EVALUATION OF HOV-LANES IN NORWAY

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1 ABSTRACT

The first HOV-lane ever in Norway was implemented in Holtermanns Road / Elgeseter Street in the city of Trondheim the 9th of May 2001. The lane is open for carpools with 2 or more occupants.

Later on other Norwegian cities have established HOV-lanes or investigated possibilities by use of simulation tools.

An evaluation based on parameters like travel time, car occupancy, traffic volume, queue length and violation are carried out both in Trondheim and in Kristiansand. The results show that an HOV-lane can give buses end carpools an improved travel time, and a more reliable travel time. Also the number of carpools has increased. The travel times for cars has increased, but not more than what is considered “acceptable”.

2 INTRODUCTION

Better efficiency of the existing road infrastructure, reduced air pollution and bus priority is important goals for the road administration. One strategy is introduction of HOV-lanes. An HOV-lane is a lane that can be used by buses, taxies, motorcycles and carpools.

In Norway several HOV-lane projects has been evaluated, but none has been implemented until 2001. Based on results from traffic simulations the first HOV-lane in Norway was implemented in Holtermanns Road / Elgeseter Street in the city of Trondheim the 9th of May 2001.

Prior to the opening of the HOV-lane different studies were carried out. A simulation tool (the simulation model CORSIM) was used to evaluate different use (2 or more occupants, 3 or more occupants, freight traffic, etc) of the lane. Also traffic safety issues were considered. Based on the results an HOV-lane for 2 or more occupants was chosen.

In the city of Bergen an HOV lane was simulated, but not implemented, because of less advantages than in Trondheim. In two other cities, Oslo and Kristiansand, HOV-lanes were established without any investigation by use of simulation tools. The HOV-lane in Kristiansand was opened the17th of December 2001.

The HOV-lanes in Trondheim and Kristiansand are evaluated through a before-after-study. The evaluation is based on parameters like on parameters like travel time, car occupancy, traffic volume, queue length and HOV-violators.

3 THE HOV SECTIONS

The HOV-section in Elgeseter Street / Holtermanns Road in Trondheim is between the intersections to Valøyvegen and Abels gate. This arterial street heads towards the city centre with 2 lanes in each direction, and it is the main entrance to the down town area from south. The HOV-lane is the right hand lane in the northbound direction (near the sidewalk). The lane is open for buses, taxis and carpools with 2 or more occupants (2+). The HOV-lane is approximately 1 km long, and there are 4 signalised intersections fixed time-control on the section.

The HOV-section in Kristiansand is between Rona and Bjørndalsletta on highway E18 east of the city. This is a 4 lane highway towards the city centre, and also the main highway through southern Norway. The HOV-lane is the right hand lane in the southbound direction. The lane is open for buses, taxis and carpools with 2 or more occupants (2+). The HOV-lane is approximately 3 km long.

Norway does not yet have specific signs for HOV-lanes. But when HOV-lanes are more common this may be an issue.

The signs that we use in Trondheim are shown in the pictures in figure 1 on the next page. Before the start of the HOV-lane there are information signs as viewed in the first picture (up to the left). Translated the sign read: “The bus lane in Holtermanns Road is allowed for vehicles with at least 2 persons”.

The actual sign for the HOV-lane is shown in the second picture (up to the right). This is the same sign that are used for bus lanes, which is a bus/taxi only sign with an additional text: “Also vehicles with at least 2 persons. Applies to the right lane”.

The road marking is shown in the third picture. The divider is only a single line marked on the road surface. The line between a general-purpose lane and a bus only lane is usually a little wider than a line between two general-purpose lanes. In July we were allowed to mark the road surface with “ BUS, TAXI and 2+”.

Marking BUS and TAXI is common, but the phrase 2+ is not well known in Norway. However, this is the symbol that is used on an HOV-lane in Leeds, England. We think that symbol is good because it is very much self-explanatory.

