The Role and Significance of Variable Message Signs in Traffic Management Systems

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Abstract. The article depicts the role of Variable Message Signs in traffic management systems. VMSs play a big role in improving the traffic safety, as they are an important source of information for the driver, thanks to their clarity and legibility. The fulfilment of formal and legal requirements regarding the VMS is an important aspect of their implementation. The article describes the principles of choosing and designing signs in regard to the traffic management projects, concepts and rules. The authors provided and compared examples of using those signs in Poland and in Austria.

Keywords: Variable Message Signs, Traffic Management Systems.

1 Introduction

Intelligent Transport Systems (ITS) are treated as advanced applications designed to ensure innovative solutions in the traffic management. Their other role is to inform the users about the current situation, thereby improving the situation on the road. The ITS connects many issues from the fields such as telecommunication, electronics, IT, transport engineering, in order to plan, design and manage transport systems.

Variable message signs are an important element of any traffic management system. Their goal is to warn travellers about the traffic events such as: traffic jams, accidents, road works, and to inform about the speed limit for the given section. The newest Polish document regarding the norms for Variable Message Signs is the work entitled "Technical Regulations of Variable Message Signs – 2011". This document contains the information regarding the rules of locating and positioning signs, dimensions of the displayed texts, requirements regarding the housing, and support constructions, technical and user properties of the signs. Another document in power is the PN-EN 12966-1+A1:2013

standard, which precisely describes the operation regulations and their compatibility evaluation methods. There is another document which regulates the use of VMSs, so called Appendix 1, "Detailed technical conditions for vertical signs and conditions of their placement on the road" to the Regulation of the Minister of Infrastructure of 3 July 2003 in regard to detailed technical conditions for the signs and road signals and safety devices in traffic, as well as conditions needed to put them on the roads. This document contains information regarding the rules of locating and positioning signs, dimensions of the displayed texts, requirements regarding the housing, and support constructions, technical and user properties of the signs.

2 Traffic Management Systems in Poland

Poland is just at the beginning of the ITS implementation. Only a few Polish cities have built traffic management systems, i.e. Szczecin, Warszawa, Wrocław, Kraków. As for today, several cities are at the stage of settling the tenders for the ITS, or are implementing them. These are: Poznań, Bydgoszcz, Białystok, Kalisz, Lublin, Tri-City, Olsztyn, Rzeszów, Gliwice. Several other work on defining the parameters of the ITS infrastructure in a way that allows future integration of different systems (for example Katowice or Bielsko-Biała). The forecast for the next several years shows that many cities intend to invest in traffic management systems. The new EU budget for the 2014-2020 strongly supports it, as much of the funds are to be spent on innovative technologies that improve the traffic safety. Another important argument in regard to intelligent transport systems is the document entitled "The National Traffic Safety Improvement Programme 2013-2020", created by the National Traffic Safety Board (The Ministry of Transport, Construction and Maritime Economy). According to this document, the reason of threats for traffic participants is a too low level of intelligent transport systems implementation as a part of the traffic management (e.g. variable message signs, traffic control systems, information systems). The necessity of implementing intelligent transport systems in order to improve the users safety is one of conclusions.

The information given above clearly shows that Poland faces the necessity of developing the ITS, which means that we have a huge chance to lower the social costs, to improve safety, environmental protection and to obtain many other benefits that come from implementing such programmes. Still, one should pay attention when designing such projects, so they can be effective, as the ITS have an individual character. When creating an Intelligent Transport System three stages are necessary – planning, designing, and implementation, from which the first and the most important stage is

planning. It consists mostly of such actions as the analysis of the use of existing road infrastructure, the identification of transport problems, conducting or updating traffic research, the analysis of possibility of expanding the existing road infrastructure. The last element of this stage should be the analysis of the existing economic benefits resulting from an ITS creation. Based on those data, one can start the process of designing a system and implementing it.

There is a document important in aiding investors (city, road administrators) when creating a technical specification for the ITS – the Directive of the European Parliament and of the Council 2010/40/EU of 7 July 2010 on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport. According to them the ITS should have the following parameters:

- efficiency,
- profitability,
- proportionality,
- supporting service continuity,
- ensuring interoperability,
- supporting backwards compatibility,
- promoting equal access,
- supporting maturity,
- ensuring the quality of describing time and place,
- facilitating the intermodality,
- respecting the coherence.

