvist, S., 2002), where it is possible to know directly the average speed and the distance point-by-point, for each section and direction of a street. This is the basic information necessary to test the hypotheses one, two and three.

Second one, from the datalogg stored in LundaISA. With a SQL code where was indicated the number of links that defined the stretches, as well as a lot of other kind of information although it was not necessary. The basic information to test the hypothesis four is the speed profile of all the cars passed for the different links.

And which is the information? When a driver is close to an intersection, he normally begins to decelerate. This is the first point (X_1) that separates the two situations, to drive free along the street or to be influenced for the intersection. It means that it is necessary to know **time**, **distance** and **speed** in that moment. Distance and average speed is the basic information that it may be found directly in *"delrapport 13 LundaISA"* (Hjälmdahl, M., Várhelyi, A., Almqvist, S., 2002) to define each point.

The second point (X_2) is where the cars have the lowest speed, generally just before the intersection. Finally, the third point (X_3) separates the end of the influence, when the car has crossed over the intersection and it is not already necessary big accelerations, with a normal stretch again.

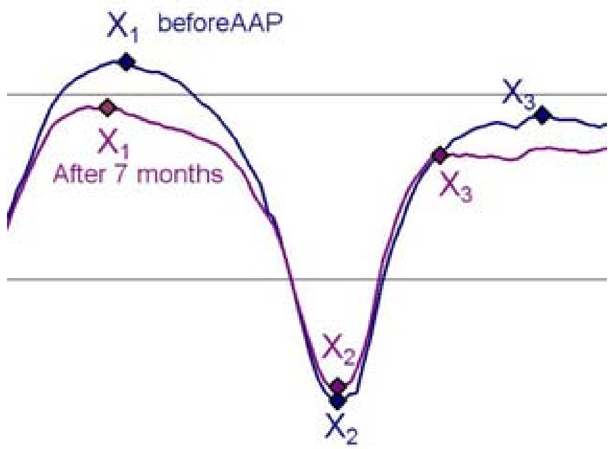


Figure 2. Detail of the influence in driving speed at an intersection

Obviously, there is other kind of interferences due to the rest of road users, as pedestrians, cyclists, car drivers among others. That might change these points, but this study does not bear in mind this kind of influences. All this study is done from the information found in LundaISA.

Not all the intersections have the three points well defined, some ones only have one or two of those points, as well as others have accelerations and decelerations inside the own intersection without the typical profiles.

The third basic value is the average travel time for each section. It has been calculated each five metres dividing this distance for the average speed. This way, it is easy to know the average travel time between any two points of a driving speed profile.

In the analysis of *"delrapport 13 LundaISA"* (Hjälmdahl, M., Várhelyi, A., Almqvist, S., 2002), it was calculated a mean speed for each interval of five metres. It means that the position of one point might be defined at the beginning, at the end, in the middle of the interval or wherever, only in order to give an exact position for the street file. The significant distance is between two points. In this analysis, the position has been chosen in the middle of all the intervals, this is not important because the distance between two points will be always multiples of five metres, due to the mean speeds and travel times are obtained from sections of five metres.

4.2. Testing Hypotheses.

Once the groups of streets are classified and it is known the original data, it is time to define which kind of analysis is made up for testing the hypotheses. Then, the analysis is explained followed for each one of them.

Hypothesis 1. Travel times in urban areas remain unchanged despite lower driving speeds.

According to earlier studies about the influence of an active accelerator pedal after a long-term use, they have shown that travel time does not change apparently in spite of the highest speeds are lower.

The travel time along the street has been obtained adding up the travel time for each section of five metres, including all the stretches. It has been calculated from the beginning (travel time=0) until the end of the whole street. Therefore, it is known the average travel time in order to compare those with/without AAP.

Then, once the travel time has been calculated, it is direct to obtain the average speed for the whole street if the total length is known. After that, it is made a numeric comparison between the changes on average speed and with the changes on maximum spot speed in the mid-block section, which were calculated in the earlier study (Hjälmdahl, M., Várhelyi, A., Almqvist, S., 2002).

Therefore, to test the hypothesis one, it is just to find the difference between these travel times, and then, to express the change in % and to do a sign test in order to show whether the great majority has gone to one direction.

Hypothesis 2. Delays at signalised intersections decrease.

One of the most important objectives of this study is to know where the drivers may recover the time missed because of an Active Accelerator Pedal. A situation could be at signalised intersections when the speeds are lower than other parts of the road.

It is known that all the intersections generate delays. However, an aim of this hypothesis is to test whether the delay driving with AAP at the intersection is smaller than driving without it. The way to calculate both delays has been the same; first of all, it has been necessary to calculate the mean speed of the points at the beginning and at the end (X_1; X_3) of the intersection, then, to obtain the distance between those points and to divide it with the mean speed, in order to calculate the imaginary travel time without the intersection. Now, it is possible to compare the real travel time between these points from the original analysis, with the imaginary travel time with/without AAP.

In order to compare delays on stretches with equal lengths, it has been necessary to define an intersection's influence area. This distance is fixed by the points X_1, X_2 and X_3 in the before situation, then it is possible to compare in the after situation along the same distance. That is X_1, X_2 and X_3 in the after situation are at the same place on the street as in the before situation, called X_1', X_2' and X_3'.

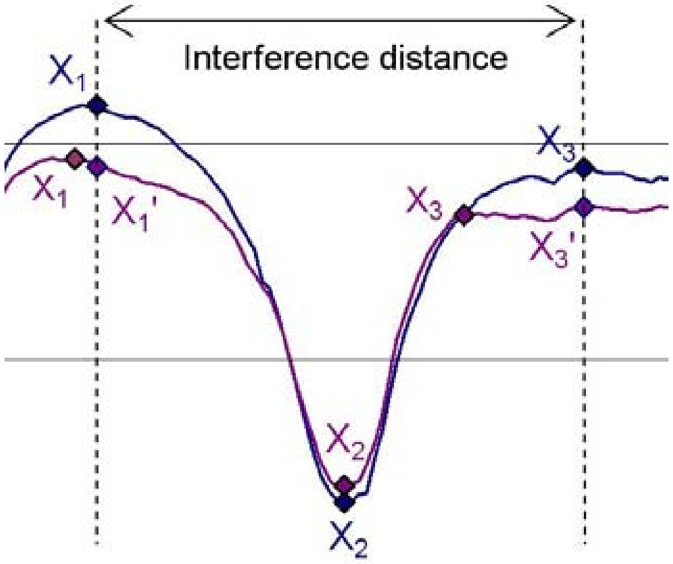


Figure 3. Detail of an interference distance at an intersection.

The way to calculate the difference on delays is as follows:

$$\Delta Delay\,[s] = \left[t_{x_1' \to x_3'}^{travel\ time} - \left(\frac{x_3 - x_1}{\frac{v_1' + v_3'}{2}} \right) \right] - \left[t_{x_1 \to x_3}^{travel\ time} - \left(\frac{x_3 - x_1}{\frac{v_1 + v_3}{2}} \right) \right]$$

Sometimes, there are intersections where the points (X_1; X_3) are not defined, normally at the beginning or at the end of a street. In these situations, the imaginary travel time has been calculated dividing the distance between the points (X_1; X_2) or (X_2; X_3) with the highest speed, where the deceleration starts or where the acceleration ends. The rest of the analysis has been the same. The way to calculate these delays is as follows:

Only decelerations:

$$\Delta Delay\,[s] = \left[t_{x_1' \to x_2'}^{travel\ time} - \left(\frac{x_2 - x_1}{v_1'} \right) \right] - \left[t_{x_1 \to x_2}^{travel\ time} - \left(\frac{x_2 - x_1}{v_1} \right) \right]$$

Only accelerations:

$$\Delta Delay\,[s] = \left[t_{x_2' \to x_3'}^{travel\ time} - \left(\frac{x_3 - x_2}{v_3'} \right) \right] - \left[t_{x_2 \to x_3}^{travel\ time} - \left(\frac{x_3 - x_2}{v_3} \right) \right]$$

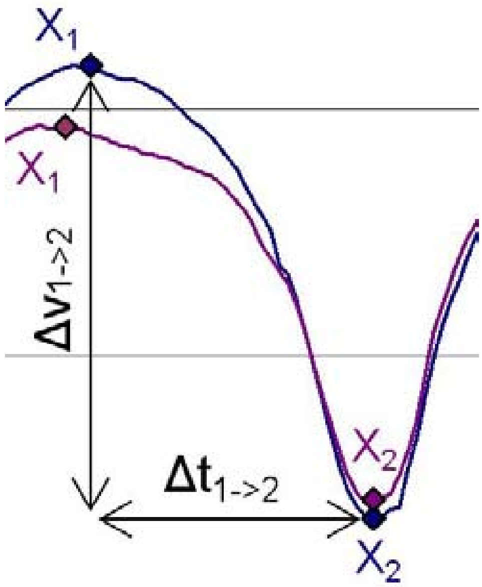
Therefore, to test the hypothesis two, it is just to find the difference between these delays, and then, to express the change in delay (%) and to do a sign test in order to show whether the great majority has gone to one direction.

Hypothesis 3. Less accelerations and decelerations.

Apparently, it is reasonable to think that if the distance of the street is the same, and the travel time does not change, automatically the average speed must be unchanged. However, it has been shown that the higher speeds decrease driving with AAP, so far, the smaller speeds may be higher driving with AAP.

A possible explanation might be whether the speed distribution is smoother, with lower maximum speeds but with less differences between maximum and minimum speeds. For that reason, this hypothesis tests the changes in accelerations/decelerations, to study whether in the intersections the speed profile is smoother driving with AAP

Although the analysis, it is possible to know the speed when the car begins to decelerate near the intersection, and when the car is crossing it with the smaller speed. As well as, it is possible to know the travel time between these two points as well. The mean deceleration has been calculated dividing the difference of speeds with the travel time difference between those points.



$$d_{mean} = \frac{\Delta v_{1\to 2}}{t_{1\to 2}} = \frac{v_2 - v_1}{t_2 - t_1}$$

Figure 4. Deceleration profile

Once the car has crossed the intersection, it begins to accelerate from the intersection until the driver is out of the influence of the intersection. The mean acceleration has been calculated with the same expression.

$$a_{mean} = \frac{\Delta v_{2\to3}}{t_{2\to3}} = \frac{v_3 - v_2}{t_3 - t_2}$$

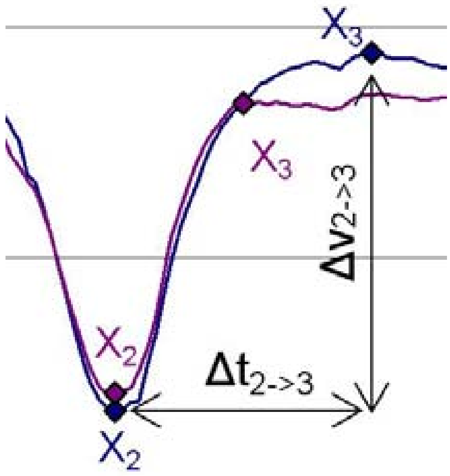


Figure 5. Acceleration profile

Therefore, to test the hypothesis three, it is just to find the difference between these accelerations/decelerations, and then, to express the change in % and to do a sign test in order to show whether the great majority has gone to one direction.

Hypothesis 4. Stopped cars decrease related to all the passing cars.

The aim of the hypothesis four is to study whether the ratio of stopped cars is lower, in order to test a theoretical decrease in travel time at intersections, but the values do not talk about how long they stop.

All the information has been obtained from the datalogg stored in LundaISA. It was extracted the speed profile of all the cars passed for all the links of each street. That speed profile has been analysed in two different weeks, first one, one week before that the device was activated (*before AAP period*). Second one, seven months later, the last week that the device was turned on (*After long-time use*).

Inside the datalogg were stored five speed values per second. With that information, it has been calculated the ratio (%) of the number of cars that stopped (speed 0.00) related to all the passing cars (different speed than 0.00).

Therefore, to test the hypothesis four, it is just to find the difference between these ratio values, and then, to express the change in % and to do a sign test in order to show whether the great majority has gone to one direction.

There is an important difference between the analyses of the three first hypotheses, with the fourth one, mainly because the sources of data are different. In the *"delrapport 13 LundaISA"*, the source for the three first ones, was made a speed profile for each direction of a street, without to think whether the street had a single or double carriage way. However, the speed profile for the hypothesis four was extracted directly from the database (LundaISA). This speed profile was assigned to links, and one link is assigned to a carriage way. It means that the stopped car ratio is calculated for one direction when the street has a double carriage way, but when the street has a single carriage way with two directions, the stopped car ratio is calculated for the two directions together, without to know which sense it is talking about, for example, either north or south direction within the same carriage way.

4.3. Street tables.

In the table below it is shown the number of streets and significant intersections analysed for the hypotheses one, two and three.

Table 2. Summary of the situations analysed

Group	Num. of streets	Interferences
1st	6	17
2nd	9	45
3rd	10	31
4th	6	15

For testing the different hypotheses, it has been necessary to classify all the data in two different kinds of tables. For the hypotheses one, three and four, it has been designed a *street file* where is possible to find all the driving information for the two periods of time separately, before AAP and after long-time use. For the hypothesis two, it has been created a specific *table of delays* because for the second period of time, the reference of the intersection's distance is fixed directly for the reference's area of the first period, before AAP. It means to define new points after long-time use, which may be different in the two kinds of tables.

4.3.1. Street files.

For the hypotheses one, three and four, it has been necessary to identify each point where the cars had a change because of the intersection's influence area. There is an example below, where it is shown how it was separated the driving speed, both driving in a free stretch and influenced for an intersection.

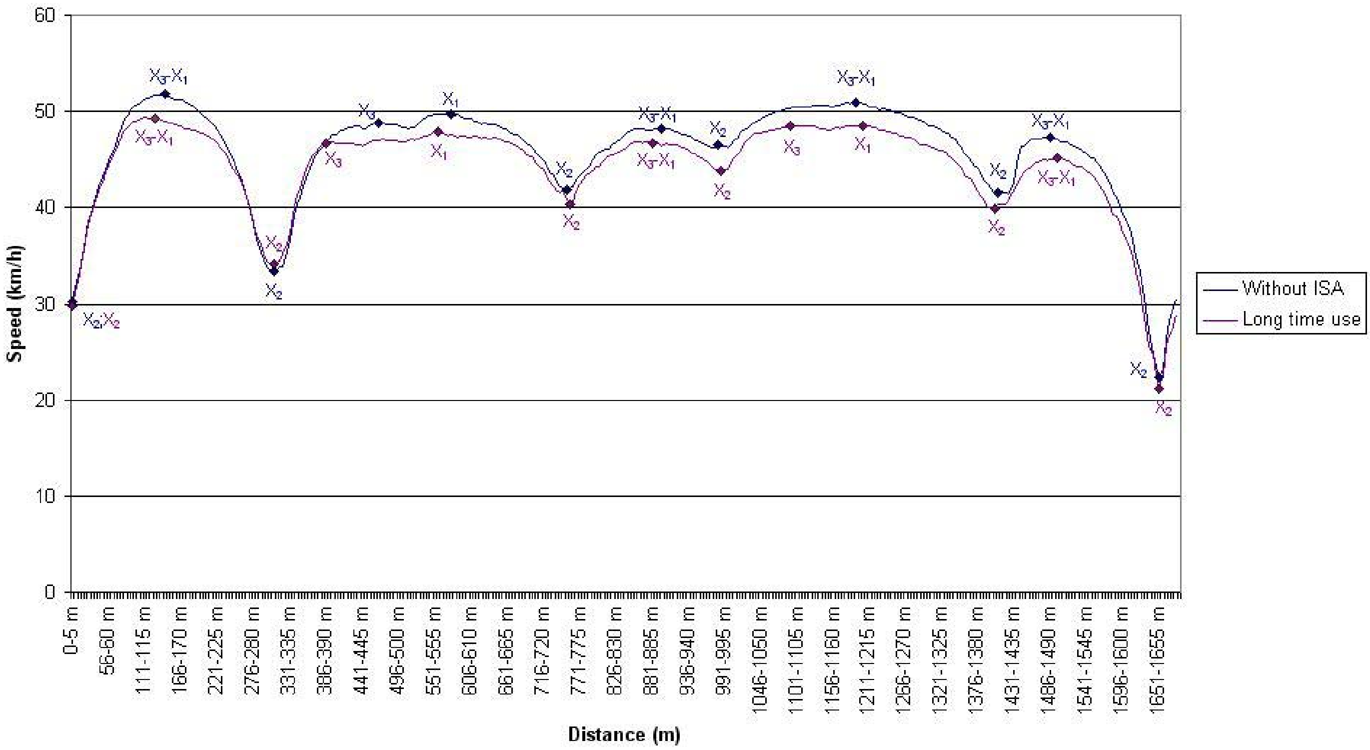


Figure 3. Classification point-by-point of driving speed for a whole street.