In Kristiansand we only use the bus/taxi only sign with an additional text: “Also vehicles with at least 2 persons” and the road marking as shown in figure 2.

Figure 1: Signs and marking of the HOV-lane in Trondheim.

Figure 2: Signs and marking from the start of the HOV-lane in Kristiansand.

4 SIMULATION IN TRONDHEIM

For simulation the program CORSIM (CORidor SIMulation) has been used. CORSIM is a part of a computer program package called TSIS (Traffic Software Integrated System) that are developed by FHWA (Federal HighWay Administration) in the USA.

This model gives us the opportunity to study each individual vehicles in movement in detail. The simulation is based on a detailed description of the traffic regulation, dynamic of the vehicles and behavior of the drivers.

The HOV-lane in the simulation model was about 2500 m, both inbound and outbound direction. The calculation was based on the peak periods, i.e. the morning peek from 7am to 9am inbound and the afternoon peek from 3pm to 5pm outbound.

The simulation study evaluated an HOV-lane for carpools with 2 or more occupants (2+) and 3 or more occupants (3+). The results showed that an HOV-lane for carpools with 2 or more occupants would improve travel time, and give more reliable travel time for buses. Travel time in the ordinary lane would increase, but not dramatic. Air pollution would not be affected.

An HOV-lane for carpools with 3 or more occupants would also improve and smooth travel time for buses, but not more than the 2+ case. Travel time and queues in the ordinary lane would increase considerable, and air pollution would increase.

One condition for establishing an outbound HOV-lane is to reduce the number of right hand turns. The right hand turns induces too much interruption.

Based on these results the local Public Roads Administration recommend an HOV-lane with carpools with 2 or more occupants, and only towards the city centre. To establish an HOV-lane in the opposite direction a number of right-hand turns have to be removed and this would claim to many changes in the traffic regulation.

5 EVALUATION IN TRONDHEIM

The HOV-Lane is evaluated through a before-after-study. Actually we had one before study and two after studies.

In the evaluation of the system we measured car occupancy, traffic volume, travel time, HOV-violators and queue length. In this paper the first four parameters are shown. All results are taken from the morning peak from 7am to 9am.

5.1 Car Occupancy

Car occupancy has increased from 1.33 persons per car in the before study to 1.37-1.38 persons per car in the after studies. The number of cars with single occupancy is reduced by almost 4 percentage points.

