USE OF ITS DURING MAJOR ROAD WORKS

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ABSTRACT
Intelligent Transport Systems (ITS) are becoming still more popular with The Danish Road Directorate when it comes to traffic management during major construction works on Danish motorways.
At the moment, major ITS applications have been established on the M3 and M10 Motorways in the Greater Copenhagen area as these motorways are widened from 4 to 6 and 8 to 10 lanes respectively.
Following the implementation of the various ITS applications, evaluation studies have been carried out for the M3. The purpose of the studies has been to estimate the impacts of ITS in general as regards to the overall success criteria of the project, and the impacts of the variable message signs regarding speeds, capacity and choice of route. The evaluation studies have also included questionnaires asking motorists of their opinion and perception of the various applications. The evaluation studies for the M10 are on-going but are to be completed during fall 2007. Hence the results presented in this paper only refers to the M3.

KEYWORDS

BACKGROUND
Intelligent Transport Systems (ITS) are becoming still more popular with The Danish Road Directorate when it comes to traffic management during major construction works on Danish motorways.
At the moment, major ITS applications have been established on the M3 and M10 Motorways in the Greater Copenhagen area as these motorways are widened from 4 to 6 and 8 to 10 lanes respectively. Both of the motorways are heavily loaded. The various applications were implemented in order to improve traffic conditions while the construction works are carried out.
STUDIES ON THE M3 AND M10
Following the implementation of the various ITS applications, evaluation studies have been carried out for the M3. The purpose of the studies has been to estimate the impacts of ITS in general as regards to the overall success criteria of the project, and the impacts of the variable message signs regarding speeds, capacity and choice of route. The evaluation studies have also included questionnaires asking motorists of their opinion and perception of the various applications. The evaluation studies for the M10 are on-going but are to be completed during fall 2007. Hence the results presented in this paper only refers to the M3.

THE STRATEGY FOR TRAFFIC MANAGEMENT – AND THE MEASURES
Overall speaking the following strategy for traffic management has been applied:
• To avoid incidents and accidents as far as possible
• To keep traffic as fluent as possible
• To control and warn when queues are forming anyway
• To clear the road as fast as possible after incidents
• To maintain the largest possible proportion of traffic on the M3 in the construction period

The measures taken in order to fulfil the strategy are to:
→ Ensure a current overview of the traffic status (provide the necessary data collection)
→ Use of ITS
→ Upgrade the traffic information centre into a traffic management centre
→ Tighten up the emergency handling procedures

USE OF ITS
The Intelligent transport systems & services consist of:
• Variable information signs on and before the M3
• Variable speed signs on M3
• Fixed information signs with a variable text part
• Visual monitoring (cameras)
• Monitoring: Data collection system (replaces the existing “TRIM” data collection system)
- Emergency roadside telephones
- Travel time measurement system on an alternative route (the Ring 3)
- Central IT system
- Automatic telephone service
- New information services on the internet

Additionally, the basic framework making the various traffic management systems function is established, for instance data communication, power supply, sign supports, T.I.C. operation, technical operation etc.

Figure 2: Information on approaching motorways leading to the M3

**IMPACTS ON TRAFFIC SAFETY**

The number of accidents that have happened after the first year of operation (with road construction) have been added up and compared with the number of accidents the previous year (before road construction).

<table>
<thead>
<tr>
<th>Period</th>
<th>Number of injuries</th>
<th>Number of materiel damages</th>
</tr>
</thead>
<tbody>
<tr>
<td>One year before road construction</td>
<td>11</td>
<td>29</td>
</tr>
<tr>
<td>First year with road construction</td>
<td>9</td>
<td>31</td>
</tr>
</tbody>
</table>

Figure 3: Development in number of injuries and material damages

The number of injuries and the number of materiel damages have not changed dramatically. The experience of the Danish Road Directorate is that the number injuries and material damages normally doubles to what it was before at big road construction works. In the case of Motorring 3 there have been no major changes. However one must be aware that the results are not statistically reliable as it requires a longer measuring period. However, the results after one year give an indication of the development.

The number of incidents was added up after half a year of operation. It turned out that the number of incidents on an average was 2 per day which is less than before the road construction started.
IMPACTS OF VARIABLE SPEED SIGNS

The following issues have been addressed:
Does the traffic management system affect driving speeds?
Does the traffic management system lead to increased traffic flows?
Does the traffic management system lead to changes in gaps between vehicles?
Does travel time information provided via VMS’s affect motorists’ choice of route?

The evaluation study focuses on a part of the M3 which is not affected by the construction works in the timeframe of the analyses. The M3-section in focus is located between Roskildevej in the south and Herlev Hovedgade in the north. On this part of the M3 there are two portals equipped with variable message signs: One in the northbound driving direction (observation point PN12) and one in the southbound driving direction (observation point PS14). Part of the evaluation also included a portal (observation point LP6) on the adjacent Holbæk Motorway.

Driving speeds
Investigations regarding travelling speeds have shown that the variable message signs have led to a slight decrease in travelling speeds, the magnitude of which depends on what is shown on the variable message signs (both speed limits and others) and the traffic conditions at hand.
It has also been shown that a greater part of the motorists refuse to comply with the speed limits when using variable speed limits than when using fixed speed limits. In total, 78% respected the fixed speed limit of 110 km/h (prior to construction), while only 67 % respected the variable speed limits (during construction).
Another factor (assumedly) affecting speeds on the M3 is the introduction of heavier speeding sanctions as of September 1st 2005.

Traffic flows
Prior to implementation, the traffic management system was expected to lead to increases in traffic flows. Such increases have not been identified. Instead a decrease in traffic flows has been detected. Decreases vary between 3 and 8%. These results are compared to the reference scenario with road construction works, but without traffic management systems. The decreases are most likely due to the construction works taking place on the adjacent parts of the motorway, creating a bottleneck which was not previously there.