All this information has been classified in many tables, from the first metre, until the end of the street in order to extract the valid information for the analysis. However, in these tables is easy to find more information than the strictly needed.

First of all, general information of whole street.

Table 3. General information of a street.

Group		Name of the street:			
		Direction			
Number of street		Speed limit (km/h)		Mean travel time	(s):
		Total Length (m)			
Code:		Mean Speed (km/h)			
				Stopped cars ratio	(%):
		Num. Interferences:			

The most significant cells are explained below:

- *Group:* there are four different groups.

- *Number of the street:* within every group of streets, it has been assigned a specific number for each street.

- *Code:* it is the name used by *"delrapport 13 LundaISA"* (Hjälmdahl, M., Várhelyi, A., Almqvist, S., 2002) to rename the streets.

- *Total length:* total distance of the street from *"delrapport 13 LundaISA"* (Hjälmdahl, M., Várhelyi, A., Almqvist, S., 2002).

- Mean travel time: significant value for the hypothesis one.

- Mean speed: the result to divide the total length with the mean travel time. Used to compare in the hypothesis one.

- Stopped cars ratio: significant value for the hypotheses two.

- *Num. Interferences:* number of significant intersections. It was necessary to travel around the test site in order to classify each one of them.

The next step has been to classify all the interferences, to place them, and to prepare the data for the analysis in each one. A normal intersection has been organized as follows:

Table 4. Numeric classification of an interference.

Number:		**Deceleration**			
Kind of interference		Distance X1 (m)		Total distance (m)	
		Distance X2 (m)			
		Speed V1 (km/h)		Decrease V2-V1 (km/h)	
		Speed V2 (km/h)			
t_1 (s)	t_2 (s)	Deceleration time (s)		**Mean Deceleration (m/s^2)**	
		Acceleration			
		Distance X2 (m)		Total distance (m)	
		Distance X3 (m)			
		Speed V2 (km/h)		Increase V3-V2 (km/h)	
		Speed V3 (km/h)			
t_2 (s)	t_3 (s)	Acceleration time (s)		**Mean Acceleration (m/s^2)**	
Travel time through the interference (s):					
Imaginary travel time without intersection (s):					
Delay because of the intersection (s):					

The most significant cells are explained below:

- *Kind of interference:* which kind of physic intersection it is: traffic light, 3-leg priority…

- *Distance X1:* absolute position of the point where the car begins to decelerate.

- *Distance X2:* absolute position of the point where the car reaches the minimum speed.

- *Total distance:* distance between point one and point two.

- *Speed V1:* mean speed of the cars in the point 1.

- *Speed V2:* mean speed of the cars in the point 2.

- *Decrease V2-V1:* mean speed difference between point one and point two.

- t_1*:* average travel time from the beginning of the street, until the point 1.

- t_2*:* average travel time from the beginning of the street, until the point 2.

- *Deceleration time:* average travel time difference between the point one and the point two.

- Mean deceleration: significant value for the hypotheses three. This is the result to divide the mean speed difference, with the deceleration time between point one and point two.

The acceleration part has the same fields. The only difference is between points, from the point two where cars have the minimum mean speed, to the point where cars finish the acceleration.

- *Travel time through the interference:* travel time difference between the point three and the point one.

- *Imaginary travel time without intersection:* result to divide the total distance of the interference, with the mean speed of the point one and the point three.

- Delay because of the intersection: difference between the real travel time with the imaginary travel time without intersection. The delays on travel time has been calculated with different distances, because of the interference's area is not the same depending on the periods of time.

For the interferences without the three points well defined, only acceleration/deceleration, the table is as follows:

Table 5. Numeric classification of acceleration interference. Just with points 2&3

Number:		**Acceleration**			
Kind of interference		Distance X2 (m)		Total distance (m)	
		Distance X3 (m)			
		Speed V2 (km/h)		Increase V3-V2 (km/h)	
		Speed V3 (km/h)			
t_2 (s)	t_3 (s)	Acceleration time (s)		**Mean Acceleration (m/s²)**	
Travel time through the interference (s)					
Imaginary travel time without intersection (s)					
Delay because of the intersection (s)					

The only difference with the standard table is that the imaginary travel time has been calculated dividing the total distance, with the speed of the point three. For deceleration interferences, it is the same but with the speed of the point one.

Table 6. Numeric classification of deceleration interference. Just with points 1&2.

Number:		**Deceleration**			
Kind of interference		Distance X1 (m)		Total distance (m)	
		Distance X2 (m)			
		Speed V1 (km/h)		Decrease V2-V1 (km/h)	
		Speed V2 (km/h)			
t_1 (s)	t_2 (s)	Deceleration time (s)		**Mean Deceleration (m/s^2)**	
Travel time through the interference (s)					
Imaginary travel time without intersection (s)					
Delay because of the intersection (s)					

Sometimes the point three, at the end of an intersection, may coincide with the point one at the beginning of the next one. However, there are many situations where cars can drive free along a stretch, both without influences and with the AAP is working.

That information has been put on the street table as well. It is the basic data between the point three and the next point one.

Table 7. Numeric classification of a stretch without influences.

Free Stretch	Travel time (s)	Distance (m)	Average speed of the stretch (km/h)

4.3.2. Table of delays.

Once the intersection's influence area has been fixed for the *before AAP* period, within the analysis of the hypothesis two, it has been necessary to define the new points X_1', X_2' and X_3' for the *long-time use* period, as well as to find their average speeds and travel times.

The way to calculate both delays is the same that it has been explained before. The streets and interferences remain unchanged despite to do a different analysis.

All this information has been classified in many tables, from the first intersection until the last one for every street, in order to extract the valid information for calculating the delays on travel time due to drive either with AAP or without AAP.

First of all, a short table for classifying every street.

Table 8. General information of a street.

Group		**Street**			
Number		**Code**		**Length (m)**	

All this information has been extracted directly from the tables of the *street files.*

The next step has been to classify all the interferences, to place the new points, to extract mean speeds and travel times. Finally, to prepare the data needed for calculating the delays within the interference area. A normal intersection has been organized as follows, where the points X_1 and X_3 are fixed:

Table 9. Numeric classification of an interference. Table of delays.

Number:	Position X1 (m)		Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)			
	Total Delay on travel time (s)			
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP				
After long time use				
Delay before AAP (s)		Delay after seven months (s)		

The most significant cells are explained below:

- *Interference distance before AAP:* distance of the intersection's influence area fixed by the points X_1 and X_3.

- *Before AAP:* mean speeds and travel time for the points X_1 and X_3.

- *After long time use:* mean speeds and travel time for the points X_1' and X_3'.

- *Delay before AAP:* numeric value of the delay on travel time explained before.

- *Delay after seven moths:* numeric value of the delay on travel time explained before, but within the distance defined by the points X_1 and X_3.

- *Total delay on travel time:* this is the significant value for the hypothesis two. It is the difference between the delay after long-time use and the delay before AAP.

For the interferences without the three points well defined, only acceleration/deceleration, the table is as follows:

Table 10. Numeric classification of acceleration interference. Only points 2&3. Table of delays

Number:	Position X2 (m)		Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)			
	Total Delay on travel time (s)			
X2 - X3 fixed	Speed in X3 (km/h)		t_2 (s)	t_3 (s)
Before AAP				
After long time use				
Delay before AAP (s)		Delay after seven months (s)		

The only difference with the standard table is that the imaginary travel time has been calculated dividing the total distance, with the speed of the point three. In this case, the mean speed in the point two is not needed for calculating the imaginary travel time without intersection.

For deceleration interferences, it is the same but with the speed of the point one.

Table 11. Numeric classification of deceleration interference. Only points 1&2. Table of delays

Number:		Position X1 (m)		Interference distance beforeAAP (m)	
Kind of interference:		Position X2 (m)			
		Total Delay on travel time		**(s)**	
X1 - X2 fixed		Speed in X1 (km/h)		t_1 (s)	t_2 (s)
Before AAP					
After long time use					
Delay before AAP (s)			Delay after seven months (s)		

In both situations, the cells have the same signification explained above.

5. Results

Due to the kind of analysis, the following results have been classified in tables where is shown the values for the two periods, before the device was turned on and after long time use. They have been ordered by pairs and for the same physical place, it means at the same intersection (hypotheses two and three) or in a whole street (hypotheses one and four).

Then, the results for each hypothesis have been separated in different groups, depending on the kind of streets. There are four groups, for every situation is shown the mean difference in the two periods, as well as the increase/decrease ratio (%).

At the end of a table it is calculated the unweighted mean value, first one, of the increase/decrease ratio for all the hypotheses, and then, of the difference in the two periods only for the hypothesis three.

Finally, in each table has been counted the number of positive and negative values for the sign test. Below mean values, it is shown the p-value for the statistical test, and a short comment in the hypothesis one, which is the most significant, in order to show either it can be regarded as a real change in a direction (p-value<0.05), or there is no difference in the mean values for the two periods.

5.1. Hypothesis 1.

This hypothesis aims to test whether there is an increase on travel time or not, for that, it is shown the mean travel time obtained from the analysis in each period. It has been calculated the difference on travel time and the increase/decrease ratio as well. Besides, there is a second table where is shown the difference between the average speed for the whole street, with the maximum spot speed value because of the effects of an active accelerator pedal, in order to show a possible relation between this speeds. It does not mean that the relation between these mean speeds are direct, it is made either for detecting possible extreme values, which should be studied individually, or for improving the comprehension of the initial paradox, once the rest of hypotheses are tested.

The initial statistical hypothesis is that do not exist difference between mean travel times in the two periods. The p-value has been calculated in order to test if it is possible to reject it, for showing a statistical difference between these mean travel times.

5.1.1. First Group.

Table 12. Mean travel time results. Group 1.

Street (speed limit 70-50km/h)	Length (m)	Hypothesis 1: Mean travel time (s)		Difference (s)	Increase (%)
		Before AAP	After 7 months	After-Before	
Dalbyvägen (west)	1213	72,59	73,14	0,55	**0,76**
Dalbyvägen (east)	1212	67,46	68,08	0,62	**0,92**
Fjelievägen (west)	410	19,29	21,97	2,68	**13,89**
Fjelievägen (east)	470	23,45	24,38	0,93	**3,97**
Norra Ringen (west)	2209	125,47	131,41	5,94	**4,73**
Norra Ringen (east)	2203	131,69	139,96	8,27	**6,28**
		Unweighted mean value			**5,09**
		p-value	**0,03** (<0,05)	Increase on travel time	

The mean travel time increases on all the streets.

Table 13. Average speed results. Group 1.

Street (speed limit 70-50km/h)	Length (m)	Average speed (km/h)		Difference (km/h)	Decrease (%)	Spot speed, mid-block section (km/h)		Difference (km/h)	Decrease (%)
		Before AAP	After 7 months	After-Before		Before AAP	After 7 months	After-Before	
Dalbyvägen (west)	1213	60,16	59,70	-0,45	**-0,75**	73,34	70,06	-3,28	**-4,47**
Dalbyvägen (east)	1212	64,68	64,09	-0,59	**-0,91**	75,45	71,63	-3,82	**-5,06**
Fjelievägen (west)	410	76,52	67,18	-9,33	**-12,20**	77,87	70,67	-7,20	**-9,25**
Fjelievägen (east)	470	72,15	69,40	-2,75	**-3,81**	74,73	70,28	-4,45	**-5,95**
Norra Ringen (west)	2209	63,38	60,52	-2,86	**-4,52**	78,18	72,22	-5,96	**-7,62**
Norra Ringen (east)	2203	60,22	56,66	-3,56	**-5,91**	76,75	71,30	-5,45	**-7,10**
		Unweighted mean values		**-3,26**	**-4,68**	Unweighted mean values		**-5,03**	**-6,58**

The third value has been written in blue colour, because Fjelievägen is the unique street where the decrease in average speed is higher than the decrease in maximum spot speed. This is not significant because it is due to a singular interference, an increase on the speed limit (70km/h to 90km/h).

The results show an increase on travel time for all the streets (p-value=0.03 <0.05), with a mean increase (unweighted) by 5.09%. Besides, it seems to be a normal relation with the difference between speeds, a higher decrease on spot speeds at mid-block sections can produce the decrease on average speeds in the whole street.

5.1.2. Second Group.

Table 14. Mean travel time results. Group 2.

Street (speed limit 50km/h)	Length (m)	Hypothesis 1: Mean travel time (s) Before AAP	After 7 months	Difference (s) After-Before	Increase (%) After-Before
Svenshögsvägen (south)	899	76,97	78,63	1,66	**2,16**
Svenshögsvägen (north)	899	69,97	73,01	3,04	**4,34**
Törnav./Solväg./Sod...(SW	1688	134,47	138,9	4,43	**3,29**
Törnav./Solväg./Sod...(NE)	1688	139,97	143,58	3,61	**2,58**
Stattenavägen (south)	1107	87,54	91,11	3,57	**4,08**
Kävlingevägen (north)	1028	72,91	76,44	3,53	**4,84**
Kävlingevägen (south)	1028	77,24	80,29	3,05	**3,95**
Tornavägen (north)	1612	142,06	145,38	3,32	**2,34**
Tornavägen (south)	1612	133,53	138,53	5,00	**3,74**
		Unweighted mean value			**3,48**
		p-value	**0,00** (<0,05)	Increase on travel time	

The mean travel time increases on all the streets.

Table 15. Average speed results. Group 2.

Street (speed limit 50km/h)	Length (m)	Average speed (km/h) Before AAP	Average speed (km/h) After 7 months	Difference (km/h) After-Before	Decrease (%) After-Before	Spot speed, mid-block section (km/h) Before AAP	Spot speed, mid-block section (km/h) After 7 months	Difference (km/h) After-Before	Decrease (%) After-Before
Svenshögsvägen (south)	899	42,05	41,16	-0,89	**-2,11**	51,36	47,82	-3,54	**-6,89**
Svenshögsvägen (north)	899	46,45	44,33	-2,13	**-4,57**	55,06	49,34	-5,72	**-10,39**
Törnav./Solväg./Sod...(SW)	1688	45,19	43,75	-1,44	**-3,19**	51,78	48,94	-2,84	**-5,48**
Törnav./Solväg./Sod...(NE)	1688	43,42	42,32	-1,09	**-2,51**	50,70	47,98	-2,72	**-5,36**
Stattenavägen (south)	1107	45,52	43,74	-1,78	**-3,92**	52,77	49,25	-3,52	**-6,67**
Kävlingevägen (north)	1028	50,76	48,41	-2,34	**-4,62**	58,74	52,10	-6,64	**-11,30**
Kävlingevägen (south)	1028	47,91	46,09	-1,82	**-3,80**	54,69	50,84	-3,85	**-7,04**
Tornavägen (north)	1612	40,85	39,92	-0,93	**-2,28**	51,10	47,37	-3,73	**-7,30**
Tornavägen (south)	1612	43,46	41,89	-1,57	**-3,61**	51,31	47,52	-3,79	**-7,39**
		Unweighted mean values		**-1,56**	**-3,40**	Unweighted mean values		**-4,04**	**-7,54**

The results show a clear increase on travel time for all the streets (p-value=0.00 <0.05), with a mean increase (unweighted) by 3.48%. Besides, it seems to be a normal relation with the difference between speeds, a higher decrease on spot speeds at mid-block sections can produce the decrease on average speeds in the whole street.