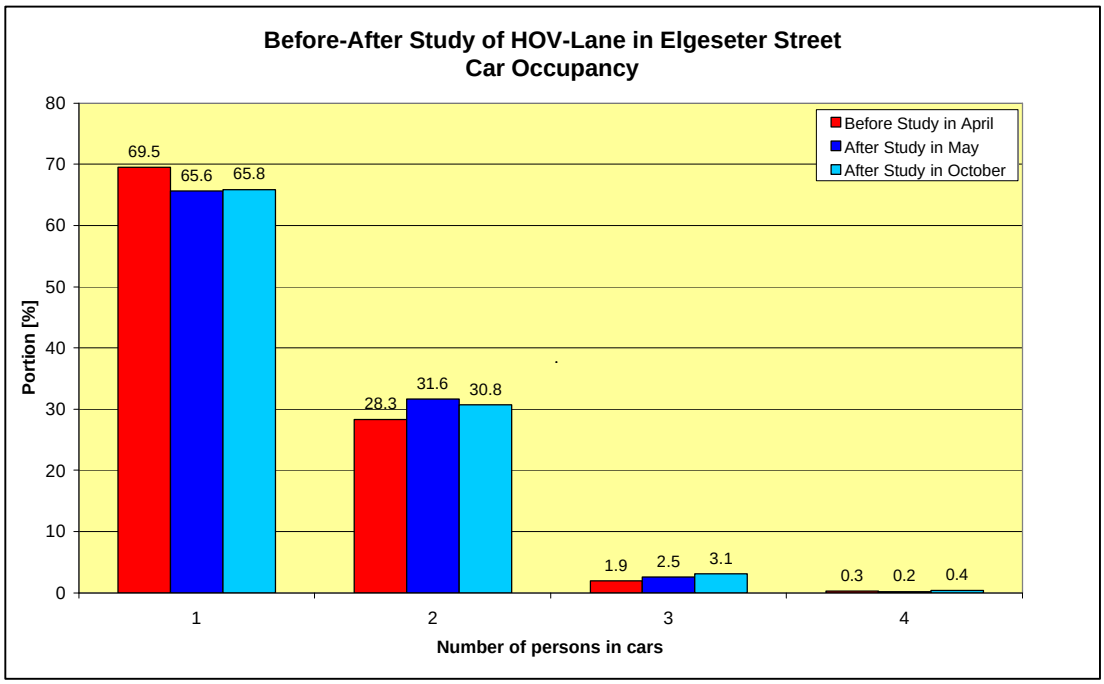

Figure 3: Number of persons per car in Trondheim.

5.2 Traffic Volume

The total traffic volume in the morning peak is approximately the same before and after the opening of the HOV-lane. There are a little decrease in traffic with the HOV-lane, but not significant.

Several people expected that the HOV-lane would transfer traffic to other streets, but no significant changes in traffic volume are to be found on the nearby streets

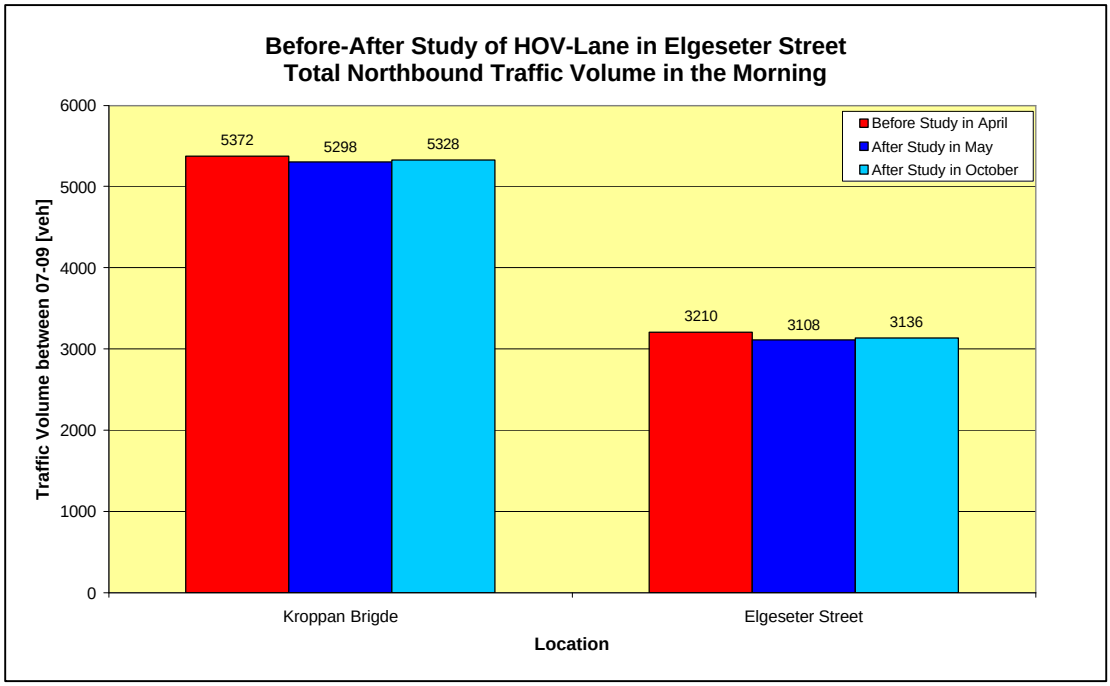

Figure 4: Total traffic volume between 7am and 9am in two different locations in Elgeseter Street in Trondheim.

