Trivector

Trivector Traffic
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Evaluation of Actibump in Linköping

Effect on speed and yielding behaviour

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Preface

Trivector Traffic has, on behalf of Edeva, performed an evaluation of Actibump, with respect to its effects on vehicle speed and drivers' yielding behaviour towards vulnerable road users. Contacts at Edeva has been David Eskilsson and Marcus Raninger. The assignment was carried out in July 2014 to June 2016. Project manager was PhD Eng Annika Nilsson at Trivector Traffic with contributions from PhD Eng Hanna Wennberg and MSc Eng Alexander Börefelt, Trivector Traffic. Studies of speed and yielding behaviour have been carried out by Leif Franzén at Franzén Transport & Machine Consultation.

Karin Wiklund at Edeva has translated the report to English.

Gothenburg, Sweden, June 2016

Trivector Traffic AB

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1. Introduction

1.1 Background and purpose

Trivector Traffic has, on behalf of Edeva, performed an evaluation of Actibump on Djurgårdsgatan by the pedestrian crossing at the junction with Väbelgatan in Linköping, Sweden. Actibump is an active dynamic speed bump that is activated only by those vehicles exceeding the speed limit.

The purpose of this study is to assess how the vehicle drivers' speed and yielding behaviour is affected by the introduction of Actibump.

1.2 Study design and hypotheses

The evaluation has been conducted through studies before and after the Actibump was installed. The evaluation was made on the basis of the following hypotheses:

1. The average speed and 85-percentile speed of free vehicles are lower with Actibump than without, comparison before-after study.
2. After implementation of Actibump, a larger share of drivers yield towards vulnerable road users crossing the street, comparison before-after study.

Hypotheses are tested by comparison of the data collected before and after Actibump is implemented.

1.3 Data collection

Speeds

Studies of motor vehicle speeds were conducted by measuring speeds of 200 free vehicles, 100 vehicles in each direction, before and after implementation. Speeds were measured in a section located closely in front of the pedestrian crossing.

Free vehicles are vehicles that independently can choose their own speed, which is defined as having 3-5 seconds between vehicles. There is a correlation between the speed of free vehicles and the risk of collisions between motor vehicles and pedestrians. Average speed of free vehicles is higher than for vehicles in general since free vehicles exclude vehicles in a queue.

In order to measure the speed of free vehicles, speeds were measured during off-peak hours from 08.45-10.15 and 13.45-15.30 as it is difficult to see enough free vehicles during other times of the day. Information on type of vehicle and direction/lane were also noted.

Yielding behaviour

Studies of yielding behaviour were conducted on more than 100 interactions between drivers of motor vehicles and pedestrians, or between drivers of motor vehicles and cyclists, where the vulnerable road users cross the street at the pedestrian crossing in question. An interaction is defined as a situation when a driver encounters one or more vulnerable road users indicating an intention to cross the street at the pedestrian crossing, either from the pavement or traffic island. It was observed whether:

- the driver stops and yields
- the driver slows down and yields
- the driver slows down but does not yield
- the driver keeps the same speed and does not yield
- the driver accelerates and does not yield

It was also observed whether the interaction was with a pedestrian or cyclist (or both) and also the number of pedestrians/cyclists in the interaction (if there were more than one). The studies were conducted in the morning and afternoon when there were an adequate number of vulnerable road users crossing the street.

1.4 Time periods and locations for data collection

Data collection has been carried out during comparable periods before and after implementation of Actibump, in September 2014 and June 2016. Actibump was installed during the fall of 2015. Speeds and yielding behaviour were studied on Monday 1 September 2014 and Tuesday 7 June 2016.

1.5 Study site

Actibump is implemented on Djurgårdsgatan by the pedestrian crossing at the junction with Väbelgatan. The street has one lane in each direction and an average annual daily traffic (AADT) of 13,500 vehicles per day (in 2015). Buses pass by every 20 minutes and Djurgårdsgatan is an emergency road (for police, ambulance and fire brigade). See photo in Figure 1-1.

At the pedestrian crossing there are traffic islands between the two driving directions. There are approximately 100 people per morning hour walking and cycling across the route where the pedestrian crossing is located. There is a shop, various residential areas and the University Hospital located in the vicinity of the pedestrian crossing. Along one side of the street there is a walking and cycling path and on the other side only a sidewalk for pedestrians. The cycling path crosses the street next to the pedestrian crossing.

