

Dynamic Traffic Management Systems on A4 Motorways

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ABSTRACT

The A4 Motorway is the key transport connection in southern Poland and carries domestic and international traffic in the east-west direction. In 2008 a traffic management system based on variable message signs (VMS) was designed for the General Directorate of National Roads and Motorways. The system covers a section of 165 km of the A4 Motorway between the interchanges Bielany (Lower Silesia) and Sośnica (Silesia).

The main purpose of the system is to ensure seamless traffic flows and road safety. Thanks to the application of VMS and a dynamic transfer of data and information the functions of the system include traffic control, speed management, alternative route guidance, traffic information and weather warnings. The design stage of the system included the mapping of data sources, grouping of potential traffic incidents, development of message signs, setting out of actuation procedures and sequences of message display as well as outlining of communications procedures and decision making process by the administrator of the system. A lot of attention was given to factors providing for reliability of the system and credibility of messages.

KEYWORDS: traffic management system, variable message signs, traffic control, speed management, road safety

The currently used Intelligent Transport Systems (ITS) serve several functions: from warnings about potential accidents to advanced traffic management and control, using such means as changeable message signs (VMS). Long-lasting studies in American and Canadian agglomerations have shown that using such systems may decrease the infrastructural costs by as much as 20-35% and yield the same system effectiveness [1] [2]. This has also been proven by European studies [3]. These systems can be used in urban streets as well as in expressways and motorways.

The General Directorate for National Roads and Highways has launched a traffic management system in a 165-km section of the A4 motorway (Wrocław-Gliwice), i.e. from the "Bielany" node (dolnośląskie voivodeship) to the "Sośnica" node (śląskie voivodeship), fig. 1. The A4 motorway connects the border crossings at Jędrzychowice (Polish-German border) and Korczowa

(Polish-Ukrainian border), and is a vital route for east- and westbound international traffic.

The nodes along the section of the A4 motorway in question now include such traffic management elements as speed-measuring stations with changeable message signs for visualising traffic parameters, as well as changeable message signs showing weather conditions. Additionally, meteorological stations and cameras were installed along the whole section included in the traffic management system. The data gathered by the system are then used for effective traffic management.

The system includes, among others:

- changeable message signs visualising traffic parameters - a total of 24 gates in both directions with VMSs, located at intersections,
- changeable message signs visualising weather parameters - a total of 23 gates in both directions with VMSs, located at intersections,



- meteorological stations – 11 stations:
- forecasting (installed in places with stable surface temperatures and used for forecasting weather and surface conditions),
- supporting (located near changeable message signs, used to support weather visualisation),
- non-forecasting (installed in places, where changing weather conditions influence traffic safety, not used for forecasting),

- traffic measurement stations – used to measure and register traffic parameters in real time, they detect and categorise traffic structure by vehicle type, classification according to EUR-6 [6],
- cameras at intersections,

The meteorological stations allow for measuring the following parameters of both the surface and its surroundings:

- air temperature and relative humidity,
- wind speed and direction,
- classification and intensity precipitation,
- surface and substrate temperature at 6 and 30 cm,
- surface conditions,
- amounts and concentrations of defrosting agents on the surface,
- visibility.

The road measurement stations measure and register all the parameters in real time. The parameters can be recorded in the “vehicle-by-vehicle” mode (for every vehicle), or in an aggregated form (e.g. every 5 minutes). Traffic measurement stations allow for measuring the following parameters:

- vehicle speed,
- vehicle length,

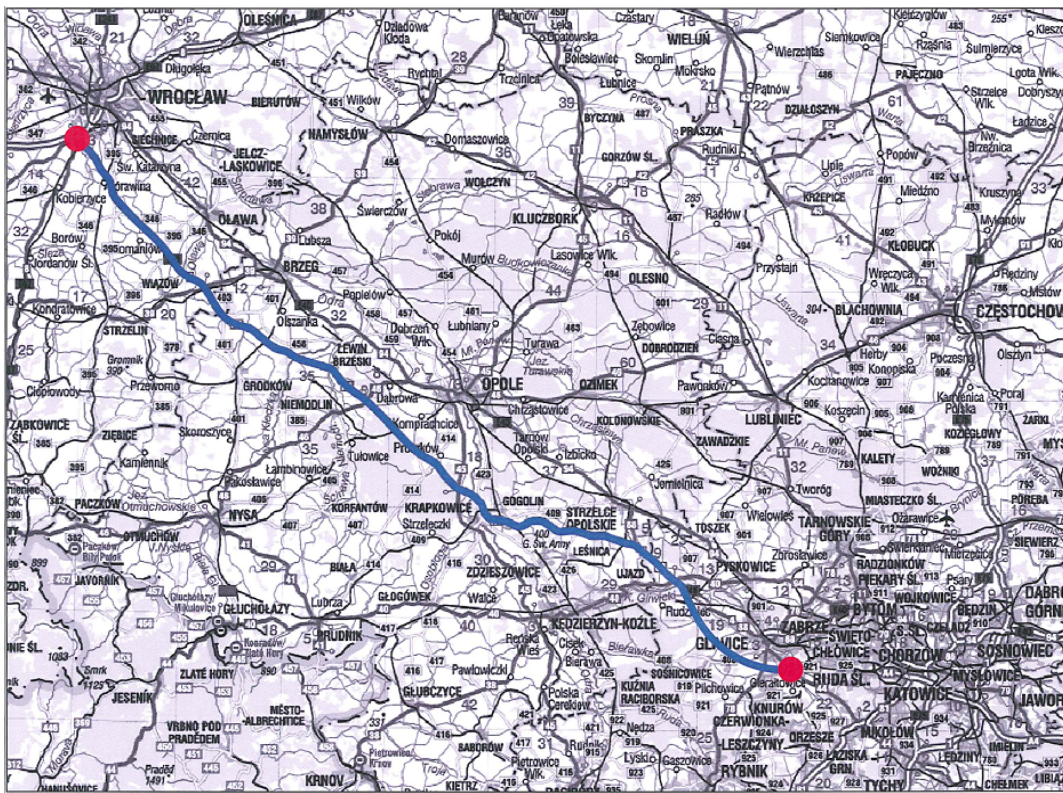


Fig. 1. The location of the A4 section included in the traffic management system

Source: [own work]



- traffic category (free, restricted),
- vehicle category,
- time and date of passing the detector,
- the lane, in which the vehicle is travelling,
- time from the previous vehicle,
- distance from previous vehicle.

In the process of preparing the traffic management project, available materials as well as data provided by the devices in the system and current knowledge were used to define the main purposes for the system, groups of events and detailed procedures. Additionally, authorisations for traffic control were given to individual centres and the system for notification and decision-making was set up to control the contents of VMSs owned by the system administration.

The traffic management system may serve several different functions. Depending on the amount of changeable message signs and detectors (traffic and weather sensors), different forms of management may be employed. If the changeable message signs are located at larger intervals, the system will serve an informative and warning function. **With relatively small distances (of approx. 2 km) between signs** along the whole section (or in places where the signs are denser due to frequent traffic jams, adverse weather conditions or other circumstances), the system can be more effective at managing vehicle speed, gradually enforcing speed limits (which directly influences the speed at the end of the line) or managing individual lanes (by closing or opening them at certain places). The main tasks, that may be fulfilled by the ITS using changeable message signs at the A4 motorway, are:

- speed control and management achieved by levelling the speed in the traffic flow, limiting the speed (in the form of road signs or recommended driving speed), lowering the speed at the end of the queues (by warning about possible jams), lowering the speed limit due to low traffic flow or bad weather conditions,

- traffic in individual lanes may be controlled and managed by closing a lane or the whole road in incidental events (accidents, collisions) and during roadworks as well as by forcing the lorries to use the right lane only,
- traffic may be redirected to alternative routes by informing the drivers through changeable message signs about detours, traffic events (accidents, collisions), traffic overloads or other obstacles in a given section (very bad weather conditions, special vehicles),
- informing about current traffic conditions by displaying the distance and time left to main intersections, warning about exceeded speed limits, travelling too close to the previous vehicle or possible hold-ups,
- warning about weather conditions that may influence road safety by limiting the visibility (fog, intensive rainfall), lowering tyre grip (wet surface, snow or ice) or causing problems with driving straight (strong side wind).

In order for traffic control and management through changeable message signs to be as effective as expected, a lot of attention should be paid to the message being broadcast to the user, i.e. the driver, who experiences the road events directly. Therefore, the messages informing them about what happened, where it happened and how they should behave should be noticeable, readable and comprehensible. One of the factors used in creating the sequence of messages displayed on these signs was the driver's perceptual capabilities. Due to the lack of Polish studies in this field, American studies were used among others [7].

The messages appearing on variable message signs should be brief and simple, while conveying the most information. **Making the message too brief may cause misinformation.** The message should not be too long either, as it may be ignored by the driver (no time to read it). Unlike the more highly developed countries, Polish literature and studies lack the principles and examples concerning the changeable message signs and the messages, that can be displayed on them.

The data provided by the devices in the ITS system along the A4 motorway are used to improve the safety of all motorists. The problem in Poland lies in the lack of such ITS elements, i.e. changeable message signs. The studies conducted along the section of A4 motorway [4] have proven that the changeable message signs impact only a small fraction of motorists. Thus, driver education should follow the introduction of warning and informative ITS devices. **VMSs can also display speed limits or other prohibitory signs, that are equal in power to fixed signs,** according to the act of June 20, 1997 - Traffic code (unified text in Journal of Laws no. 58 of 2003, as amended). **Obviously, the changeable message signs do not replace fixed signs or temporary signs, so all of these elements should**

be interconnected. **The traffic management system** prepared by EKKOM for the 165-km section of the motorway, which utilises, among others, the changeable message signs, is the first such solution in Poland.

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