5.1.3. Third Group.

Table 16. Mean travel time results. Group 3.

Street (speed limit 50km/h)	Length (m)	Hypothesis 1: Mean travel time (s) Before AAP	After 7 months	Difference (s) After-Before	Incr/Decr (%) After-Before
Tunavägen (east)	557	50,48	54,10	3,62	**7,17**
Tunavägen (west)	557	50,51	52,23	1,72	**3,41**
Dalbyvägen (west)	282	25,38	26,58	1,20	**4,73**
Dalbyvägen (east)	281	26,65	26,88	0,23	**0,86**
Fjelievägen (N-E)	403	33,54	33,55	0,01	**0,03**
Fjelievägen (S-W)	403	38,02	38,04	0,02	**0,05**
Kung Oscars väg (west)	683	64,55	63,88	-0,67	**-1,04**
Kung Oscars väg (east)	683	60,78	62,57	1,79	**2,95**
Sölvegatan (south)	735	76,55	81,78	5,23	**6,83**
Sölvegatan (north)	735	74,82	77,73	2,91	**3,89**
		Unweighted mean value			**2,89**
		p-value	**0,02** (<0,05)	Increase on travel time	

The seventh value has been written in red colour, because this is the unique street where the mean travel time decreases. Mean travel time increases in the rest of the streets, nine of ten.

The results show an increase on travel time for the streets (p-value=0.02 <0.05), with a mean increase (unweighted) by 2.89%.

Table 17. Average speed results. Group 3.

Street (speed limit 50km/h)	Length (m)	Average speed (km/h) Before AAP	After 7 months	Difference (km/h) After-Before	Incr/Decr (%) After-Before	Spot speed, mid-block section (km/h) Before AAP	After 7 months	Difference (km/h) After-Before	Decrease (%) After-Before
Tunavägen (east)	557	39,72	37,06	-2,66	**-6,69**	50,23	45,98	-4,25	**-8,46**
Tunavägen (west)	557	39,70	38,39	-1,31	**-3,29**	49,26	47,43	-1,83	**-3,71**
Dalbyvägen (west)	282	40,00	38,19	-1,81	**-4,51**	48,18	45,46	-2,72	**-5,65**
Dalbyvägen (east)	281	37,96	37,63	-0,32	**-0,86**	46,33	44,84	-1,49	**-3,22**
Fjelievägen (N-E)	403	43,26	43,24	-0,01	**-0,03**	45,15	43,38	-1,77	**-3,92**
Fjelievägen (S-W)	403	38,16	38,14	-0,02	**-0,05**	42,30	42,17	-0,13	**-0,31**
Kung Oscars väg (west)	683	38,09	38,49	0,40	**1,05**	51,75	50,89	-0,86	**-1,66**
Kung Oscars väg (east)	683	40,45	39,30	-1,16	**-2,86**	49,54	45,15	-4,39	**-8,86**
Sölvegatan (south)	735	34,57	32,36	-2,21	**-6,40**	41,35	38,18	-3,17	**-7,67**
Sölvegatan (north)	735	35,36	34,04	-1,32	**-3,74**	42,46	40,28	-2,18	**-5,13**
		Unweighted mean values		**-1,04**	**-2,74**	Unweighted mean values		**-2,28**	**-4,86**

Once more, it seems to be a normal relation between speeds. However, in Kung Oscars vägen, the average speed has increased despite a decrease in maximum spot speed, it means that it is possible to drive faster without AAP along a whole street, although sometimes the maximums spot speeds could be lower.

5.1.4. Fourth Group.

Table 18. Mean travel time results. Group 4.

Street (speed limit 30km/h)	Length (m)	Hypothesis 1: Mean travel time (s) Before AAP	Mean travel time (s) After 7 months	Difference (s) After-Before	Incr/Decr (%) After-Before
Stora Tomegatan	237	34,19	35,58	1,39	**4,07**
Östra Martensgatan	110	16,54	16,95	0,41	**2,48**
Västra Martensgatan	221	45,32	46,89	1,57	**3,46**
St Petri Kyrkogata	220	35,64	34,89	-0,75	**-2,10**
Kyrkogatan	265	39,37	37,29	-2,08	**-5,28**
Skomakaregatan	215	35,90	36,49	0,59	**1,64**
		Unweighted mean value			**0,71**
		p-value	**0,68** (>0,05)	No statistically significant	

Two of them have been written in red colour, because in these streets is where the mean travel time decreases. For the others four streets, there is an increase on travel time.

The results may not show an increase on travel time for the streets (p-value=0.68, >0.05), with a mean increase (unweighted) by 0.71%, almost zero.

Table 19. Average speed results. Group 4.

Street (speed limit 30km/h)	Length (m)	Average speed (km/h) Before AAP	Average speed (km/h) After 7 months	Difference (km/h) After-Before	Incr/Decr (%) After-Before	Spot speed, mid-block section (km/h) Before AAP	Spot speed, mid-block section (km/h) After 7 months	Difference (km/h) After-Before	Incr/Decr (%) After-Before
Stora Tomegatan	237	24,95	23,98	-0,97	**-3,91**	30,19	26,85	-3,34	**-11,06**
Östra Martensgatan	110	23,94	23,36	-0,58	**-2,42**	25,00	23,69	-1,31	**-5,24**
Västra Martensgatan	221	17,56	16,97	-0,59	**-3,35**	26,66	26,26	-0,40	**-1,50**
St Petri Kyrkogata	220	22,22	22,70	0,48	**2,15**	25,80	26,61	0,81	**3,14**
Kyrkogatan	265	24,23	25,58	1,35	**5,58**	27,59	27,72	0,13	**0,47**
Skomakaregatan	215	21,56	21,21	-0,35	**-1,62**	27,18	26,43	-0,75	**-2,76**
		Unweighted mean values		**-0,11**	**-0,59**	Unweighted mean values		**-0,81**	**-2,83**

Again, there is a normal relation between speeds. In this group, there are five streets where an increase/decrease in average speed might lead to an increase/decrease in maximum spot speeds, without others possible interferences. However, the blue one is the unique street where the decrease in average speed is higher than the decrease in maximum spot speed; it might be apparently provoked for another kind of interferences, meaningless in this work.

It has been calculated the average travel time and average speed for thirty-one streets. Only in two of them, the decrease on average speed ratio has been higher than the decrease on maximum speed ratio. For the rest of streets, an increase/decrease of average speed for the whole stretch has been followed for a higher increase/decrease in maximum speeds.

Only in three of the thirty-one streets, first one in the third group and the others two in the fourth group, the average travel time has been shorter after a long time use with AAP. However, it can be verified a clear relation between the speed limit of every group and the travel time missed. Lower speed limits imply a decrease on travel time lost.

5.2. Hypothesis 2.

This hypothesis aims to test a decrease on delays at intersections. This is the basic hypothesis done in this study, in order to show whether delay on travel time at intersections have improved due to drive with AAP after long time use, otherwise, it might be apparently a direct relation between the decrease in spot speeds at mid-block section, once it was showed in an early study (Hjälmdahl, et al., 2002), with the generalize decrease in average speeds showed before.

There is a table for each group where it is shown the delay obtained from the analysis in the two periods, besides, it has been calculated the difference between them and the increase/decrease ratio.

There are a few intersections where the delays have been negatives. Physically, it is impossible, for this reason, all the interferences with negative values have been ignored in the results. It has been considered that these intersections do not produce delay.

The initial hypothesis is that do not exist difference between delays in the two periods. The p-value has been calculated in order to test if it is possible to reject it, for showing a statistical difference between these mean delays across intersections.

5.2.1. First Group.

Table 20. Delay time results. Group 1.

Hypothesis 2					
Street (speed limit 70-50km/h)	Influence distance (m)	Average delay on travel time		Difference (s)	Incr/Decr (%)
		Before AAP	After 7 months	After-Before	
Dalbyvägen (west)	340	0,53	0,44	-0,09	-16,98
	605	3,33	3,11	-0,22	-6,61
	220	2,38	2,74	0,36	15,13
Dalbyvägen (east)	125	0,37	0,42	0,05	13,51
	665	3,41	2,05	-1,36	-39,88
	190	0,38	0,44	0,06	15,79
Fjelievägen (west)	210	0,56	1,12	0,56	100,00
Fjelievägen (east)	470	0,91	0,86	-0,05	-5,49
Norra Ringen (west)	490	3,72	3,25	-0,47	-12,63
	520	3,64	3,66	0,02	0,55
	477	0,01	-0,21	-----	-----
	510	2,01	1,30	-0,71	-35,32
Norra Ringen (east)	450	1,28	1,23	-0,05	-3,91
	531	3,13	2,64	-0,49	-15,65
	480	-1,62	-0,55	-----	-----
	490	6,69	6,54	-0,15	-2,24
Sign test; p-value	**0,42** (>0,05)	Unweighted mean value			**0,45**

It has been accepted fourteen significant intersections, because two of them have a negative delay and it is impossible physically.

There are nine intersections where the delays have decreased, the red ones. Otherwise, the others five intersections have increased after a long time use. The average delay ratio (unweighted) has increased by 0.45 %, almost zero.

The p-value from the sign test is 0.42, therefore, it is not possible to show a clear improvement about the delay time driving on turning stretches, only a few tendency.

5.2.2. Second Group.

Table 21. Delay time results. Group 2.

Hypothesis 2					
Street (speed limit 50km/h)	Influence distance	Average delay on travel time (s)		Difference (s)	Incr/Decr (%)
		Before AAP	After 7 months	After-Before	
Svenshögsvägen (south)	195	1,70	0,99	-0,71	-41,76
	340	2,20	1,47	-0,73	-33,18
	245	3,54	3,12	-0,42	-11,86
	40	0,38	0,21	-0,17	-44,74
Svenshögsvägen (north)	210	0,30	-0,02	-----	-----
	450	2,40	1,39	-1,01	-42,08
	240	3,75	3,08	-0,67	-17,87
Törnav./Solväg./Sod...(SW)	140	1,52	1,20	-0,32	-21,05
	325	3,32	2,53	-0,79	-23,80
	320	1,24	0,96	-0,28	-22,58
	295	0,31	0,24	-0,07	-22,58
	295	1,02	1,04	0,02	1,96
	165	2,95	3,07	0,12	4,07
Törnav./Solväg./Sod...(NE)	120	0,77	0,74	-0,03	-3,90
	315	1,15	0,98	-0,17	-14,78
	295	0,49	0,29	-0,20	-40,82
	310	1,43	1,46	0,03	2,10
	345	3,98	2,69	-1,29	-32,41
	115	4,60	4,69	0,09	1,96
Stattenavägen (south)	605	1,84	0,97	-0,87	-47,28
	300	4,03	4,21	0,18	4,47
	165	3,35	2,54	-0,81	-24,18
Kävlingevägen (north)	185	1,34	1,08	-0,26	-19,40
	235	-0,01	-0,13	-----	-----
	345	0,83	0,21	-0,62	-74,70
	250	2,83	2,05	-0,78	-27,56
Kävlingevägen (south)	160	0,97	0,60	-0,37	-38,14
	425	1,55	0,86	-0,69	-44,52
	285	0,24	0,02	-0,22	-91,67
	140	3,83	3,80	-0,03	-0,78
Tornavägen (north)	110	0,13	0,02	-0,11	-84,62
	270	2,06	1,79	-0,27	-13,11
	345	7,51	5,11	-2,40	-31,96
	90	-0,31	0,06	-----	-----
	130	0,34	0,11	-0,23	-67,65
	244	3,12	5,00	1,88	60,26
	165	-0,04	-0,09	-----	-----
	230	4,45	4,41	-0,04	-0,90
Tornavägen (south)	165	1,51	1,04	-0,47	-31,13
	235	0,48	0,28	-0,20	-41,67
	218	3,03	3,48	0,45	14,85
	170	0,40	0,19	-0,21	-52,50
	344	6,49	6,45	-0,04	-0,62
	350	2,56	1,93	-0,63	-24,61
	120	0,26	0,15	-0,11	-42,31
Sign test; p-value	**0,00** (<0,05)	Unweighted mean value			**-25,44**

It has been accepted forty-one significant intersections, because four of them have a negative delay and it is impossible physically.

There are thirty four intersections where the delays have decreased, the red ones. Otherwise, the others six intersections have increased the time missed across them after a long time use.

The results show a clear decrease on delay time (p-value=0.00, <0.05) across forty-one, where the average delay (unweighted) has decreased by 25.44 %.

5.2.3. Third Group.

Table 22. Delay time results. Group 3.

Hypothesis 2					
Street (speed limit 50km/h)	Influence distance (m)	Average delay on travel time (s)		Difference (s)	Incr/Decr (%)
		Before AAP	After 7 months	After-Before	
Tunavägen (east)	175	2,92	2,69	-0,23	-7,88
	225	1,54	1,02	-0,52	-33,77
	125	3,98	4,94	0,96	24,12
Tunavägen (west)	130	0,92	0,64	-0,28	-30,43
	230	1,29	1,22	-0,07	-5,43
	175	4,64	5,03	0,39	8,41
Dalbyvägen (west)	120	0,56	0,49	-0,07	-12,50
	140	2,74	2,75	0,01	0,36
Dalbyvägen (east)	95	1,16	0,97	-0,19	-16,38
	150	2,75	2,63	-0,12	-4,36
Fjelievägen (N-E)	140	1,10	0,53	-0,57	-51,82
	250	0,87	0,09	-0,78	-89,66
Fjelievägen (S-W)	403	0,52	0,33	-0,19	-36,54
	100	2,77	2,75	-0,02	-0,72
Kung Oscars väg (west)	65	0,71	0,78	0,07	9,86
	365	1,95	1,16	-0,79	-40,51
	155	-0,24	0,06	-----	-----
	65	4,01	3,33	-0,68	-16,96
Kung Oscars väg (east)	210	3,04	2,52	-0,52	-17,11
	380	1,27	0,13	-1,14	-89,76
	70	1,68	1,84	0,16	9,52
Sölvegatan (south)	110	1,05	1,18	0,13	12,38
	75	0,26	0,16	-0,10	-38,46
	110	0,60	0,39	-0,21	-35,00
	87	2,39	0,27	-2,12	-88,70
	90	4,97	5,66	0,69	13,88
Sölvegatan (north)	210	2,08	1,47	-0,61	-29,33
	153	0,81	0,50	-0,31	-38,27
	100	0,11	-0,54	-----	-----
	100	0,24	0,35	0,11	45,83
	115	4,72	4,37	-0,35	-7,42
Sign test; p-value	**0,02** (<0,05)	Unweighted mean value			**-19,54**

It has been studied thirty-one intersections, despite two of them are not significant because of a negative delay.

There are twenty-one intersections where the delays have decreased, the red ones. Otherwise, the others eight intersections have increased the delays on travel time after a long time use.

The results show a decrease on delay time (p-value=0.02, <0.05) across the thirty-one intersections, where the average delay (unweighted) has decreased by 25.44 %.

5.2.4. Fourth Group.

Table 23. Delay time results. Group 4.