5.3 Travel Times

Figure 5 shows that the travel time in the HOV-lane has decreased in the morning peak. The travel time is also more reliable since there are only small variations through the peak. The average reduction in travel time per vehicle is 35 seconds, but in the peek period the maximum reduction is almost 2 minutes.

Travel time in the left lane has increased in the morning peak. The peak also starts earlier, and lasts longer as a result of the HOV lane.

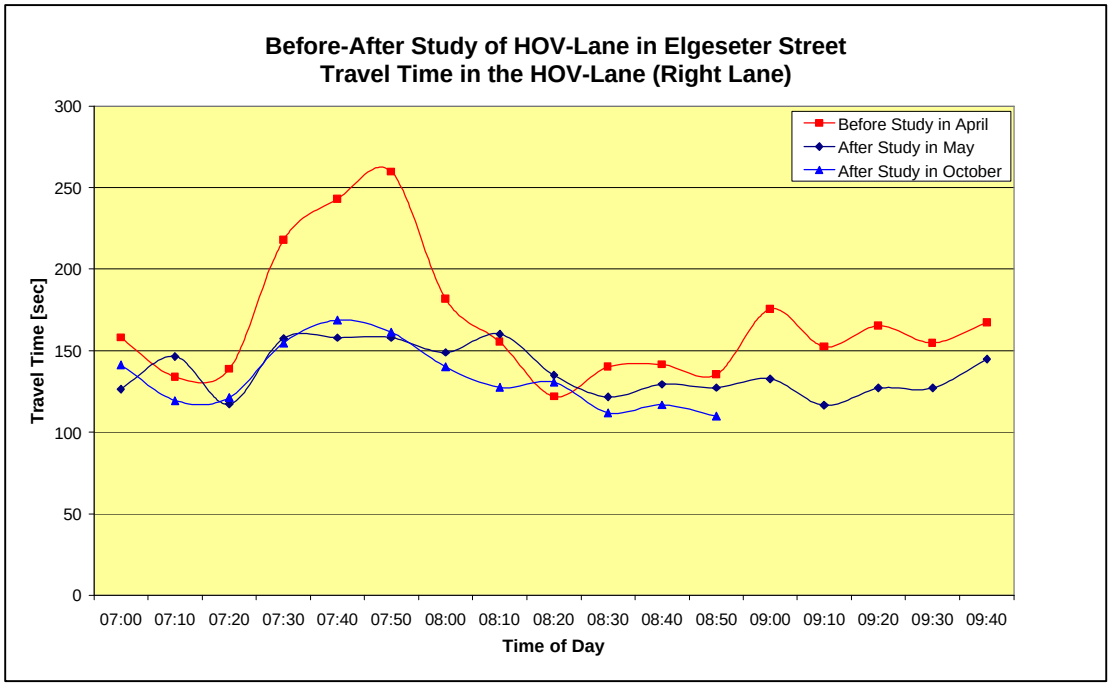

Figure 5 : Travel time in the HOV-lane (right lane).