The speed limit is 40 km/h, but prior to the implementation of the Actibump the limit was 50 km/h. Prior to installation there were also detectors with flashing lights above the pedestrian crossing signs, activated when someone was approaching the pedestrian crossing. Since the installation of Actibump the flashing lights have not been in use, but the fittings etc. are not dismantled, see Figure 1-2. The site is fitted with warning signage including special additional sign since the installation of Actibump, see Figure 1-3

Figure 1-1 Photo on site before the implementation. Photo in North easterly direction towards the shop. Photo: Leif Franzén.

Figure 1-2 Photo on site after the implementation. Photo in a northerly direction towards the city centre. Photo: Leif Franzén.

Figure 1-3 Photo on site after the implementation. Photo of south-westerly direction, from the city centre. Photo: Leif Franzén. The text sign would be translated as “If speeding”

1.6 Data analysis

The data collected on speeds and yielding behaviour has been analysed in Excel and SPSS. The hypothesis of average speed has been tested using T-test for analyses of statistical significances while Chi2-test has been used for testing the hypothesis on the share of drivers yielding for vulnerable road users.

2. Results

2.1 Speeds

There has been a statistically significant decrease of average speed after the implementation of Actibump compared to before (Table 2-1). The difference in speed is 10.6 km/h in total and a little less for the lane in the south westerly direction. The range of speed has also decreased somewhat since the implementation of Actibump.

Table 2-1 Vehicle speeds (km/h) before and after implementation of Actibump. Statistical significances (sign.) at the 95% level. Note that this only applies to free vehicles.

Directions	Speed parameters (km/h)								
	Number of observations		Average speed		Standard deviation		Difference after-before	Share of heavy traffic	
	before	after	before	after	before	after	average speed	before	after
Both directions	200	200	41.3	30.7	7.2	6.3	-10.6 (sign.)	5.5 %	3.5 %
South westerly, from city centre	100	100	42.1	32.1	6.4	5.5	-10.0 (sign.)	5 %	4 %
Northerly, to city centre	100	100	40.5	29.4	7.8	6.7	-11.1 (sign.)	6 %	3 %

The 85th-percentile has decreased as well. For all measured vehicles, the 85-percentile speed has decreased from 47.2 km/h to 37.0 km/h. Figure 2-1 below shows speed profiles before and after implementation of Actibump. In general, speeds have been lowered. The share of drivers exceeding the speed limit of 40 km/h was 6 % after implementation. Before implementation, when the speed limit was 50 km/h, 55 % of drivers exceeded 40 km/h. Note that these figures apply only to free vehicles.

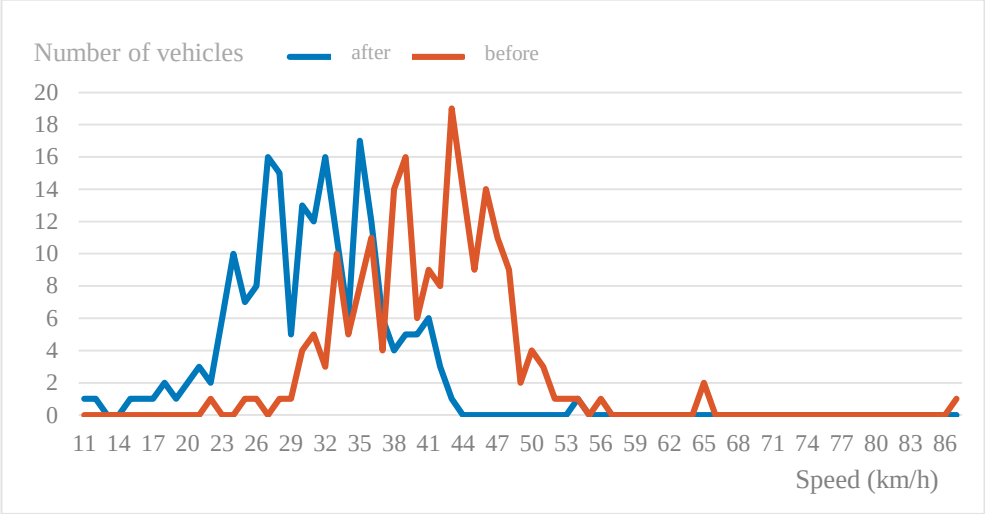

Figure 2-1 Number of vehicles with different speed before and after the implementation of the Actibump. Note that this applies to the speed of free vehicles.

