

Evaluation summary of “Effect of variable message signs on the Motorring 3”

Summary of a Danish evaluation report issued in September 2015

Background and objective

On the Danish Motorring 3 (M3) between Jægersborg and the Holbæk Motorway near Copenhagen a Motorway Control System is installed. It was originally established in relation to major construction works when widening the motorway from 4 to 6 lanes (2005-2011) in order to improve traffic conditions during the period with construction works. After the construction works ended, most of the system was kept for permanent traffic management on 15 km of the M3. The AADT on the motorway varies from 94,000 to 114,000 in 2015.



In 2015 the Danish Ministry of Transport initiated an evaluation project with the purpose to conduct an evaluation with trustworthy, reliable and easy-to-communicate results on the effect of the variable message signs on the M3.

The ITS system on the M3 had not previously been evaluated as comparable before and after situations did not exist. In order to find the effects of the variable message signs (VMS) on traffic flows and speeds, it was decided to shut down all variable signs for a time period in 2015 and an evaluation was conducted by comparing the traffic conditions with and without the VMS in operation.

The period from February through May 2014 with VMS in operation has been compared with the same period in 2015 without VMS in operation. The chosen evaluation set-up has been used in order to remove as many uncertainties as possible when comparing the time periods.

Figure 1. M3 around Copenhagen.
The ITS system is shown with a red line.

Description of the ITS on the M3

The M3 system comprises:

- Variable speed limit signs (mandatory) – set automatically, but may be set manually also
- Variable message signs with text information – e.g. automatic queue warnings or travel times. The Traffic control centre also displays text information on incidents and events by manually setting the signs
- Information signs with a variable text placed at strategic locations (near motorway entries) displaying travel times to specific destinations further down the M3 motorway
- Central IT system
- Data collection systems and communication
- Surveillance cameras

The M3 system and the entire motorway stretch are monitored by the Traffic control centre 24/7.



Figure 2 Variable speed signs and variable message signs with text information showing travel times (or other information)

Evaluation – timing, type, methods and data

The evaluation is an ex-post evaluation comparing data from two time periods:

February-May 2014 with VMS in operation versus February-May 2015 without VMS in operation.

The evaluation comprises a 13 km section between “Lyngby Omfartsvej” to the north and “Roskildevej” to the south.

Methods include traffic data and system data analyses, accident statistics analyses, video recordings and user surveys.

Evaluation data:

- Traffic volumes per cross section and exit/entry slip roads
- Vehicle speeds per cross section
- Travel times on segments
- Accident statistics
- Incident log (by the Traffic control centre) with incidents reported or detected, and the traffic management actions taken
- VMS log with all information shown at any time during the evaluation period
- Video recordings from the surveillance cameras on the M3
- List of errors/detector failures

- User survey responses

Results

Taking into account all the analyses performed the **overall key result** is that the variable message signs have a positive effect on the traffic flow on the M3. Especially on the travel times which in average are shorter with the VMS in operation. The evaluation also shows that the capacity during peak hours is higher with the VMS in operation, specifically in the maximum 15-minute peak. In addition, the road users are in general satisfied with the service that the VMS information provides.

Before the evaluation was done a number of evaluation questions to be answered in the evaluation were formulated. In the following the results per question are summarised.

Is the motorway utilization better with VMS in operation?

The motorway is better utilized with VMS in operation. The analyses of traffic in the maximum 15-minute peak on the most congested segments of M3 show that traffic throughput has increased 1.4 - 1.9 %. Hence, the capacity is higher with VMS in operation which means that peak hours begin a little later when VMS are in operation.

In the two hours morning and afternoon peak periods the traffic volumes on the M3 are about the same in 2014 and 2015. An exception is the northbound direction during the morning peak in which the traffic volume has increased by 2.3 % in 2015 (without VMS in operation). The reason for this increase is assessed to be a general increase in traffic volumes.

Do the VMS reduce travel times?

On the entire 13 km evaluation stretch the travel time is 0.5 to 1.5 minute faster with VMS in operation. In average, during normal traffic conditions, the travel time during peak hour is 10-14 minutes without VMS in operation. The change in travel time is largest in the southbound direction during the afternoon peak and in the northbound direction during the morning peak.