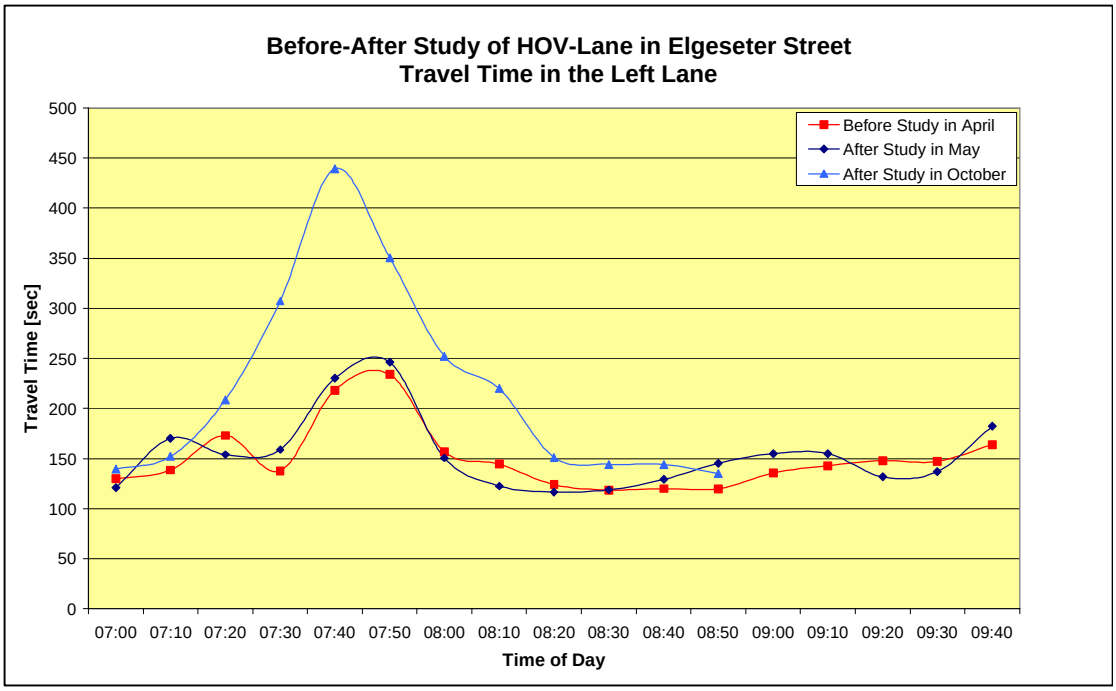

Figure 6 : Travel time in the left lane.

5.4 Violators

In the first after study the number of violators (i.e. number of vehicles with only 1 person) in the HOV-Lane was unacceptable, especially after the morning peek

To improve the situation the Norwegian Public Roads Administration and the police first carried out an information campaign where violators were stopped, and given an information brochure. Later on the police also had a control where violators got fines. The symbol 2+ where also painted on the road surface.

In the second after study number of violators was down to about 10 in the morning peek, but still the portion of violators is higher (up to 20%) during the daytime.