Hypothesis 2					
Street (speed limit 30km/h)	Influence distance (m)	Average delay on travel time (s)		Difference (s)	Incr/Decr (%)
		Before AAP	After 7 months	After-Before	
Stora Tomegatan	55	0,29	0,11	-0,18	-62,07
	140	4,52	3,47	-1,05	-23,23
Östra Martensgatan	30	0,16	0,05	-0,11	-68,75
	35	0,09	0,04	-0,05	-55,56
	35	0,16	0,11	-0,05	-31,25
Västra Martensgatan	140	6,25	6,43	0,18	2,88
	50	3,98	4,01	0,03	0,75
St Petri Kyrkogata	30	0,48	0,49	0,01	2,08
	70	0,77	0,79	0,02	2,60
	85	1,41	1,64	0,23	16,31
Kyrkogatan	25	0,07	0,17	0,10	142,86
	115	1,01	0,52	-0,49	-48,51
	115	3,53	2,81	-0,72	-20,40
Skomakaregatan	115	2,44	2,19	-0,25	-10,25
	90	3,69	4,00	0,31	8,40
Sign test; p-value	**1,00** (>0,05)	Unweighted mean value			**-9,61**

All the fifteen intersections have been accepted as significant, because none of them have a negative delay.

There are eight intersections where the delays on travel time have decreased, the red ones. Otherwise, the others seven intersections have increased after a long time use.

The average delay (unweighted) has decreased by 9.61 %, despite it is not possible to show a tendency to improve the mean delays, because of the p-value from the sign test is 1 (>0.05).

5.3. Hypothesis 3.

This hypothesis aims to test a decrease in mean accelerations/decelerations due to interferences at signalised intersections where the speed profile may be smoother. There is a table for each group where it is shown the accelerations/decelerations obtained from the analysis in the two periods, besides, it has been calculated the difference between them and the increase/decrease ratio.

Both tables are showed together, but it does not mean that a row belongs to the same intersection. The values for each part of the table are independent.

The initial hypothesis is that do not exist difference between accelerations/decelerations in the two periods. The p-value has been calculated in order to test if it is possible to refuse it, for showing a statistical difference between these accelerations/decelerations across intersections.

5.3.1. First Group.

Table 24. Acceleration/deceleration results. Group 1.

Hypothesis 3							
Acceleration (m/s^2)		Ac. Difference	Incr/Decr (%)	Deceleration (m/s^2)		Dec. Difference	Incr/Decr (%)
Before AAP	After 7 months	After-Before		Before AAP	After 7 months	After-Before	
0,15	0,18	0,03	22,13	-0,37	-0,36	-0,01	-2,91
0,64	0,58	-0,06	-9,04	-0,42	-0,44	0,02	4,16
0,30	0,36	0,06	18,46	-0,32	-0,38	0,06	19,11
0,45	0,35	-0,10	-22,92	-0,30	-1,80	1,50	508,55
0,31	0,40	0,09	27,29	-0,58	-0,59	0,00	0,77
0,51	0,32	-0,19	-37,19	-0,32	-0,24	-0,08	-26,04
0,42	0,34	-0,08	-18,94	-0,54	-0,48	-0,06	-10,28
0,74	0,75	0,01	1,39	-0,40	-0,42	0,02	4,68
0,48	0,47	-0,01	-2,06	-0,23	-0,14	-0,08	-37,47
0,21	0,22	0,01	2,39	-0,51	-0,46	-0,05	-10,12
0,75	0,71	-0,04	-5,05	-0,31	-0,50	0,19	59,21
0,48	0,51	0,03	5,85	-0,44	-0,42	-0,02	-3,55
Unweighted mean values		**-0,02**	**-1,48**	Unweighted mean values		**0,00**	**-0,22**
Sign test; p-value **1,00** (>0,05)		No statistically significant		Sign test; p-value **1,00** (>0,05)		No statistically significant	

Acceleration results.

There are six intersections where the difference of mean accelerations have decreased, the red ones. Otherwise, in the others six intersections have increased the acceleration value. Therefore, it is normal that p-value of the sign test is 1, where is not possible to show any change after a long time usage.

The average value (unweighted) of mean accelerations after the two periods has decreased by $0.02 m \cdot s^{-2}$. The average acceleration ratio (unweighted) has decreased as well by 1.48 %.

Deceleration results.

The fourth deceleration value has been left out from the analysis, because it is an extreme value which influences the whole result on its own. Hence, there are six intersections where the difference of mean decelerations have decreased, the red ones. Otherwise, in the others five intersections have increased the deceleration value. Therefore, the results are similar talking about the accelerations, where the p-value of the sign test is 1 again.

However, the average value (unweighted) of mean decelerations after the two periods remains unchanged. The average deceleration ratio (unweighted) has decreased by 0.22 %, insignificant.

For this group, it does not seem to be any change on accelerations due to drive with or without AAP not imply the necessity to reach faster the maximum speed allowed. Besides, there is no tendency to break on a different way when car drivers used an AAP.

5.3.2. Second Group.

Table 25. Acceleration/deceleration results. Group 2.

Hypothesis 3							
Accelerations (m/s^2)		Ac. Difference	Incr/Decr (%)	Decelerations (m/s^2)		Dec. Difference	Incr/Decr (%)
Before AAP	After 7 months	After-Before		Before AAP	After 7 months	After-Before	
0,41	0,52	0,12	28,74	-0,22	-0,17	-0,06	-24,92
0,36	0,23	-0,13	-35,41	-0,45	-0,50	0,06	12,60
0,72	0,59	-0,13	-17,72	-0,30	-0,18	-0,12	-39,16
0,46	0,41	-0,04	-9,61	-0,26	-0,19	-0,07	-28,38
0,27	0,25	-0,02	-7,25	-0,17	-0,19	0,02	12,08
0,53	0,52	-0,01	-2,00	-0,45	-0,40	-0,04	-9,78
0,33	0,53	0,21	62,81	-0,38	-0,27	-0,11	-28,47
0,16	0,18	0,02	14,09	-0,16	-0,13	-0,04	-22,86
0,09	0,15	0,06	65,10	-0,10	-0,10	0,00	-0,22
0,25	0,17	-0,07	-30,22	-0,16	-0,15	0,00	-3,05
-0,45	-0,43	0,01	-2,98	-0,17	-0,13	-0,04	-22,72
0,35	0,41	0,06	17,22	-0,09	-0,09	0,00	3,62
0,18	0,16	-0,02	-9,91	-0,26	-0,21	-0,05	-19,87
0,12	0,13	0,02	13,74	-0,39	-0,37	-0,02	-5,15
0,21	0,15	-0,07	-31,02	-0,73	-0,51	-0,21	-29,39
0,33	0,45	0,12	34,81	-0,08	-0,16	0,08	95,33
0,20	0,18	-0,02	-10,16	-0,46	-0,43	-0,04	-7,76
0,64	0,74	0,10	15,45	-0,50	-0,41	-0,09	-17,43
0,36	0,33	-0,03	-9,42	-0,08	0,04	-0,13	-148,21
0,10	0,03	-0,07	-69,65	-0,04	-0,02	-0,02	-48,63
0,14	0,04	-0,09	-68,55	-0,49	-0,36	-0,13	-26,25
0,35	0,22	-0,12	-35,97	-0,16	-0,13	-0,03	-17,05
0,10	0,10	0,00	1,18	-0,09	-0,06	-0,03	-37,92
0,05	0,08	0,04	83,38	-0,62	-0,50	-0,12	-19,73
0,07	0,12	0,05	65,69	-0,28	-0,25	-0,03	-11,46
0,33	0,36	0,02	6,63	-0,44	-0,37	-0,07	-16,25
0,46	0,43	-0,03	-6,32	-0,09	-0,07	-0,02	-23,24
0,17	0,11	-0,06	-37,35	-0,11	-0,11	0,00	-2,81
0,14	0,12	-0,02	-15,94	-0,45	-0,49	0,04	8,86
0,36	0,57	0,21	58,87	-0,18	-0,10	-0,08	-45,15
0,19	0,19	0,01	2,99	-0,40	-0,37	-0,03	-7,01
0,41	0,32	-0,09	-22,26	-0,20	-0,15	-0,05	-24,81
0,19	0,21	0,02	8,48	-0,61	-0,53	-0,08	-13,45
0,57	0,53	-0,04	-6,86	-0,17	-0,11	-0,06	-32,96
0,14	0,13	-0,01	-5,68	-0,44	-0,34	-0,10	-22,27
0,55	0,58	0,03	6,23	-0,27	-0,25	-0,01	-5,37
0,26	0,16	-0,10	-38,58	-0,11	-0,06	-0,04	-40,00
Unweighted mean valors		**0,00**	**0,34**	Unweighted mean valors		**-0,05**	**-18,09**
Sign test; p-value	**0,74** (>0,05)	No statistically significant		Sign test; p-value	**0,00** (<0,05)	**Less decelerations**	

Acceleration results.

There are twenty intersections where the difference of mean accelerations have decreased, the red ones. Otherwise, in the others seventeen intersections have increased after a long time use. The p-value of the sign test is 0.74, this is an insufficient p-value in order to show if there is a real decrease on accelerations.

The average value (unweighted) of mean accelerations after the two periods remain unchanged apparently, almost 0.00 $m \cdot s^{-2}$. The average acceleration ratio (unweighted) has increased by 0.34 %.

Deceleration results.

There are thirty-two intersections where the difference of mean decelerations have decreased, the red ones. Otherwise, in the others five intersections have increased after a long time use. The p-value of the sign test is 0.00.

The average value (unweighted) of mean decelerations has decreased 0.05 $m \cdot s^{-2}$ after the two periods. The average deceleration ratio (unweighted) has decreased as well by 18.09 %.

For this group, there is not any change on accelerations due to drive with AAP not imply the necessity to reach faster the maximum speed allowed. However, the results show clearly that to drive with AAP lead to a decrease on decelerations.

5.3.3. Third Group.

Table 26. Acceleration/deceleration results. Group 3.

Hypothesis 3							
Accelerations (m/s^2)		Ac. Difference	Incr/Decr (%)	Decelerations (m/s^2)		Dec. Difference	Incr/Decr (%)
Before AAP	After 7 months	After-Before		Before AAP	After 7 months	After-Before	
0,49	0,43	-0,06	-11,38	-0,31	-0,21	-0,11	-33,70
0,34	0,17	-0,16	-49,09	-0,67	-0,60	-0,07	-10,99
0,35	0,42	0,07	20,31	-0,24	-0,18	-0,07	-27,07
0,35	0,38	0,03	8,37	-0,55	-0,56	0,01	1,19
0,24	0,30	0,07	27,95	-0,51	-0,44	-0,07	-14,64
0,58	0,57	-0,01	-2,11	-0,47	-0,47	0,00	-0,05
0,36	0,49	0,13	34,85	-0,22	-0,21	-0,01	-6,54
0,17	0,13	-0,05	-26,09	-0,23	-0,21	-0,03	-11,22
0,12	0,12	0,00	-1,75	-0,57	-0,54	-0,03	-4,65
0,51	0,53	0,02	4,80	-0,28	-0,35	0,06	22,71
0,22	0,21	-0,01	-6,46	-0,29	-0,31	0,02	8,27
0,34	0,89	0,55	159,99	-0,88	-0,73	-0,15	-16,76
0,49	0,41	-0,07	-15,31	-0,19	-0,22	0,03	14,36
0,27	0,25	-0,02	-8,06	-0,55	-0,48	-0,07	-13,38
0,28	0,35	0,07	24,25	-0,14	-0,12	-0,02	-17,45
0,42	0,11	-0,31	-73,05	-0,14	-0,19	0,05	32,96
0,47	1,06	0,59	124,12	-0,45	-0,29	-0,16	-35,28
0,41	0,32	-0,10	-23,48	-0,59	-0,50	-0,08	-14,40
0,26	0,35	0,09	34,05	-0,33	-0,32	-0,01	-2,68
0,19	0,12	-0,07	-36,78	-0,17	-0,08	-0,09	-51,49
0,27	0,14	-0,13	-48,70	-0,46	-0,73	0,27	58,16
0,12	0,14	0,02	18,35	-0,56	-0,62	0,05	9,15
Unweighted mean valors		**0,03**	**7,04**	Unweighted mean valors		**-0,02**	**-5,16**
Sign test; p-value	**0,83** (>0,05)	No statistically significant		Sign test; p-value	**0,13** (>0,05)	No statistically significant	

Acceleration results.

There are twelve intersections where the difference of mean accelerations have decreased, the red ones. Otherwise, in the others ten intersections have increased after a long time use. The p-value of the sign test is 0.83, this is an insufficient p-value in order to show if there is a real decrease on accelerations.

The average value (unweighted) of mean accelerations after the two periods has increased 0.03 $m{\cdot}s^{-2}$. The average acceleration ratio (unweighted) has increased as well by 7.04 %.

Deceleration results.

There are fifteen intersections where the difference of mean decelerations have decreased, the red ones. Otherwise, in the others seven intersections have increased after a long time use. The p-value of the sign test is 0.13.

The average value (unweighted) of mean decelerations has decreased 0.02 $m{\cdot}s^{-2}$ after the two periods. The average deceleration ratio (unweighted) has decreased as well by 5.16 %.

For this group, it is not possible to show a significant decrease on accelerations. Otherwise, there is a clear tendency to decelerate more and a bit stronger before the AAP was turned on. The same tendency showed within the second group of streets.

5.3.4. Fourth Group.

Table 27. Acceleration/deceleration results. Group 4.

Hypothesis 3							
Accelerations (m/s²)		Ac. Difference	Incr/Decr (%)	Decelerations (m/s²)		Dec. Difference	Incr/Decr (%)
Before AAP	After 7 months	After-Before		Before AAP	After 7 months	After-Before	
0,17	0,15	-0,02	-14,11	-0,22	-0,26	0,04	16,87
0,14	0,05	-0,09	-61,99	-0,13	-0,04	-0,09	-67,03
0,10	0,08	-0,02	-18,16	-0,08	-0,17	0,09	100,83
0,09	0,07	-0,02	-24,02	-0,34	-0,31	-0,03	-7,69
0,40	0,44	0,04	8,94	-0,24	-0,25	0,01	3,95
0,34	0,31	-0,03	-8,01	-0,12	-0,10	-0,01	-9,07
0,23	0,29	0,07	29,69	-0,14	-0,18	0,04	26,43
0,20	0,14	-0,06	-30,62	-0,08	-0,17	0,09	115,11
0,20	0,17	-0,03	-16,08	-0,18	-0,25	0,07	37,66
0,32	0,28	-0,04	-13,77	-0,50	-0,63	0,12	24,53
Unweighted mean valors		**-0,02**	**-14,81**	Unweighted mean valors		**0,03**	**24,16**
Sign test; p-value	**0,10** (>0,05)	No statistically significant		Sign test; p-value	**0,34** (>0,05)	No statistically significant	

Acceleration results.

There are eight intersections where the difference of mean accelerations have decreased, the red ones. Otherwise, in the others two intersections have increased after a long time use. The p-value of the sign test is 0.10.

The average value (unweighted) of mean accelerations after the two periods has decreased 0.02 $m \cdot s^{-2}$. The average acceleration ratio (unweighted) has decreased as well by 14.81 %.

Deceleration results.

There are only three intersections where the difference of mean decelerations have decreased, the red ones. Otherwise, in the others seven intersections have increased after a long time use. The p-value of the sign test is 0.34.

The average value of mean decelerations has increased 0.03 $m \cdot s^{-2}$ after the two periods. The average deceleration ratio has increased as well by 24.16 %, although two mean accelerations have increase more than 100%.

For this group, it is not possible to show significant statistical changes on accelerations/decelerations as well. However, the results driving with AAP point to a high decrease on mean accelerations, as well as a little increase on mean decelerations.

5.4. Hypothesis 4.

This hypothesis aims to test if the share of stopped cars decrease related to all the passing cars. The objective of these results is to complete the results of the hypothesis two, as well as to introduce an idea about the real stop time at intersections.

Results have been classified in tables, with the name of each street, separated in the same groups, single or double direction, as well as the number of speed observations during the two periods, the stopped cars ratio, and the difference between them. Besides, it is shown the difference between ratios, and finally the unweighted mean value of them.

Table 28. Stopped cars ratio results. Group 1.