Gaps between vehicles
The traffic management system in general causes the drivers to drive more closely to each other at speeds between 80 km/h and 100 km/h. Outside of this speed interval the time gaps have generally increased. The decreased gap between vehicles seems not to have affected the traffic safety in general.

Travel time and route choice
It has been analysed whether travel times displayed at observation point LP6 have caused motorists to change route as a consequence of the travel times displayed.
At LP6, travel times to the two closest exits on M3 are displayed. Motorists passing LP6 have the option of going via the M3 or alternatively go via the parallel road of Avedøre Havnevej. The question is, whether displayed travel times regarding the M3 cause more motorists to go via Avedøre Havnevej when the displayed travel times are higher than normal.
The analysis was inconclusive. The share of vehicles driving via the M3 apparently drops when then displayed travel times increase, but it is unclear whether this is due to the displayed travel times alone.
QUESTIONNAIRE SURVEY REGARDING TRAFFIC MANAGEMENT APPLICATIONS

In 2005 the Road Directorate carried out a post card survey with a focus on motorists' perception of the various traffic management applications implemented on the Motorring 3. Most of the questions in the post card survey dealt with motorists' perception of variable message signs (VMS') and signals implemented on the motorway. Types of VMS' and signals included in the survey were signs showing variable speed limits, queue and travel time information as well as signals used for lane management.

The survey was carried out as a post card survey: questionnaires were printed on post cards after which the post cards were handed out to motorists at five ramps leading to/from the motorway. Motorists were then to fill out the questionnaire at the end of their trip and return it by mail.

A total of 7,635 post cards were distributed. Once the final date of participation was exceeded the answers were collected for analysis. The main results of the various analyses are described below.

Out of the 7,635 post cards that were distributed 2,059 were returned. Hence the response rate was 27% (the expected response rate was 25%).

Uncertainties of the obtained results are within a few (less than five) percentage points. The results do not include motorists driving all the way through Motorring 3 without using entry or exit ramps, the result being that only traffic with origin and/or destination in the local area was included in the survey.

Motorists' understanding of VMS'

Most of the respondents understand the VMS' and signals as intended. Signs showing variable speed limits are correctly understood by 82% of the respondents. When it comes to lane closures combined with variable speed limits, 96% of the respondents understand the VMS' and signals as intended. However 42% do not understand at which point the lane closure takes effect.

Information regarding queues is perceived as intended by 88% of the respondents. In case queue information is supplemented by information regarding the distance to the rear end of the queue ahead, 61% understands the information as intended whereas the rest of the respondents do not.

Figure 3: Variable information sign informing about a queue 1800 m ahead as a supplement to variable speed signs.
Motorists' attitude towards VMS' and signals
The survey has shown that the motorists generally appreciate the VMS'. 84% of the respondents have a generally positive attitude towards the variable speed limits. 58% thinks that the variable speed limits have a positive effect on traffic flow whereas 12% think the variable speed limits have a negative effect. When it comes to traffic safety, the corresponding figures are 33 and 3% respectively. The rest of the respondents do not think that the variable speed limits affect traffic flow and safety. When it comes to queue information 86% of the respondents have a positive attitude towards the VMS' and only 5% have a negative attitude towards the VMS'.

Use of traffic information services
The survey included one question regarding motorists' use of traffic information services besides the VMS'. The services were promoted using billboards along the motorway. Services include a website and an automated telephone service. However, only very few of the respondents use the services: 9% use the website, 2% use the telephone service and 2% use both services.

TRAFFIC MANAGEMENT AT SMALL AND MEDIUM SIZED ROAD WORKS
At small and medium sized construction works, the drivers at times pass construction works, where nobody is working, even though warning signs have been put up. The discrepancies between the signposting and the actual conditions have a negative effect on the traffic flow and on the individual driver. This discrepancy can in fact reduce the respect for sign posting. It can reduce traffic safety and result in a reduced safety for the roadmen. At the same time this discrepancy in signposting will reduce the traffic flow due to a reduction in speed and changes of lanes. It is very important for the Danish Road Directorate to reduce potential dangers for the roadworkers, in other words to increase the safety of the roadworkers; this can be the case if roadworkers are crossing the highway when establishing, changing and taking down the signposting. From this point of view the DRD has found it important to examine the recent electronic traffic management system based on variable flap signs.

The following issues have been examined:
- The flap signs’ technical construction
- The equipment’s technical functionality
- The remote control of the flap signs
- Practical conditions regarding the setting up and removal of such signs

The investigation and evaluation of the system was based on tests and observations.
The concept has proven to have large advantages with regard to:

- The effective hours for road works where road blockings are in force, is being reduced.
- Time is saved daily due to the fact that installations can be controlled by means of remote control and also the signs can be closed, when no work is being carried out.
- The signing is expected to become realistic, because the sign easily can be changed depending on the actual working situation on site. By this, the traffic flow will be improved.
- As a consequence of the above, it is expected that the road users will show more respect for the marking, when it is correct. It is expected to increase the safety for the road workers and the road safety in general.
- The use and service of the flap signs are expected to be safer for the workers. This is due to the fact that crossing of the roads no longer will be necessary to adjust traditional signs.
- The flap signs can be set up in periods with little traffic and will be activated when the construction works begin. It becomes important for the road workers’ safety, traffic flow and the work organization.
- In case of accident or changes in the plan of the construction works, it is possible to change the sign posting immediately, taking into consideration the limitations of two images per sign.
- The use of flap signs opens the possibility for the Danish Road Directorate to issue a general work permission on a stretch of road without time restrictions, but with instruction to stop the roadwork immediately in case of increasing traffic flow.