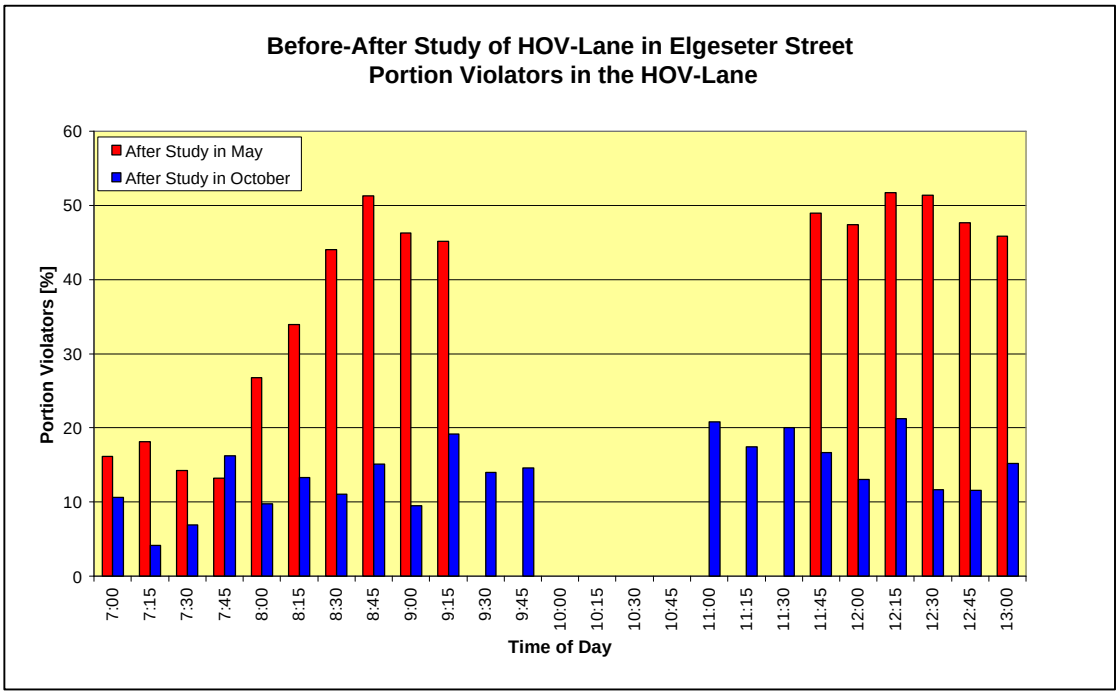

Figure 7 : Portion of violators in the HOV-lane in Trondheim.

5.5 Traffic Safety

Traffic safety issues were also considered prior to the opening of the HOV-lane. Factors like number of lane changes, speed level and existing accident level was studied. It was expected fewer accidents in the 2+ case than in the 3+ case due to fewer lane changes and more equal speed in the 2 lanes. The theory was supported by results from the HOV-lane in Leeds.

One year after the opening of the HOV-lane in Trondheim the accident rate had not increased, but rather decreased a little. None of the accidents on the section the last year are directly connected to the HOV-lane. However, it is too early to conclude as regards to the accident rate.

6 EVALUATION IN KRISTIANSAND

The HOV-lane in Kristiansand is also evaluated through one before study and two after studies in the same way as in Trondheim. We measured car occupancy, traffic volume, travel time and HOV-violators.

6.1 Car Occupancy

The average car occupancy was 1.27 persons per car in the before study and 1.26 persons per car in the first after study. In the second after study car occupancy had increased to 1.31 persons per car. So the overall average car occupancy showed only small changes.

The morning peak was the only period with significant increase in car occupancy – from 1.20 persons per car in the before study to 1.24 and 1.27 persons per car in the after studies.