1st group					
Street/ speed limit (km/h)	Directions	Observations (before/after)	stopped cars ratio (%)		Difference (%)
			Before AAP	Long-time use	
Dalbyvagen (west)/70	Single	53307/19419	12,64	10,05	-2,59
Dalbyvagen (east)/70	Single	47644/18674	10,22	5,41	-4,81
Fjelievägen (west)/70	Single	8100/3475	0,67	0,00	-0,67
Fjelievägen (east)/70	Single	8789/3290	0,59	0,37	-0,22
Norra Ringen (west)/50,70	Single	188804/74682	9,83	11,06	1,23
Norra Ringen (east)/50,70	Single	219098/72608	13,56	14,22	0,66
			Unweighted mean value		-1,07

The stopped cars ratio decreases in four streets, while it has been increased in the others two. The unweighted mean value of the difference is -1.07, and the p-value of the sign test is 0.68.

Table 29. Stopped cars ratio results. Group 2.

2nd group					
Street/ speed limit (km/h)	Directions	Observations (before/after)	stopped cars ratio (%)		Difference (%)
			Before AAP	Long-time use	
Svenshögsvägen /50	Double	87861/45223	12,11	11,48	-0,63
Törnavägen,Solvägen, Södra vägen /50	Double	185639/66223	8,93	5,91	-3,02
Stattenavägen/50	Single	55763/16167	10,92	8,30	-2,62
Kävlingevägen /50	Double	45865/18718	7,64	5,25	-2,39
Törnavägen /50	Double	118831/57604	11,85	13,15	1,30
			Unweighted mean value		-1,47

The stopped cars ratio decreases in four streets, while it has been increased in the other one. The unweighted mean value of the difference is -1.47, and the p-value of the sign test is 0.37.

Table 30. Stopped cars ratio results. Group 3.

3rd group					
Street/ speed limit (km/h)	Directions	Observations (before/after)	stopped cars ratio (%)		Difference (%)
			Before AAP	Long-time use	
Tunavägen /50	Double	29257/5134	14,44	11,66	-2,78
Dalbyvägen (west) /50	Single	12216/3049	3,31	0,16	-3,15
Dalbyvägen (east) /50	Single	14913/5697	23,49	23,31	-0,18
Fjelievägen /50	Double	38175/14047	10,59	8,72	-1,87
Kung Oscars Väg /50	Double	68960/25292	12,86	13,53	0,67
Sölvegatan /50	Double	19471/5732	12,68	11,63	-1,05
			Unweighted mean value		-1,39

The stopped cars ratio decreases in five streets, while it has been increased in the other one. The unweighted mean value of the difference is -1.39, and the p-value of the sign test is 0.21, it means that there is a tendency to

Table 31. Stopped cars ratio results. Group 4.

4th group					
Street/ speed limit (km/h)	Directions	Observations (before/after)	stopped cars ratio (%)		Difference (%)
			Before AAP	Long-time use	
Stora Tomegatan /30	Single	7768/4451	15,65	16,58	0,93
Östra Martensgatan /30	Single	11418/2222	22,82	14,58	-8,24
Västra Martensgatan /30	Single	15948/3038	20,56	11,65	-8,91
St Petri Kyrkogata /30	Single	5485/864	5,78	1,04	-4,74
Kyrkogatan /30	Single	6337/1348	8,55	11,87	3,32
Skomakaregatan /30	Single	6158/3323	14,53	20,82	6,29
			Unweighted mean value		-1,89

The stopped cars ratio decreases in three streets, while it has been increased in the others three. The unweighted mean value of the difference is -1.89, and the p-value of the sign test is 1.00, hence there is no difference in stopped cars ratio.

An extended sign test analysis might be done without to separate ratios in different groups, due to there are not enough observations for each group separately. There are sixteen streets where the stopped cars ratio decreases, and seven streets where the stopped cars ratio increases. In that situation, the p-value of the sign test is 0.09, enough to guarantee a general decrease in stopped cars ratio with a confidence level of the 90%.

On the other hand, if the sign test is done for the three first groups of streets together, the number of observations increases, there are thirteen streets where the stopped cars ratio increases, as well as, there are four streets where it decreases. The result of the p-value is 0.04 (<0.05), therefore, it means that there is a significant decrease on the stopped cars related to all the passing cars.

Studying separately the results of every group, they do not show a significant decrease in the stopped cars ratio, only a tendency except in the streets where the speed limit is 30km/h. However, this tendency increases significantly when the study do not depend on the group.

6. Discussion

6. 1. Hypothesis 1

The hypothesis (1): **"Travel times in urban areas remain unchanged despite lower driving speeds"** can be rejected for the groups of streets one, two and three. Otherwise, the hypothesis one can be verified for the group four.

As expected, the results have shown a significant increase on travel time for the first group, which has the highest speed limit (70 km/h). The effects are largest on arterial roads which have the highest average increase ratio in travel time (5.09 %) if it is compared with the rest of the groups, because of drivers may drive above the speed limit without AAP during longer distances.

These results are in line with earlier studies, which were found over predetermined routes (Persson et al., 1993; Almqvist and Nygård, 1997; Várhelyi and Mäkinen, 2001) where was found an increase in travel time by between 2% and 7%. Besides, this finding is according to a previous study (Hjälmdahl et al., 2002) where the test route was the entire city of Lund.

For this group, there is the lowest difference between the average decrease on driving speeds (4.68%) and the average decrease ratio of highest speeds (6.58%), due to the fact that speeds were usually controlled by the AAP, not by other traffic conditions.

However, the new findings for main streets (groups two and three) are not according with earlier studies (Hjälmdahl et al., 2002; Várhelyi et al., 2003) where travel time was not higher driving with AAP. The results show a statistical significant average increase of time consumption (3.48%) despite driving speeds have less decreases if they are compared with the decrease on highest speeds.

Within the second group made up of main arterial streets where cars may reach easily the speed limit, there is the highest difference between maximum spot speeds at mid-block sections (7.54%) and the average decrease on driving speeds (3.40%). This is most likely due to the fact that turning speeds are higher driving with AAP, and because the traffic conditions for these streets allow it when the AAP does not interfere.

This idea is showed as well for the third group, which is made up of main streets with frequent interferences. The average increase in time consumption (2.89%) is shorter than the second group, due to with more interferences it is more difficult to reach the prevailing speed limit. However, the results show that more interferences are not a necessary condition for the average driving speeds in order to get higher decreases, because the average value (2,74%) decreases less than the second group.

Finally, for the fourth group which is made up of central streets, the results are in line with earlier studies (Hjälmdahl et al., 2002; Várhelyi et al., 2003). Travel time remain unchanged, with an insignificant decrease (0.59%) in average driving speeds, despite higher speeds in the mid-block sections have an average decrease by 2.83%. Apparently, these results confirm that driving speeds were already controlled by the street design and the prevailing traffic conditions, where speeds are so low that AAP does not need to interfere upon cars.

This fact is showed for all the groups. The increase in time consumption became shorter when there is a decrease either the prevailing speed limit or the frequency of the interferences. The discussion of the results for the next hypotheses should be used to explain better this affirmation.

6. 2. Hypothesis 2

The hypothesis (2): **"Delays at signalised intersections decrease"** can be verified for the group of streets made up of main streets, it means for the groups two and three. Otherwise, this hypothesis cannot be verified for the first group made up of arterial streets, as well as it can be rejected for the fourth one made up of central streets.

For the first group, the delay on travel time due to signalised intersections is the same in the periods of time, in fact, the average delay ratio increases by 0.45%, almost zero, despite delays for nine of the fourteen intersections decrease. The results cannot be verified because the great majority does not go to one direction, then, it is not possible to show a real decrease on delays.

The explanation would be that they might not drive faster across interferences with/without AAP for security reasons, but this does not mean that drivers may decrease delays before the real distance of the intersection, both with a decrease of the stop time and with a decrease on travel time during the decelerations.

Otherwise, the findings are very clear for the groups two and three of streets, which are made up of main streets. The results show a decrease on delay time within the intersection's influence area.

For the second group, where was easy to reach the speed limit because of the few number of interferences with others road users, the average delay across them decreased by 25.44%. These results certifies the (Várhelyi et al., 2003), this strong decrease is due to the users begin to drive in more strategic way, when the AAP is working because they may not interfere on driving speed. The car drivers use more information of what is going on further along their route, besides this finding is in line with a previous study (Hjälmdahl, M., Várhelyi, A., 2003), which verified that drivers get used to the system "taking control" and thereby delegate responsibility.

It means that they can drive faster along a turning stretch because the design of the intersection allows it, just before or across the real intersection's distance, as well as they do not need to drive faster along the free stretch whether they finds out at an early stage the traffic signal is red anyway, or there is a queue because drivers prefer to lose time during the free stretch, once the car arrives at the next intersection.

This way, these consequences can be applied for the third group as well, which is made up of main streets but with a higher number of interferences, despite the results are not as clear as the before group. Once more, these results reflect the effects of the influence at intersections, due to they have shown an important average decrease by 19.54% on delay time, where the ratio is a bit smaller than for the same kind of streets with less interferences, as well as a decrease in the number of intersections where there is a negative difference on this delay if it is compared with the group made up of main arterial streets.

On the other hand, the hypothesis two may absolutely be rejected for the group made up of central streets. As expected, the traffic conditions for theses kind of streets are clearly over the interferences on speed that the AAP can make, as well as these streets are not designed for reaching high driving speeds in order to recover part of the travel time missed due to the AAP along the free stretch.

6. 3. Hypothesis 3

The hypothesis (3): **"Less accelerations and decelerations"** cannot be verified for any group. Apparently, the results of this study are opposite to a previous study (Mäkinen and Várhelyi, 2000) where it was found that speeds were smoother with the speed limiter, although there is a very important difference, in the early study the test drivers drove along a specific route, besides, drivers had not enough time to get used to the device and to adapt their driver behaviour (Várhelyi et al., 2003).

It means that this study, which has been made for a long time use (seven months) as well as for an entire city, Lund, may reveal more aspects on driver behaviour, especially this hypothesis which is centred in the actuation of the drivers, going in and out of the intersection's influence area.

For the first group, which is made up of arterial streets with a speed limit of 70 km/h, the hypothesis three can be rejected. The results has been highly clear, the number of intersections where the accelerations/decelerations have decreased are equal. Drivers do not want to increase the risk level if they arrive too fast at the turning stretch, although it does not mean that drivers decelerate before when they know that they are losing travel time due to the effects of the AAP along the free stretch.

The same way, they do not need to accelerate stronger, once car drivers has been adapted after a long time use in order to reach faster the speed limit, because they are driving in normal conditions, and to reach a speed limit of 70 km/h needs long distances as well as it would require to consume excessive fuel.

Otherwise, for the second group, which is made up of streets with a speed limit of 50km/h with not many interferences, the results show a real decrease on mean decelerations after long time use, with a significant average ratio by 18%. It means that after seven months, car drivers wait to star the decelerations when they are closer to the intersection.

Within the discussion for the hypothesis two, it has been showed the decrease on delay time at signalised intersections, as well as it has been argued the two possible situations where drivers may recover part of this delay, both just before the real intersection and with across it. Therefore, the results for this group show that a part of these delays is recovered just before the intersection.

However, for the third group exists the same tendency that it has been explained before, although the results are not as significant as for the second group with a confidence level by 95%. There are fifteen intersections where the decelerations decrease against seven intersections where the decelerations increase. Therefore, for the group made up of main streets but with mixed traffic is not possible to verify a real change in the same direction of the second group. It means that before the intersection, apparently, the frequent interferences do not allow recovering part of delay time, despite it has been showed a real decrease for this group as well within the hypothesis two.

On the other hand, the results, both the second group of streets and the third one, have shown the same tendency, the ratio of interferences where accelerations increase/decrease remain unchanged, both in before situation and in after situation. The argue is the same that it has been explained for the first group of streets, it is not necessary to reach faster when they drive in normal conditions; in spite of within the streets with a speed limit of 50 km/h, there are more intersections with a decrease of mean accelerations after long time use, than for the streets with a speed limit of 70 km/h, likely due to drivers know that they are losing more travel time when the prevailing speed limit is higher.

Finally, the results for the central streets have shown a not significant increase on mean decelerations. However, the results of mean accelerations point out to a significant decrease, in fact, it could be show with a confidence level by 90%. This is due to after a long time usage, car drivers have improved their driving behaviour related to road safety, as it has been showed in several studies (Nilsson 1982; Finch et al. 1994; Mäkinen and Várhelyi, 2000; Hjälmdahl et al., 2002; Várhelyi et al., 2003). Despite this clear tendency, the results may not show a real change in that direction, due to the traffic conditions and the design at intersections are over the effects that the AAP can produce.

6. 4. Hypothesis 4

The hypothesis (4): **"Stopped cars decrease related to all the passing cars"** cannot be verified for each group separately, basically due to there are not enough values for the statistical analysis in order to show a real change in any direction.

Within the discussion of the three previous hypotheses, it has been showed that there are only real effects on travel time and driver behaviour for the three first groups, because of the traffic conditions and road design are not over the effects that the AAP can produce. Hence, if the discussion is centred for these groups, the results can verify the hypothesis four. It has been shown a significant decrease of the stopped cars related to all the passing cars.

This is the confirmation that a part of travel time lost along the free stretch, where the AAP may normally be working, it is recovered just before the intersection because drivers have not to wait there. In spite of this finding, the hypothesis neither can quantify how much time car drivers recover, nor assess if this hypothesis is related with the findings showed in the hypothesis three. A further research in that field is needed.

On the other hand, the hypothesis four can be rejected for the group made up of central streets; the stopped cars do not decrease in the two periods of time. The reason is the same that it has been explained many times before, following the results, the effects of the AAP are meaningless for this group of streets.

7. Conclusions

The positive effects of an active accelerator pedal on the speed level, speed distribution and great traffic safety potential have been shown in earlier studies (Mäkinen and Várhelyi, 2000; Hjälmdahl et al., 2002; Várhelyi et al., 2003), however, the effects both on travel time and on driver behavioural adaptation were quite unknown. These fields are where it has been centred this study.

All the results obtained in this study have been following the line of the previous studies, which were the origin, and the different findings have been accorded with them. The aim of the present study was to go deeply into a paradox found within earlier studies, a significant decrease on maximum driving speeds after a long time using an AAP, but where the time consumption apparently remained unchanged .

This study has shown that the time consumption remains unchanged only in central streets with a speed limit of 30 km/h. The results have not been able to show any effect of the AAP after seven months, the adaptation was excellent as well as the safety consequences.

Most of the results of the evaluation study are positive. Despite it would be able to seem that an increase on travel time is not positive, the results show car drivers recovered time at signalised intersections. It means that the effects in flow traffic are not as negative as it seems, because if the system is installed within an enough number of cars, where the "contagion" effects in the entire city were high, not low how it was show by Várhelyi et al., 2003, the travel time lost would be minimized and with traffic safety showed in earlier studies intact.

For that reason, a further research is highly needed in order to improve the knowledge about the effects that an AAP may produce on travel time, obviously, this study have only done a fast regard inside this complex world. It has not been analysed the influence neither in the free stretches, nor the stop time, as well as the effects within the real distance at intersections. Maybe, to design specific carriage ways only for AAP users around the entire city, mixed with the rest of road users, it would be an interesting study in order to improve the effects of the AAP.

Since the beginning, this study has only pretended to contribute a bit, within the excellent work that it has been carried out at the traffic division of the University of Lund, Sweden.

8. References

Literature

Almqvist, S., Nygård, M., 1997. *Dynamic speed adaptation. Field trials with automatic speed adaptation in an urban area.* Department of Traffic Planning and Engineering, Lund University, Sweden.

Finch, D.J., Kompfner, P., Lockwood. C.R., Maycock, G., 1994. *Speed, speed limits and accidents.* Project report 58. Transport research laboratory, Crowthorne, UK.

Hegeman, G., 2002. *Green Light for ISA? The effect of intelligent speed adaptation on the traffic flow.* Institute for Transport Studies. The university of Leeds.