As mentioned above, the traffic volume has increased by 2.3 % in northbound direction during morning peak and the observed change in travel time may partly be due to more congestion. The traffic volumes in southbound direction (both morning and afternoon peak) and as well northbound during the afternoon peak are unchanged, thus the general increase in traffic volume is assessed not to have an impact on the changes in travel time.

An analysis of the duration and extension of queues shows that there is less queueing with VMS in operation. When the VMS are not in operation, the speed is below 40 km/h approximately 10 % of the time during peak hours. With VMS in operation, the speed is below 40 km/h only 6 % of the time during peak hours. The time period with free flowing traffic (speeds above 80 km/h) is longer with VMS in operation, 78 % versus 68 %.

Do the VMS improve traffic safety?

From the analyses performed it cannot be concluded whether traffic safety has changed. The primary reason is that the time period without VMS in operation has been too short for assessing significant changes in the accident rate.

On the M3 relatively few accidents are registered by the police. Experiences show that in accident analyses a 5-year before and after period is needed. However, the VMS system has only been shut

down for less than half a year, so the data set is not comprehensive enough to draw conclusions on traffic safety.

Accidents with limited material damage, e.g. rear end collisions, are not registered systematically by the police. Therefore, it has not been possible to draw conclusions in relation to this type of accidents either.

The speed towards a recurrent bottleneck has been tested as an indicator of the accident risk. It is assumed that when road users are not warned about a queue ahead of them, they drive faster towards the rear end of the queue. It means that the higher the speed towards the rear end of the queue is, the higher the accident risk will be. The analysis has led to ambiguous results and therefore no conclusion can be drawn from it.

How are the VMS used?

An evaluation of messages displayed on the VMS has been performed to compare the actual VMS messages shown in 2014 with the messages that would have been shown in 2015, if the VMS had been in operation. Even though the VMS were shut down in 2015, the underlying system has been collecting speeds and volumes, and processing output for the control of the VMS.

The analysis shows that speeds corresponding to queue would have been displayed for a longer time when VMS were not in operation. Speeds corresponding to free flow conditions were shown during longer time periods with VMS in operation.

Also, the variable message signs with text information would have displayed "queue" for a longer time during the period without VMS in operation.

Note that the VMS have been used manually, also during the period "without VMS in operation", in case of urgent needs in relation to emergency vehicles and incidents etc. VMS warnings on emergencies are used to help 10-15 emergency vehicles per month driving through the M3.

What are the attitudes of the road users towards the VMS?

The overall picture is that the respondents in general are positive towards the VMS.

As part of the evaluation a road user survey has been conducted. The road users on the M3 have been asked about various questions in relation to the VMS. 5000 questionnaires were handed out and 1298 were returned which is a response rate of 26 %.

70 % of the respondents find that the level of traffic information without VMS in operation is too poor. 56 % find that their overall experience of driving on the M3 without VMS in operation is bad, but 11 % find that their overall experience is better without VMS in operation. 45 % find that it is more unsafe to drive on the M3 without VMS in operation.

88-94 % of the respondents think that actual information on queues and incidents is important or very important. 67 % think that travel time information is important or very important and 63 % that variable speed limits are important or very important.

Transferability

Local traffic conditions and other local characteristics as well as traffic culture are factors influencing the results. The detailed results are not transferable to other sites, since they depend to a large extent on the local factors, however the overall results in relation to this kind of motorway control system with variable speed limits and VMS with warnings, travel times and other information are assessed to be transferable, i.e. the variable message signs have a positive effect on the traffic flow and user acceptance is relatively high with this type of system on a busy urban motorway.

References and further information

“Effekt af de variable tavler på Motorring 3. Evalueringsrapport”, Rambøll, Sept. 2015 (Main report in Danish) http://vejdirektoratet.dk/DA/viden_og_data/temaer/its/Sider/ITS_og_samfundsøkonomi.aspx

“Bilagsrapport. Effekt af de variable tavler på Motorring 3”, Rambøll, Sept. 2015 (Appendix in Danish). Same link as above.

Contact information: Please refer to the front page of this document.