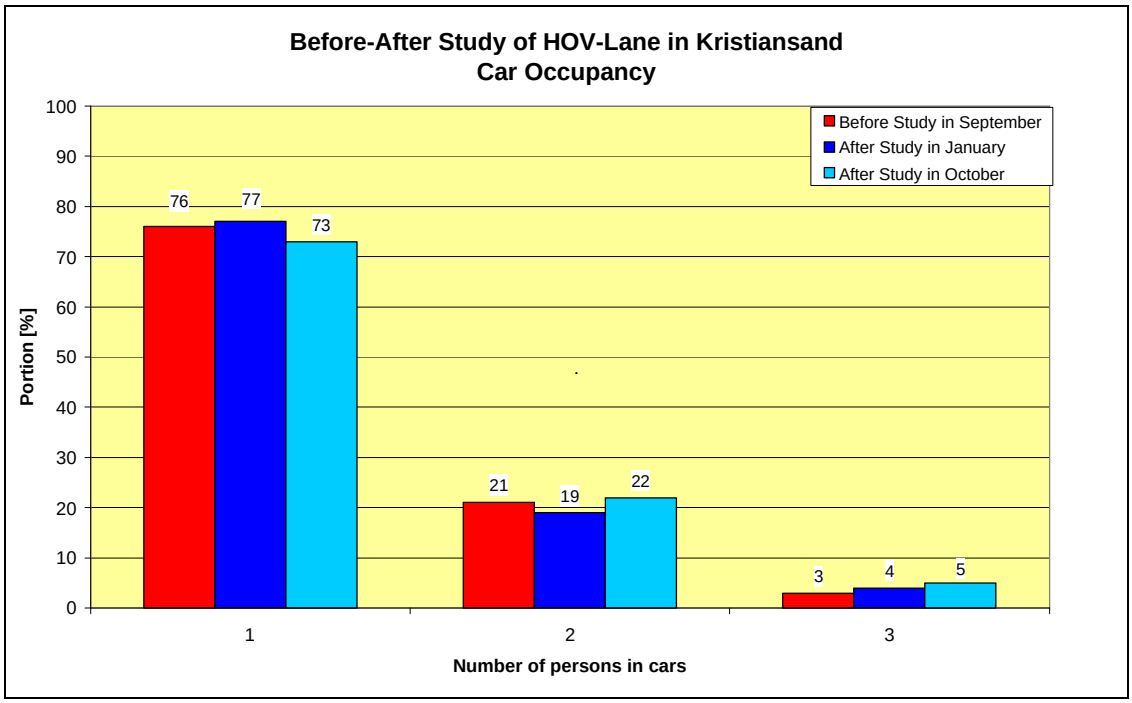

Figure 8: Number of persons per car in Kristiansand.

6.2 Traffic Volume

There was a little decrease in the total traffic volume in the morning peak in the first after study. I the second after study the traffic volume had increased again. The variations were ±5-15%.

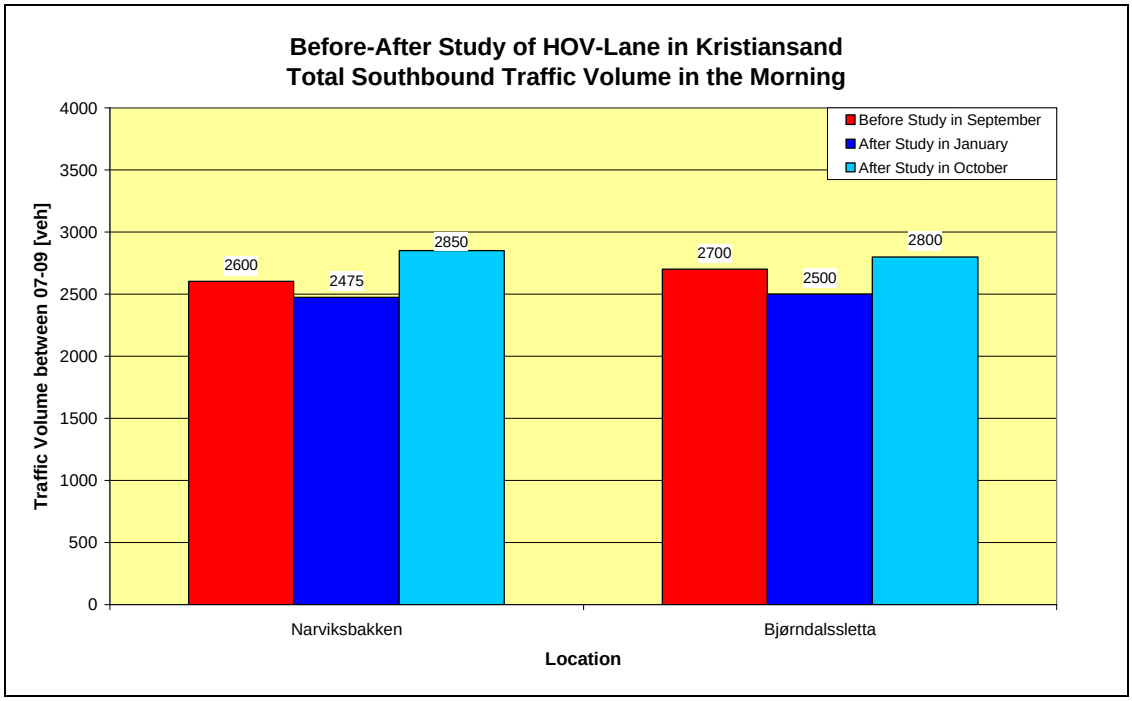

Figure 9: Total traffic volume between 7am and 9am in two different locations on E18 in Kristiansand.