Hjälmdahl, M., Almqvist, S., Várhelyi, A., 2002. *Speed regulation by in-car active accelerator pedal.* Lund University, Sweden.

Hjälmdahl, M., 2003. *Analysis of an ISA system's safety potential and effectiveness for different types of drivers.* Lund University, Sweden.

Hjälmdahl, M., Várhelyi, A., 2003. *Speed regulation by in-car, active accelerator pedal, effects on driver behaviour.* Lund University, Sweden.

Hjälmdahl, M., Várhelyi, A., Almqvist, S., 2002. *Effekten av aktiv gaspedal på körmönster. Delrapport 13 LundaISA.* Lund University, Sweden.

Persson, H., Towliat, M., Almqvist, S., Risser, R., Magdeburg, M., 1993. *Speed limiter in the car. A field study on speeds, behaviour, conflicts and driver comments when driving in built-up area.* Lund University, Sweden.

Nilsson, G., 1982. *Effects of speed limits on traffic accidents & transport energy use.* VTI särtryck 68, Linköping, Sweden.

Vägverket, 2002. *Intelligent speed adaptation (ISA). Results of a large-scale of trials in Borlänge, Lidköping, Lund and Umeå during the period 1999-2002.* Swedish Road administration, Börlange, Sweden.

Vägverket, 2002. *Results of the world's largest isa trial*. Swedish Road administration, Börlange, Sweden.

Várhelyi, A., 1996. *Dynamic speed adaptation based on information technology –a theoretical background.* Ph.D. thesis, Lund University, Sweden.

Várhelyi, A., Mäkinen, T., 2001. *The effects of in-car speed limiters: field studies*. Lund University, Lund.

Várhelyi, A., 2002. *Speed management via in-car devices: effects, implications, perspectives*. Lund University, Sweden.

Várhelyi, A., 2002. *Dynamic speed adaptation in adverse conditions -a system proposal-*. Lund University, Sweden.

Várhelyi, A., Hjälmdahl, M., Hydén, C., Draskóczy, M., 2003. *Effects of an active accelerator pedal on driver behaviour and traffic safety after long-term use in urban areas*. Lund University, Sweden.

Others

Diario del consumidor. Consumer.es
http://www.consumer.es/web/es/noticias/salud_y_seguridad/2004/01/13/93938.php
Download March, 2004

IEE. The largest professional engineering society in Europe
http://www.iee.org/events/isa.cfm
Download March, 2004

International cooperation on theories and concepts in traffic safety.
http://www.ictct.org
Download May, 2004

MSc thesis guidelines for students at the Department of Technology and Society. Lund University, Division of Traffic Engineering. Sweden. (Not mentioned in the text)

Results of the world's largest ISA trial.
Vägverket. Swedish National Road Administration.

Institute of Phonetic Sciences (IFA)
http://www.fon.hum.uva.nl/Service/Statistics/Sign_Test.html
Download September, 2004

Appendix I

Street files. Before AAP
Group 4

Group	Name of the street:		Stora Tomegatan	
4	Direction	North		
Number of street	Speed limit (km/h)	30	Mean travel time	(s):
1	Total Length (m)	237	34,19	
Code: C1	Mean Speed (km/h)	24,95		
			Stopped cars ratio	(%):
	Num. Interferences:	2	15,65	

Number: 1		Acceleration			
Kind of interference:		Distance X2 (m)	3	Total distance	(m)
3-leg intersection, with priority		Distance X3 (m)	58	55	
		Speed V2 (km/h)	25,92	Increase V3-V2	(km/h)
		Speed V3 (km/h)	30,18	4,26	
t_2 (s)	t_3 (s)	Acceleration time (s)		Mean Acceleration (m/s^2)	
0,69	7,54	6,85		0,17	
Travel time through the interference (s)				6,85	
Imaginary travel time without intersection (s)				6,56	
Delay because of the intersection (s)				0,29	

Free Stretch	Travel time (s)	Distance (m)	Average speed of the stretch (km/h)
	1,82	15	29,67

Number: 2		Deceleration			
Kind of interference:		Distance X1 (m)	73	Total distance	(m)
Traffic Light		Distance X2 (m)	213	140	
		Speed V1 (km/h)	29,94	Decrease V2-V1	(km/h)
		Speed V2 (km/h)	13,11	-16,83	
t_1 (s)	t_2 (s)	Deceleration time (s)		Mean Deceleration (m/s^2)	
9,36	30,71	21,35		-0,22	
Travel time through the interference (s)				21,35	
Imaginary travel time without intersection (s)				16,83	
Delay because of the intersection (s)				4,52	

Group	**Name of the street:**		**Östra Mårtensgatan**	
4	Direction	West		
Number of street	Speed limit (km/h)	30	**Mean travel time**	**(s):**
2	Total Length (m)	110	16,54	
Code: C2	Mean Speed (km/h)	23,94		
			Stopped cars ratio	**(%):**
	Num. Interferences:	3	22,82	

Number:	**1**	**Acceleration**			
Kind of interference:		Distance X2 (m)	3	Total distance	(m)
Traffic Light		Distance X3 (m)	33	30	
		Speed V2 (km/h)	22,05	Increase V3-V2	(km/h)
		Speed V3 (km/h)	24,37	2,32	
t_2 (s)	t_3 (s)	Acceleration time (s)		**Mean Acceleration (m/s^2)**	
0,81	5,40	4,59		0,14	
Travel time through the interference (s)				4,59	
Imaginary travel time without intersection (s)				4,43	
Delay because of the intersection (s)				0,16	

Number:	**2**	**Deceleration**			
Kind of interference:		Distance X1 (m)	33	Total distance	(m)
3-leg intersection, with priority		Distance X2 (m)	43	10	
		Speed V1 (km/h)	24,37	Decrease V2-V1	(km/h)
		Speed V2 (km/h)	23,67	-0,70	
t_1 (s)	t_2 (s)	Deceleration time (s)		**Mean Deceleration (m/s^2)**	
5,40	6,91	1,51		-0,13	
		Acceleration			
		Distance X2 (m)	43	Total distance	(m)
		Distance X3 (m)	68	25	
		Speed V2 (km/h)	23,67	Increase V3-V2	(km/h)
		Speed V3 (km/h)	25,01	1,34	
t_2 (s)	t_3 (s)	Acceleration time (s)		**Mean Acceleration (m/s^2)**	
6,91	10,59	3,68		0,10	
Travel time through the interference (s)				5,19	
Imaginary travel time without intersection (s)				5,10	
Delay because of the intersection (s)				0,09	

Number:	**3**	**Deceleration**			
Kind of interference:		Distance X1 (m)	68	Total distance	(m)
3-leg intersection, with priority		Distance X2 (m)	103	35	
		Speed V1 (km/h)	25,00	Decrease V2-V1	(km/h)
		Speed V2 (km/h)	23,42	-1,58	
t_1 (s)	t_2 (s)	Deceleration time (s)		**Mean Deceleration (m/s^2)**	
10,59	15,79	5,2		-0,08	
Travel time through the interference (s)				5,20	
Imaginary travel time without intersection (s)				5,04	
Delay because of the intersection (s)				0,16	

Group	Name of the street:		Västra Mårtensgatan	
4	Direction	West		
Number of street	Speed limit (km/h)	30	Mean travel time	(s):
3	Total Length (m)	221	45,32	
Code: C3	Mean Speed (km/h)	17,56		
			Stopped cars ratio	(%):
	Num. Interferences:	2	20,56	

Free Stretch	Travel time (s)	Distance (m)	Average speed of the stretch (km/h)
	3,41	23	24,28

Number: 1		Deceleration			
Kind of interference:		Distance X1 (m)	23	Total distance	(m)
Speed-control hump		Distance X2 (m)	83	60	
		Speed V1 (km/h)	26,43	Decrease V2-V1	(km/h)
		Speed V2 (km/h)	13,40	-13,03	
t_1 (s)	t_2 (s)	Deceleration time (s)		**Mean Deceleration (m/s^2)**	
3,41	14,15	10,74		-0,34	
		Acceleration			
		Distance X2 (m)	83	Total distance	(m)
		Distance X3 (m)	163	80	
		Speed V2 (km/h)	13,4	Increase V3-V2	(km/h)
		Speed V3 (km/h)	18,98	5,58	
t_2 (s)	t_3 (s)	Acceleration time (s)		**Mean Acceleration (m/s^2)**	
14,15	31,86	17,71		0,09	
Travel time through the interference (s)				28,45	
Imaginary travel time without intersection (s)				22,20	
Delay because of the intersection (s)				6,25	

Number: 2		Deceleration			
Kind of interference:		Distance X1 (m)	163	Total distance	(m)
3-leg intersection, without priority		Distance X2 (m)	213	50	
		Speed V1 (km/h)	18,98	Decrease V2-V1	(km/h)
		Speed V2 (km/h)	7,27	-11,71	
t_1 (s)	t_2 (s)	Deceleration time (s)		**Mean Deceleration (m/s^2)**	
31,86	45,32	13,46		-0,24	
Travel time through the interference (s)				13,46	
Imaginary travel time without intersection (s)				9,48	
Delay because of the intersection (s)				3,98	

Street files. Before AAP
Group 4

Group	**Name of the street:**		**St. Petri Kyrkogata**	
4	Direction	East		
Number of street	Speed limit (km/h)	30	**Mean travel time**	**(s):**
4	Total Length (m)	220	35,64	
Code: C4	Mean Speed (km/h)	22,22		
			Stopped cars ratio	**(%):**
	Num. Interferences:	3	5,78	

Number:	**1**	**Acceleration**			
Kind of interference:		Distance X2 (m)	3	Total distance	(m)
3-leg intersection, with priority		Distance X3 (m)	33	30	
		Speed V2 (km/h)	15,46	Increase V3-V2	(km/h)
		Speed V3 (km/h)	22,99	7,53	
t_2 (s)	t_3 (s)	Acceleration time (s)		**Mean Acceleration (m/s^2)**	
1,16	6,34	5,18		0,40	
Travel time through the interference (s)				5,18	
Imaginary travel time without intersection (s)				4,70	
Delay because of the intersection (s)				0,48	

Free Stretch	Travel time (s)	Distance (m)	Average speed of the stretch (km/h)
	3,14	20	22,93

Number:	**2**	**Deceleration**			
Kind of interference:		Distance X1 (m)	53	Total distance	(m)
3-leg intersection, with priority		Distance X2 (m)	93	40	
		Speed V1 (km/h)	23,08	Decrease V2-V1	(km/h)
		Speed V2 (km/h)	20,33	-2,75	
t_1 (s)	t_2 (s)	Deceleration time (s)		**Mean Deceleration (m/s^2)**	
9,48	16,10	6,62		-0,12	
		Acceleration			
		Distance X2 (m)	93	Total distance	(m)
		Distance X3 (m)	123	30	
		Speed V2 (km/h)	20,33	Increase V3-V2	(km/h)
		Speed V3 (km/h)	25,8	5,47	
t_2 (s)	t_3 (s)	Acceleration time (s)		**Mean Acceleration (m/s^2)**	
16,1	20,56	4,46		0,34	
Travel time through the interference (s)				11,08	
Imaginary travel time without intersection (s)				10,31	
Delay because of the intersection (s)				0,77	

Number:	**3**	**Deceleration**					
Kind of interference:		Distance X1	(m)	123	Total distance		(m)
4-leg intersection, with priority		Distance X2	(m)	208		85	
		Speed V1	(km/h)	25,80	Decrease V2-V1		(km/h)
		Speed V2	(km/h)	19,13		-6,67	
t_1 (s)	t_2 (s)	Deceleration time (s)			**Mean Deceleration (m/s^2)**		
20,56	33,83	13,27				-0,14	
Travel time through the interference (s)						13,27	
Imaginary travel time without intersection (s)						11,86	
Delay because of the intersection (s)						1,41	

Group	**Name of the street:**		**Kyrkogatan**	
4	Direction	South		
Number of street	Speed limit (km/h)	30	**Mean travel time**	**(s):**
5	Total Length (m)	265	39,37	
Code: C5	Mean Speed (km/h)	24,23		
			Stopped cars ratio	**(%):**
	Num. Interferences:	3	8,55	

Number:	**1**	**Acceleration**			
Kind of interference:		Distance X2 (m)	3	Total distance	(m)
3-leg intersection, with priority		Distance X3 (m)	28	25	
		Speed V2 (km/h)	22,99	Increase V3-V2	(km/h)
		Speed V3 (km/h)	25,87	2,88	
t_2 (s)	t_3 (s)	Acceleration time (s)		**Mean Acceleration (m/s²)**	
0,78	4,33	3,55		0,23	
Travel time through the interference (s)				3,55	
Imaginary travel time without intersection (s)				3,48	
Delay because of the intersection (s)				0,07	

Number:	**2**	**Deceleration**			
Kind of interference:		Distance X1 (m)	28	Total distance	(m)
3-leg intersection, with priority		Distance X2 (m)	98	70	
		Speed V1 (km/h)	25,87	Decrease V2-V1	(km/h)
		Speed V2 (km/h)	22,99	-2,88	
t_1 (s)	t_2 (s)	Deceleration time (s)		**Mean Deceleration (m/s²)**	
4,33	14,55	10,22		-0,08	
		Acceleration			
		Distance X2 (m)	98	Total distance	(m)
		Distance X3 (m)	143	45	
		Speed V2 (km/h)	22,99	Increase V3-V2	(km/h)
		Speed V3 (km/h)	27,59	4,60	
t_2 (s)	t_3 (s)	Acceleration time (s)		**Mean Acceleration (m/s²)**	
14,55	20,83	6,28		0,20	
Travel time through the interference (s)				16,50	
Imaginary travel time without intersection (s)				15,49	
Delay because of the intersection (s)				1,01	

Number:	**3**	**Deceleration**			
Kind of interference:		Distance X1 (m)	143	Total distance	(m)
3-leg intersection, with priority		Distance X2 (m)	258	115	
		Speed V1 (km/h)	27,59	Decrease V2-V1	(km/h)
		Speed V2 (km/h)	15,52	-12,07	
t_1 (s)	t_2 (s)	Deceleration time (s)		**Mean Deceleration (m/s²)**	
20,83	39,37	18,54		-0,18	
Travel time through the interference (s)				18,54	
Imaginary travel time without intersection (s)				15,01	
Delay because of the intersection (s)				3,53	

Group	**Name of the street:**		**Skomakaregatan**		
4	Direction	East			
Number of street	Speed limit (km/h)	30	**Mean travel time**	**(s):**	
6	Total Length (m)	215	35,9		
Code: C6	Mean Speed (km/h)	21,56			
			Stopped cars ratio	**(%):**	
	Num. Interferences:	2	14,53		

Number: 1		**Acceleration**			
Kind of interference:		Distance X2 (m)	3	Total distance (m)	
3-leg intersection, with priority		Distance X3 (m)	118	115	
		Speed V2 (km/h)	14,37	Increase V3-V2 (km/h)	
		Speed V3 (km/h)	27,18	12,81	
t_2 (s)	t_3 (s)	Acceleration time (s)		**Mean Acceleration (m/s^2)**	
1,25	18,92	17,67		0,20	
Travel time through the interference (s)				17,67	
Imaginary travel time without intersection (s)				15,23	
Delay because of the intersection (s)				2,44	

Number: 2		**Deceleration**			
Kind of interference:		Distance X1 (m)	118	Total distance (m)	
3-leg inters., without priority and with speed-control hump		Distance X2 (m)	163	45	
		Speed V1 (km/h)	27,18	Decrease V2-V1 (km/h)	
		Speed V2 (km/h)	11,75	-15,43	
t_1 (s)	t_2 (s)	Deceleration time (s)		**Mean Deceleration (m/s^2)**	
18,92	27,44	8,52		-0,50	
		Acceleration			
		Distance X2 (m)	163	Total distance (m)	
		Distance X3 (m)	208	45	
		Speed V2 (km/h)	11,75	Increase V3-V2 (km/h)	
		Speed V3 (km/h)	21,58	9,83	
t_2 (s)	t_3 (s)	Acceleration time (s)		**Mean Acceleration (m/s^2)**	
27,44	35,90	8,46		0,32	
Travel time through the interference (s)				16,98	
Imaginary travel time without intersection (s)				13,29	
Delay because of the intersection (s)				3,69	