2.2 Yielding behaviour

There has been a statistically significant increase of the share of drivers yielding towards vulnerable road users at the pedestrian crossing after the implementation of Actibump compared to before (Table 2-2). The share increased with 10 percentage points, from 72 % to 82 %, in total, for both directions. Looking at drivers in each direction separately, the difference was not statistically significant since the number of observed interactions was to limited. The largest difference seems to be in interactions with drivers from the city centre.

The share of interactions with pedestrians in the before and the after measurements were not entirely comparable. In the before-situation a little over 51 % of the interactions included pedestrians (the other 49 % were cyclists). In the after-situation 61 % of interactions included pedestrians (and 39 % cyclists). Because of this difference, yielding towards pedestrians and yielding towards cyclists are analysed separately as well. The increase in yielding towards cyclists seems to have been slightly larger than the increase in yielding to pedestrians, But the degree of yielding to pedestrians was already high before the implementation of Actibump.

Table 2-2 Share of drivers yielding towards vulnerable road users before and after implementation of Actibump. Statistical significances (sign.) at the 95% level.

Directions	Number of observations		Share of drivers yielding		Difference in share of drivers yielding after-before	Share of interactions with pedestrians	
	before	after	before	after		before	after
Both directions	164	153	72 %	82 %	10 %-points (sign.)	51 %	61 %
South westerly, from city centre	80	73	64 %	78 %	14 %-points (no sign.)	53 %	60 %
North easterly, to city centre	84	80	80 %	86 %	6 %-points (no sign.)	49 %	63 %
Both directions, towards pedestrians	83	94	87 %	89 %	3 %-points (no sign.)		
Both directions, towards cyclists	81	59	57 %	71 %	14 %-points (no sign.)		

3. Conclusions

An evaluation of the active, dynamic speed bump Actibump has been conducted by studies before and after the implementation of Actibump on Djurgårdsgatan in Linköping, Sweden. The following hypotheses have been tested:

1. The average speed and 85-percentile speed of free vehicles are lower with Actibump than without, comparison before-after
2. After implementation of Actibump, a larger share of drivers yields towards vulnerable road users crossing the street, comparison before-after

The results show that the average speed and 85-percentile speed of free motor vehicles have decreased and that the share of drivers yielding towards vulnerable road users has increased after the implementation of Actibump.

The average speed decreased 11 km/h from a little over 41 km/h to a little under 31 km/h. Aside from the implementation of Actibump the speed limit has been decreased from 50 km/h to 40 km/h. Lowering the speed limit (including a change of signage) is a way to reduce speed in and of itself. As a general rule of thumb a decrease of the speed limit of 10 km/h gives an actual decrease in speed of 2.5 km/h. [1]

Motor vehicle speeds are correlated with the expected traffic safety effects in terms of reducing risks of accidents and injuries. Decreased speed therefore implies an improvement of traffic safety by the implementation of Actibump.

The share of drivers that yielded towards the vulnerable road users at the pedestrian crossing increased by 10 percentage points from 72 % to 82 %. Yielding behaviour towards pedestrians was already at a high level before the implementation of Actibump (87 %) and the largest effect in this case concerns yielding behaviour towards cyclists. Drivers yielding towards vulnerable road users leads to an increased accessibility for the vulnerable road users.

An evaluation, using the same method, has been carried out in Uppsala where Actibump has been implemented on Dag Hammarskjölds väg. [2] On the Actibump site in Uppsala there is one lane in one direction and two lanes in the other direction and an annual average daily traffic (AADT) of approximately 14,000-15,000 vehicles per day. The speed limit is 30 km/h Monday through Friday 7 a.m. to 6 p.m.

The effect on average speed was lower in Uppsala than in Linköping, it decreased from 33 km/h to 27,5 km/h. The effect on yielding behaviour was larger in

[1] Swedish Association of Local Authorities and Regions (2009). Åtgärdskatalog för säker trafik i tätort. Third edition. Stockholm, Sweden: Kommentus förlag.

[2] Evaluation of Actibump in Uppsala. Effect on speed, yielding behaviour and noise level. Trivector Traffic report 2015:45

Uppsala where yielding towards vulnerable road users went from 51 % to 72 %. However, the initial situation was different in Uppsala. Before the implementation of Actibump in Uppsala 51 % yielded towards vulnerable road users, whereas the corresponding number for the initial situation in Linköping was 72 %. After implementation both sites have become more similar with an average speed of free vehicles of around 30 km/h and more than 70 % of drivers yielding towards vulnerable road users about to cross the street.