6.3 Travel Times

The travel times from the before and after study are not comparable due to several other traffic management solutions in the area. (The travel time is reduced by approximately 50% in the morning peak and 70% in the afternoon peak, but not only due to the HOV-lane).

6.4 Violators

The number of violators (i.e. number of vehicles with only 1 person) in the HOV-lane is high. The respect for the HOV-lane has also decreased over the time, even though the symbol 2+ has been painted on the road surface. The best way to improve the situation is if the police make HOV-violators a high-priority task.

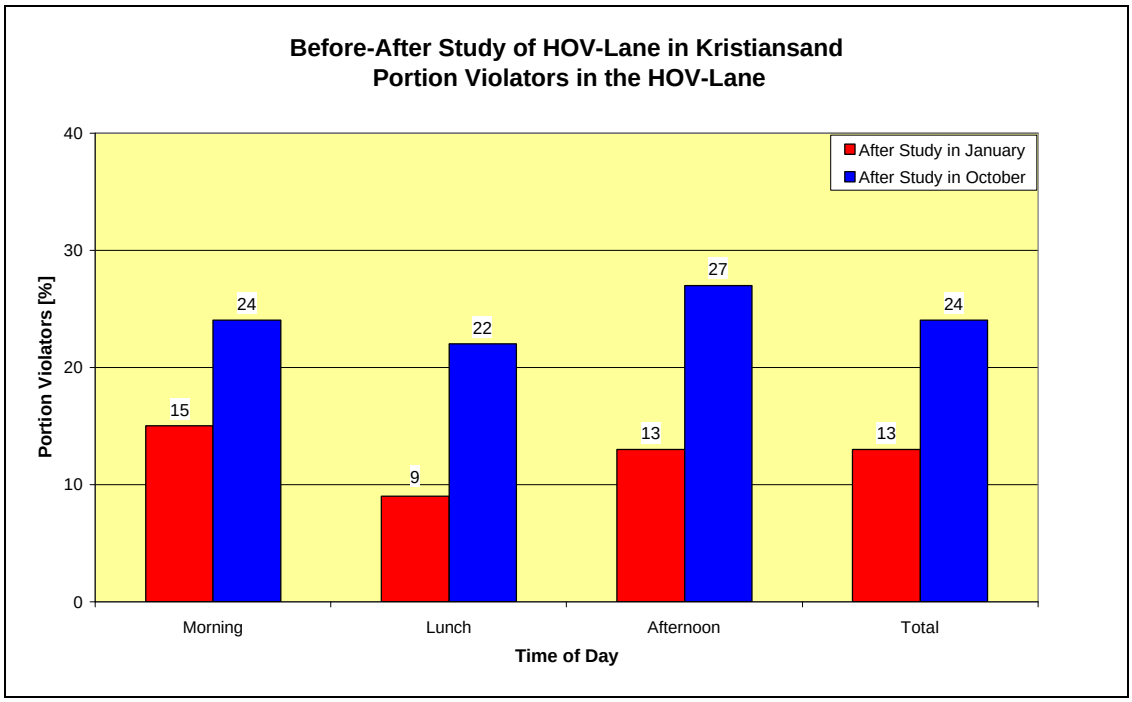

Figure 10 : Portion of violators in the HOV-lane in Kristiansand.

7 CONCLUDING REMARKS

Our experience with the use of CORSIM for evaluation of HOV lanes is that the model produces accurate results. Results from the field trial are similar to the simulation results.

Our experience is that HOV-lanes gives:

- Improved travel time for buses.
- Increased car occupancy.
- No significant changes in traffic volume on the nearby streets.
- No changes in accident level.
- Not too much decrease in travel time in the ordinary lane.

Conclusions are therefore that HOV lanes can give the wanted priority for public transport, without causing too much negative impact on the total traffic flow situation.

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