Appendix II

Street files. After long time use
Group 4

Group	**Name of the street:**		**Stora Tomegatan**	
4	Direction	North		
Number of street	Speed limit (km/h)	30	**Mean travel time**	**(s):**
1	Total Length (m)	237	35,58	
Code: C1	Mean Speed (km/h)	23,98		
			Stopped cars ratio	**(%):**
	Num. Interferences:	2	16,58	

Number:	**1**	**Acceleration**			
Kind of interference:		Distance X2 (m)	3	Total distance	(m)
3-leg intersection, with priority		Distance X3 (m)	33	30	
		Speed V2 (km/h)	24,79	Increase V3-V2	(km/h)
		Speed V3 (km/h)	26,98	2,19	
t_2 (s)	t_3 (s)	Acceleration time (s)		**Mean Acceleration (m/s^2)**	
0,72	4,82	4,10		0,15	
Travel time through the interference (s)				4,10	
Imaginary travel time without intersection (s)				4,00	
Delay because of the intersection (s)				0,10	

Free Stretch	Travel time (s)	Distance (m)	Average speed of the stretch (km/h)
	11,44	85	26,75

Number:	**2**	**Deceleration**			
Kind of interference:		Distance X1 (m)	118	Total distance	(m)
Traffic Light		Distance X2 (m)	208	90	
		Speed V1 (km/h)	27,04	Decrease V2-V1	(km/h)
		Speed V2 (km/h)	13,35	-13,69	
t_1 (s)	t_2 (s)	Deceleration time (s)		**Mean Deceleration (m/s^2)**	
16,26	31,12	14,86		-0,26	
Travel time through the interference (s)				14,86	
Imaginary travel time without intersection (s)				11,98	
Delay because of the intersection (s)				2,88	

Street files. After long time use
Group 4

Group	Name of the street:		Östra Mårtensgatan	
4	Direction	West		
Number of street	Speed limit (km/h)	30	**Mean travel time**	**(s):**
2	Total Length (m)	110	16,95	
Code: C2	Mean Speed (km/h)	23,36		
			Stopped cars ratio	**(%):**
	Num. Interferences:	3	14,58	

Number: 1		Acceleration			
Kind of interference:		Distance X2 (m)	3	Total distance	(m)
Traffic Light		Distance X3 (m)	28	25	
		Speed V2 (km/h)	22,44	Increase V3-V2	(km/h)
		Speed V3 (km/h)	23,32	0,88	
t_2 (s)	t_3 (s)	Acceleration time (s)		**Mean Acceleration (m/s^2)**	
4,63	9,21	4,58		0,05	
Travel time through the interference (s)				4,58	
Imaginary travel time without intersection (s)				3,86	
Delay because of the intersection (s)				0,72	

Number: 2		Deceleration			
Kind of interference:		Distance X1 (m)	28	Total distance	(m)
3-leg intersection, with priority		Distance X2 (m)	58	30	
		Speed V1 (km/h)	24,02	Decrease V2-V1	(km/h)
		Speed V2 (km/h)	23,32	-0,70	
t_1 (s)	t_2 (s)	Deceleration time (s)		**Mean Deceleration (m/s^2)**	
4,63	9,21	4,58		-0,04	
		Acceleration			
		Distance X2 (m)	58	Total distance	(m)
		Distance X3 (m)	78	20	
		Speed V2 (km/h)	23,32	Increase V3-V2	(km/h)
		Speed V3 (km/h)	24,22	0,9	
t_2 (s)	t_3 (s)	Acceleration time (s)		**Mean Acceleration (m/s^2)**	
9,21	12,23	3,02		0,08	
Travel time through the interference (s)				7,60	
Imaginary travel time without intersection (s)				7,46	
Delay because of the intersection (s)				0,14	

Number: 3		Deceleration			
Kind of interference:		Distance X1 (m)	78	Total distance	(m)
3-leg intersection, with priority		Distance X2 (m)	98	20	
		Speed V1 (km/h)	24,22	Decrease V2-V1	(km/h)
		Speed V2 (km/h)	22,31	-1,91	
t_1 (s)	t_2 (s)	Deceleration time (s)		**Mean Deceleration (m/s^2)**	
12,23	15,36	3,13		-0,17	
Travel time through the interference (s)				3,13	
Imaginary travel time without intersection (s)				2,97	
Delay because of the intersection (s)				0,16	

Street files. After long time use
Group 4

Group	Name of the street:		Västra Mårtensgatan	
4	Direction	West		
Number of street	Speed limit (km/h)	30	Mean travel time	(s):
3	Total Length (m)	221	46,89	
Code: C3	Mean Speed (km/h)	16,97		
			Stopped cars ratio	(%):
	Num. Interferences:	2	11,65	

Free Stretch	Travel time (s)	Distance (m)	Average speed of the stretch (km/h)
	2,76	18	23,48

Number:	1	Deceleration			
Kind of interference:		Distance X1 (m)	18	Total distance	(m)
Speed-control hump		Distance X2 (m)	83	65	
		Speed V1 (km/h)	26,15	Decrease V2-V1	(km/h)
		Speed V2 (km/h)	12,79	-13,36	
t_1 (s)	t_2 (s)	Deceleration time (s)		Mean Deceleration (m/s^2)	
2,76	14,69	11,93		-0,31	
		Acceleration			
		Distance X2 (m)	83	Total distance	(m)
		Distance X3 (m)	178	95	
		Speed V2 (km/h)	12,79	Increase V3-V2	(km/h)
		Speed V3 (km/h)	17,87	5,08	
t_2 (s)	t_3 (s)	Acceleration time (s)		Mean Acceleration (m/s^2)	
14,69	35,91	21,22		0,07	
Travel time through the interference (s)				33,15	
Imaginary travel time without intersection (s)				26,17	
Delay because of the intersection (s)				6,98	

Number:	2	Deceleration			
Kind of interference:		Distance X1 (m)	178	Total distance	(m)
3-leg intersection, without priority		Distance X2 (m)	213	35	
		Speed V1 (km/h)	17,87	Decrease V2-V1	(km/h)
		Speed V2 (km/h)	7,94	-9,93	
t_1 (s)	t_2 (s)	Deceleration time (s)		Mean Deceleration (m/s^2)	
35,91	46,89	10,98		-0,25	
Travel time through the interference (s)				10,98	
Imaginary travel time without intersection (s)				7,05	
Delay because of the intersection (s)				3,93	

Group	Name of the street:		St. Petri Kyrkogata	
4	Direction	East		
Number of street	Speed limit (km/h)	30	Mean travel time	(s):
4	Total Length (m)	220	34,89	
Code: C4	Mean Speed (km/h)	22,70		
			Stopped cars ratio	(%):
	Num. Interferences:	3	1,04	

Number: 1	Acceleration			
Kind of interference:	Distance X2 (m)	3	Total distance	(m)
3-leg intersection, with priority	Distance X3 (m)	33	30	
	Speed V2 (km/h)	16,72	Increase V3-V2	(km/h)
	Speed V3 (km/h)	24,48	7,76	
t_2 (s) / t_3 (s)	Acceleration time (s)		Mean Acceleration (m/s^2)	
1,08 / 5,98	4,90		0,44	
Travel time through the interference (s)			4,90	
Imaginary travel time without intersection (s)			4,41	
Delay because of the intersection (s)			0,49	

Free Stretch	Travel time (s)	Distance (m)	Average speed of the stretch (km/h)
	0,74	5	24,32

Number: 2	Deceleration			
Kind of interference:	Distance X1 (m)	38	Total distance	(m)
3-leg intersection, with priority	Distance X2 (m)	93	55	
	Speed V1 (km/h)	24,25	Decrease V2-V1	(km/h)
	Speed V2 (km/h)	20,96	-3,29	
t_1 (s) / t_2 (s)	Deceleration time (s)		Mean Deceleration (m/s^2)	
6,72 / 15,43	8,71		-0,10	
	Acceleration			
	Distance X2 (m)	93	Total distance	(m)
	Distance X3 (m)	123	30	
	Speed V2 (km/h)	20,96	Increase V3-V2	(km/h)
	Speed V3 (km/h)	25,8	4,84	
t_2 (s) / t_3 (s)	Acceleration time (s)		Mean Acceleration (m/s^2)	
15,43 / 19,72	4,29		0,31	
Travel time through the interference (s)			13,00	
Imaginary travel time without intersection (s)			12,23	
Delay because of the intersection (s)			0,77	

Number:	**3**	**Deceleration**				
Kind of interference:		Distance X1	(m)	123	Total distance	(m)
4-leg intersection, with priority		Distance X2	(m)	213	90	
		Speed V1	(km/h)	25,8	Decrease V2-V1	(km/h)
		Speed V2	(km/h)	16,77	-9,03	
t_1 (s)	t_2 (s)	Deceleration time (s)			**Mean Deceleration (m/s^2)**	
19,72	33,93	14,21			-0,18	
Travel time through the interference (s)					14,21	
Imaginary travel time without intersection (s)					12,56	
Delay because of the intersection (s)					1,65	

Group	**Name of the street:**		**Kyrkogatan**	
4	Direction	South		
Number of street	Speed limit (km/h)	30	**Mean travel time**	**(s):**
5	Total Length (m)	265	37,29	
Code:	Mean Speed (km/h)	25,58		
			Stopped cars ratio	**(%):**
	Num. Interferences:	3	11,87	

Number:	**1**	**Acceleration**			
Kind of interference:		Distance X2 (m)	3	Total distance	(m)
3-leg intersection, with priority		Distance X3 (m)	33	30	
		Speed V2 (km/h)	23,89	Increase V3-V2	(km/h)
		Speed V3 (km/h)	28,13	4,24	
t_2 (s)	t_3 (s)	Acceleration time (s)		**Mean Acceleration (m/s^2)**	
0,75	4,78	4,03		0,29	
Travel time through the interference (s)				4,03	
Imaginary travel time without intersection (s)				3,84	
Delay because of the intersection (s)				0,19	

	Travel time (s)	Distance (m)	Average speed of the stretch (km/h)
Free Stretch	3,84	30	28,13

Number:	**2**	**Deceleration**			
Kind of interference:		Distance X1 (m)	63	Total distance	(m)
3-leg intersection, with priority		Distance X2 (m)	103	40	
		Speed V1 (km/h)	28,23	Decrease V2-V1	(km/h)
		Speed V2 (km/h)	24,89	-3,34	
t_1 (s)	t_2 (s)	Deceleration time (s)		**Mean Deceleration (m/s^2)**	
8,62	14,13	5,51		-0,17	
		Acceleration			
		Distance X2 (m)	103	Total distance	(m)
		Distance X3 (m)	153	50	
		Speed V2 (km/h)	24,89	Increase V3-V2	(km/h)
		Speed V3 (km/h)	28,29	3,40	
t_2 (s)	t_3 (s)	Acceleration time (s)		**Mean Acceleration (m/s^2)**	
14,13	20,82	6,69		0,14	
Travel time through the interference (s)				12,20	
Imaginary travel time without intersection (s)				11,46	
Delay because of the intersection (s)				0,74	

Number:	**3**	**Deceleration**					
Kind of interference:		Distance X1	(m)	153	Total distance		(m)
3-leg intersection, with priority		Distance X2	(m)	258		105	
		Speed V1	(km/h)	28,29	Decrease V2-V1		(km/h)
		Speed V2	(km/h)	13,53		-14,76	
t_1 (s)	t_2 (s)	Deceleration time (s)			**Mean Deceleration (m/s^2)**		
20,82	37,29	16,47				-0,25	
Travel time through the interference (s)						16,47	
Imaginary travel time without intersection (s)						13,36	
Delay because of the intersection (s)						3,11	

Group	Name of the street:		Skomakaregatan	
4	Direction	East		
Number of street	Speed limit (km/h)	30	Mean travel time	(s):
6	Total Length (m)	215	36,49	
Code: C6	Mean Speed (km/h)	21,21		
			Stopped cars ratio	(%):
	Num. Interferences:	2	20,82	

Number: 1	Acceleration			
Kind of interference:	Distance X2 (m)	3	Total distance	(m)
3-leg intersection, with priority	Distance X3 (m)	123	120	
	Speed V2 (km/h)	15,17	Increase V3-V2	(km/h)
	Speed V3 (km/h)	26,45	11,28	
t_2 (s) / t_3 (s)	Acceleration time (s)		Mean Acceleration (m/s^2)	
1,18 / 19,72	18,54		0,17	
Travel time through the interference (s)			18,54	
Imaginary travel time without intersection (s)			16,33	
Delay because of the intersection (s)			2,21	

Number: 2	Deceleration			
Kind of interference:	Distance X1 (m)	123	Total distance	(m)
3-leg inters., without priority and with speed-control hump	Distance X2 (m)	158	35	
	Speed V1 (km/h)	26,45	Decrease V2-V1	(km/h)
	Speed V2 (km/h)	11,52	-14,93	
t_1 (s) / t_2 (s)	Deceleration time (s)		Mean Deceleration (m/s^2)	
19,72 / 26,34	6,62		-0,63	
	Acceleration			
	Distance X2 (m)	158	Total distance	(m)
	Distance X3 (m)	208	50	
	Speed V2 (km/h)	11,52	Increase V3-V2	(km/h)
	Speed V3 (km/h)	21,69	10,17	
t_2 (s) / t_3 (s)	Acceleration time (s)		Mean Acceleration (m/s^2)	
26,34 / 36,49	10,15		0,28	
Travel time through the interference (s)			16,77	
Imaginary travel time without intersection (s)			12,71	
Delay because of the intersection (s)			4,06	

Appendix III

Group	2	Street	Svenshögsvägen (south)		
Number	1	Code	IG 1F	Length (m)	899

Number: 1	Position X2 (m)	3	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	198	195	
Traffic Light	Total Delay on travel time		(s)	-0,71
X2 - X3 fixed	Speed in X3 (km/h)		t_2 (s)	t_3 (s)
Before AAP	51,35		0,62	15,99
After long time use	47,81		0,60	16,27
Delay before AAP (s)	1,70	Delay after seven months (s)		0,99

Number: 2	Position X1 (m)	198	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	538	340	
Traffic Light	Total Delay on travel time		(s)	-0,73
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	51,35	50,11	15,99	42,32
After long time use	47,81	47,26	16,27	43,49
Delay before AAP (s)	2,20	Delay after seven months (s)		1,47

Number: 3	Position X1 (m)	598	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	843	245	
Traffic Light	Total Delay on travel time		(s)	-0,42
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	49,52	34,28	46,67	71,26
After long time use	47,14	33,57	48,06	73,04
Delay before AAP (s)	3,54	Delay after seven months (s)		3,12

Number: 4	Position X1 (m)	843	Interference distance beforeAAP (m)	
Kind of interference:	Position X2 (m)	883	40	
Roundabout	Total Delay on travel time		(s)	-0,17
X1 - X2 fixed	Speed in X1 (km/h)		t_1 (s)	t_2 (s)
Before AAP	34,28		71,26	75,84
After long time use	33,57		73,04	77,54
Delay before AAP (s)	0,38	Delay after seven months (s)		0,21

Group	2	Street	Svenshögsvägen (north)		
Number	2	Code	IG 1B	Length (m)	899

Number: 1	Position X1 (m)	3	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	213	210	
Traffic Light	Total Delay on travel time		(s)	-0,33
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	35,40	53,14	0,51	17,89
After long time use	36,64	49,06	0,49	18,11
Delay before AAP (s)	0,30	Delay after seven months (s)		-0,02

Number: 2	Position X1 (m)	213	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	663	450	
Traffic Light	Total Delay on travel time		(s)	-1,00
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	53,14	55,06	17,89	50,23
After long time use	49,06	49,34	18,11	52,43
Delay before AAP (s)	2,40	Delay after seven months (s)		1,39

Number: **3**	Position X1 (m)	663	Interference distance beforeAAP (m)	
Kind of interference:	Position X2 (m)	903	240	
Traffic Light	**Total Delay on travel time**		**(s)**	**-0,67**
X1 - X2 fixed	Speed in X1 (km/h)		t_1 (s)	t_2 (s)
Before AAP	55,06		50,23	69,67
After long time use	49,34		52,43	73,02
Delay before AAP (s)	**3,75**	Delay after seven months (s)		**3,08**

Group	2	**Street**	**Törnavägen/Solvägen/Södra vägen (S-W)**	
Number	3	**Code**	IG 4F	**Length (m)** 1688

Number: **1**	Position X2 (m)	3	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	143	140	
Traffic Light	**Total Delay on travel time**		**(s)**	**-0,32**
X2 - X3 fixed	Speed in X3 (km/h)		t_2 (s)	t_3 (s)
Before AAP	51,78		0,59	11,84
After long time use	48,93		0,60	12,10
Delay before AAP (s)	**1,52**	Delay after seven months (s)		**1,20**

Number: **2**	Position X1 (m)	143	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	468	325	
Traffic Light	**Total Delay on travel time**		**(s)**	**-0,80**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	51,78	48,87	11,84	38,41
After long time use	48,93	47,07	12,10	39,00
Delay before AAP (s)	**3,32**	Delay after seven months (s)		**2,53**

Number: **3**	Position X1 (m)	578	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	898	320	
Roundabout	**Total Delay on travel time**		**(s)**	**-0,28**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	49,75	48,21	46,48	71,24
After long time use	47,61	46,46	47,37	72,82
Delay before AAP (s)	**1,24**	Delay after seven months (s)		**0,96**

Number: **4**	Position X1 (m)	898	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	1193	295	
3-leg inters. With priority	**Total Delay on travel time**		**(s)**	**-0,07**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	48,21	50,86	71,24	92,99
After long time use	46,46	48,49	72,82	95,43
Delay before AAP (s)	**0,31**	Delay after seven months (s)		**0,24**

Number: **5**	Position X1 (m)	1193	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	1488	295	
4-leg inters. With priority	**Total Delay on travel time**		**(s)**	**0,02**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	50,86	47,29	92,99	115,65
After long time use	48,49	45,02	95,43	119,18
Delay before AAP (s)	**1,02**	Delay after seven months (s)		**1,04**

Number: 6	Position X1 (m)	1488	Interference distance beforeAAP (m)	
Kind of interference:	Position X2 (m)	1653	165	
Traffic Light	**Total Delay on travel time**		**(s)**	**0,12**
X1 - X2 fixed	Speed in X1 (km/h)		t_1 (s)	t_2 (s)
Before AAP	47,29		115,65	131,16
After long time use	45,02		119,18	135,44
Delay before AAP (s)	**2,95**	Delay after seven months (s)		**3,07**

Group	2	**Street**	**Törnavägen/Solvägen/Södra vägen (N-E)**	
Number	4	**Code**	IG 4B	**Length (m)** 1688

Number: 1	Position X2 (m)	8	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	128	120	
Traffic Light	**Total Delay on travel time**		**(s)**	**-0,03**
X2 - X3 fixed	Speed in X3 (km/h)		t_2 (s)	t_3 (s)
Before AAP	45,57		1,09	11,34
After long time use	45,29		1,03	11,31
Delay before AAP (s)	**0,77**	Delay after seven months (s)		**0,74**

Number: 2	Position X1 (m)	128	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	443	315	
4-leg inters. With priority	**Total Delay on travel time**		**(s)**	**-0,17**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	45,57	50,81	11,34	36,02
After long time use	45,29	47,96	11,31	36,61
Delay before AAP (s)	**1,15**	Delay after seven months (s)		**0,98**

Number: 3	Position X1 (m)	443	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	738	295	
3-leg inters. With priority	**Total Delay on travel time**		**(s)**	**-0,20**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	50,81	48,92	36,02	57,81
After long time use	47,96	47,45	36,61	59,16
Delay before AAP (s)	**0,49**	Delay after seven months (s)		**0,29**

Number: 4	Position X1 (m)	738	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	1048	310	
Roundabout	**Total Delay on travel time**		**(s)**	**0,03**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	48,92	49,89	57,81	81,83
After long time use	47,45	48,01	59,16	84,00
Delay before AAP (s)	**1,43**	Delay after seven months (s)		**1,46**

Number: 5	Position X1 (m)	1208	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	1553	345	
Traffic Light	**Total Delay on travel time**		**(s)**	**-1,28**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	49,72	47,98	93,45	122,85
After long time use	47,8	44,49	96,01	125,62
Delay before AAP (s)	**3,98**	Delay after seven months (s)		**2,69**

Number: **6**	Position X1 (m)	1553	Interference distance beforeAAP (m)		
Kind of interference:	Position X2 (m)	1668	115		
Traffic Light	**Total Delay on travel time**		**(s)**		**0,09**
X1 - X2 fixed	Speed in X1 (km/h)		t_1 (s)		t_2 (s)
Before AAP	47,98		122,85		136,08
After long time use	44,49		125,62		139,62
Delay before AAP (s)	**4,60**	Delay after seven months (s)			**4,69**

Group	2	**Street**		**Stattenavägen**	
Number	5	**Code**	IG 6F	**Length (m)**	1107

Number: **1**	Position X1 (m)	3	Interference distance beforeAAP (m)		
Kind of interference:	Position X3 (m)	608	605		
4-leg inters. With priority	**Total Delay on travel time**		**(s)**		**-0,87**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)		t_3 (s)
Before AAP	54,66	52,77	0,33		42,72
After long time use	50,13	49,25	0,36		45,16
Delay before AAP (s)	**1,84**	Delay after seven months (s)			**0,97**

Number: **2**	Position X1 (m)	608	Interference distance beforeAAP (m)		
Kind of interference:	Position X3 (m)	908	300		
Traffic Light	**Total Delay on travel time**		**(s)**		**0,18**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)		t_3 (s)
Before AAP	52,77	47,86	42,72		68,21
After long time use	49,25	45,82	45,16		72,09
Delay before AAP (s)	**4,03**	Delay after seven months (s)			**4,21**

Number: **3**	Position X1 (m)	908	Interference distance beforeAAP (m)		
Kind of interference:	Position X2 (m)	1073	165		
Traffic Light	**Total Delay on travel time**		**(s)**		**-0,81**
X1 - X2 fixed	Speed in X1 (km/h)		t_1 (s)		t_2 (s)
Before AAP	47,86		68,21		83,97
After long time use	45,82		72,09		87,59
Delay before AAP (s)	**3,35**	Delay after seven months (s)			**2,54**

Group	2	**Street**	**Kävlingevägen (north)**		
Number	6	**Code**	IG 8F	**Length (m)**	1028

Number: 1	Position X2 (m)	3	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	188	185	
Roundabout	**Total Delay on travel time**		**(s)**	**-0,26**
X2 - X3 fixed	Speed in X3 (km/h)		t_2 (s)	t_3 (s)
Before AAP	49,22		0,60	15,47
After long time use	48,44		0,58	15,41
Delay before AAP (s)	**1,34**	Delay after seven months (s)		**1,08**

Number: 2	Position X1 (m)	188	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	423	235	
3-leg inters. With priority	**Total Delay on travel time**		**(s)**	**-0,11**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	49,22	53,86	15,47	31,87
After long time use	48,44	49,71	15,41	32,52
Delay before AAP (s)	**-0,01**	Delay after seven months (s)		**-0,13**

Number: 3	Position X1 (m)	423	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	768	345	
3-leg inters. With priority	**Total Delay on travel time**		**(s)**	**-0,62**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	53,86	58,73	31,87	54,76
After long time use	49,71	52,10	32,52	57,13
Delay before AAP (s)	**0,83**	Delay after seven months (s)		**0,21**

Number: 4	Position X1 (m)	768	Interference distance beforeAAP (m)	
Kind of interference:	Position X2 (m)	1018	250	
Traffic Light	**Total Delay on travel time**		**(s)**	**-0,78**
X1 - X2 fixed	Speed in X1 (km/h)		t_1 (s)	t_2 (s)
Before AAP	58,73		54,76	72,91
After long time use	52,10		57,13	76,45
Delay before AAP (s)	**2,83**	Delay after seven months (s)		**2,05**

Group	2	**Street**		**Kävlingevägen (south)**	
Number	7	**Code**	IG 8B	**Length (m)**	1028

Number: 1	Position X2 (m)	3	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	163	160	
Traffic Light	**Total Delay on travel time**		**(s)**	**-0,37**
X2 - X3 fixed	Speed in X3 (km/h)		t_2 (s)	t_3 (s)
Before AAP	54,69		0,44	11,94
After long time use	50,84		0,43	12,36
Delay before AAP (s)	**0,97**	Delay after seven months (s)		**0,60**

Number: 2	Position X1 (m)	163	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	588	425	
4-leg inters. With priority	**Total Delay on travel time**		**(s)**	**-0,70**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	54,69	52,99	11,94	41,91
After long time use	50,84	49,44	12,36	43,73
Delay before AAP (s)	**1,55**	Delay after seven months (s)		**0,86**

Number: 3	Position X1 (m)	588	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	873	285	
3-leg inters. With priority	**Total Delay on travel time**		**(s)**	**-0,22**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	52,99	49,18	41,91	62,23
After long time use	49,44	47,44	43,73	64,93
Delay before AAP (s)	**0,24**	Delay after seven months (s)		**0,02**

Number: 4	Position X1 (m)	873	Interference distance beforeAAP (m)	
Kind of interference:	Position X2 (m)	1013	140	
Roundabout	**Total Delay on travel time**		**(s)**	**-0,04**
X1 - X2 fixed	Speed in X1 (km/h)		t_1 (s)	t_2 (s)
Before AAP	49,18		62,23	76,31
After long time use	47,44		64,93	79,35
Delay before AAP (s)	**3,83**	Delay after seven months (s)		**3,80**

Group	2	**Street**	**Tornavägen (north)**		
Number	8	**Code**	IG10,11,13F	**Length (m)**	1612

Number: 1	Position X2 (m)	3	Interference distance beforeAAP (m)		
Kind of interference:	Position X3 (m)	113	110		
3-leg inters. With priority	**Total Delay on travel time**		**(s)**	**-0,11**	
X2 - X3 fixed	Speed in X3 (km/h)		t_2 (s)	t_3 (s)	
Before AAP	51,10		0,36	8,24	
After long time use	47,37		0,39	8,77	
Delay before AAP (s)	**0,13**	Delay after seven months (s)		**0,02**	

Number: 2	Position X1 (m)	113	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	383	270	
Traffic Light	**Total Delay on travel time**		**(s)**	**-0,27**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	51,10	47,25	8,24	30,07
After long time use	47,37	45,8	8,77	31,43
Delay before AAP (s)	**2,06**	Delay after seven months (s)		**1,79**

Number: 3	Position X1 (m)	383	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	728	345	
Traffic Light	**Total Delay on travel time**		**(s)**	**-2,40**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	47,25	45,63	30,07	64,32
After long time use	45,8	45,99	31,43	63,60
Delay before AAP (s)	**7,51**	Delay after seven months (s)		**5,11**

Number: 4	Position X1 (m)	728	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	818	90	
3-leg inters. With priority	**Total Delay on travel time**		**(s)**	**0,37**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	45,63	47,75	64,32	70,95
After long time use	45,99	45,96	63,60	70,71
Delay before AAP (s)	**-0,31**	Delay after seven months (s)		**0,06**

Number: 5	Position X1 (m)	818	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	948	130	
3-leg inters. With priority	**Total Delay on travel time**		**(s)**	**-0,22**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	47,75	45,72	70,95	81,30
After long time use	45,96	44,5	70,71	81,17
Delay before AAP (s)	**0,34**	Delay after seven months (s)		**0,11**

Number: 6	Position X1 (m)	948	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	1192	244	
Traffic Light	**Total Delay on travel time**		**(s)**	**1,88**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	45,72	41,47	81,30	104,57
After long time use	44,5	40,12	81,17	106,93
Delay before AAP (s)	**3,12**	Delay after seven months (s)		**5,00**

Number: 7	Position X1 (m)	1192	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	1357	165	
3-leg inters. With priority	**Total Delay on travel time**		**(s)**	**-0,05**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	41,47	49,21	104,57	117,63
After long time use	40,12	46,95	106,93	120,48
Delay before AAP (s)	**-0,04**	Delay after seven months (s)		**-0,09**

Number: 8	Position X1 (m)	1357	Interference distance beforeAAP (m)	
Kind of interference:	Position X2 (m)	1587	230	
Traffic Light	**Total Delay on travel time**		**(s)**	**-0,04**
X1 - X2 fixed	Speed in X1 (km/h)		t_1 (s)	t_2 (s)
Before AAP	49,21		117,63	138,91
After long time use	46,95		120,48	142,53
Delay before AAP (s)	**4,45**	Delay after seven months (s)		**4,41**

Group	2	**Street**		**Tornavägen (south)**		
Number	9	**Code**	IG10,11,13B	**Length (m)**		1612

Number: 1	Position X2 (m)	3	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	168	165	
Traffic Light	**Total Delay on travel time**		**(s)**	**-0,48**
X2 - X3 fixed	Speed in X3 (km/h)		t_2 (s)	t_3 (s)
Before AAP	51,31		0,56	13,65
After long time use	47,32		0,56	14,15
Delay before AAP (s)	**1,51**	Delay after seven months (s)		**1,04**

Number: 2	Position X1 (m)	168	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	403	235	
3-leg inters. With priority	**Total Delay on travel time**		**(s)**	**-0,21**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	51,31	43,23	13,65	32,03
After long time use	47,52	40,68	14,15	33,61
Delay before AAP (s)	**0,48**	Delay after seven months (s)		**0,28**

Number: 3	Position X1 (m)	403	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	621	218	
Traffic Light	**Total Delay on travel time**		**(s)**	**0,45**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	43,23	48,72	32,03	52,13
After long time use	40,68	46,60	33,61	55,07
Delay before AAP (s)	**3,03**	Delay after seven months (s)		**3,48**

Number: 4	Position X1 (m)	621	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	791	170	
3-leg inters. With priority	**Total Delay on travel time**		**(s)**	**-0,20**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	48,72	48,08	52,13	65,17
After long time use	46,60	45,80	55,07	68,51
Delay before AAP (s)	**0,40**	Delay after seven months (s)		**0,19**

Number: 5	Position X1 (m)	791	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	1135	344	
3-leg inters. With priority	**Total Delay on travel time**		**(s)**	**-0,04**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	48,08	48,55	65,17	97,29
After long time use	45,80	47,18	68,51	101,60
Delay before AAP (s)	**6,49**	Delay after seven months (s)		**6,45**

Number: 6	Position X1 (m)	1135	Interference distance beforeAAP (m)	
Kind of interference:	Position X3 (m)	1485	350	
Traffic Light	**Total Delay on travel time**		**(s)**	**-0,63**
X1 - X3 fixed	V1 (km/h)	V3 (km/h)	t_1 (s)	t_3 (s)
Before AAP	48,55	51,89	97,29	124,94
After long time use	47,18	49,39	101,60	129,63
Delay before AAP (s)	**2,56**	Delay after seven months (s)		**1,93**

Number: 7	Position X1 (m)	1485	Interference distance beforeAAP (m)	
Kind of interference:	Position X2 (m)	1605	120	
3-leg inters. With priority	**Total Delay on travel time**		**(s)**	**-0,11**
X1 - X2 fixed	Speed in X1 (km/h)		t_1 (s)	t_2 (s)
Before AAP	51,89		124,94	133,53
After long time use	49,39		129,63	138,53
Delay before AAP (s)	**0,26**	Delay after seven months (s)		**0,15**