The ITS designed in such way should fulfil users expectations in 100%. Realization of such projects according to those tips will allow to standardize traffic management systems both in Poland and in the whole Europe. This can have an influence on the optimization of costs when integrating such systems into bigger agglomerations of several cities, or even nationwide.

3 Variable Message Signs in the Context of Traffic Safety Improvement

Poland is a country in which the network of state roads and highways is still insufficient for effective and safe travel. As of 11 November 2012 the total amount of built kilometres of the A and S class roads is about 2500, and 600 more is under construction. This means that the amount of kilometres given to use has quadrupled since 2003. According to the police statistics, the number of traffic accidents during the same time has dropped by 27.5%, the number of people killed in them has lowered by 35.7%, and the number of injured by 28.3%. Still, in comparison to other countries of the European

Union, Poland is third to last when it comes to the fatal accidents per million citizens, before Lithuania and Romania. The European Union started an action programme to increase the traffic safety for years 2011-2020, the goal is to reduce the number of fatalities by half. It contains propositions of increasing vehicle safety and the infrastructure. Poland designed its own programme, called "The National Traffic Safety Programme 2013-2020". Its structure is based on five pillars:

- safe behaviour of traffic participants,
- safe road infrastructure,
- safe speed,
- safe vehicles,
- rescue and medical assistance system.

The main part of fatalities in car accidents due to the drivers behaviour comprises: a failure to give right of way, a failure to keep a safe distance, a speed inappropriate to traffic conditions, an incorrect overtaking, and an inappropriate behaviour regarding the pedestrians. Actions aimed at equipping the already existing roads with variable message signs can greatly affect the road safety. Test results and the analysis of traffic management systems in Germany can be an example here. They were conducted by the Straßenforschung Straßenverkehrstechnik BMVBW and are presented in the following figure:

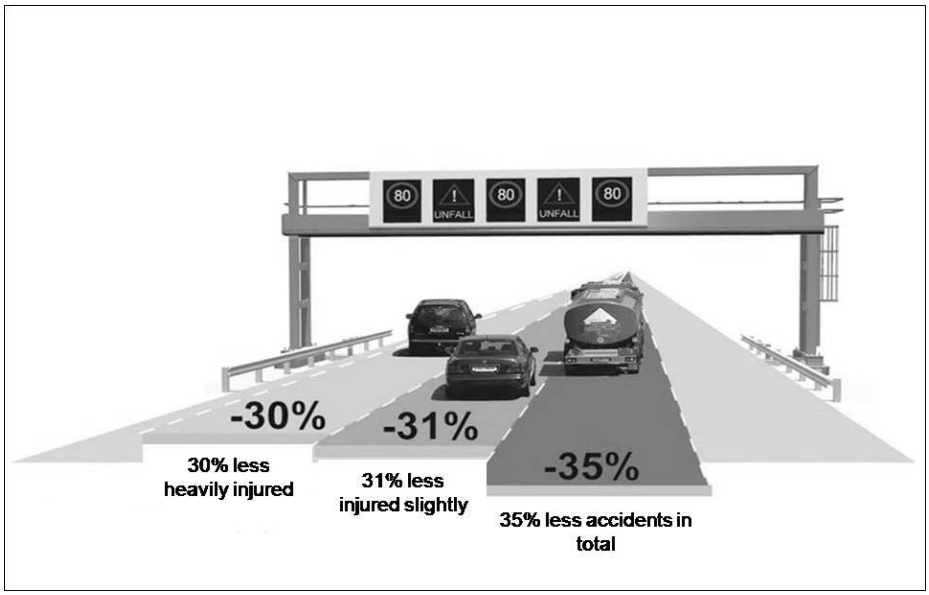

Fig. 1. The analysis of traffic management systems effect on the safety improvement in Germany

As the figure above shows, investments in variable message signs in Germany resulted in tangible benefits. The use of innovative solutions in the field of providing drivers with

dynamic information resulted in lowering the number of heavily injured by 30%, 31% less was injured slightly, and there was 35% less accidents in total.

However, the installing of as many variable message signs as possible is not a solution itself. One cannot do that and wait for improvement in the statistics. The key to the success is conducting an analysis of the current situation in a selected area, and choosing proper signs, as well as creating an intelligent control system.

The expressway S-7 Kalsk (Pasłęk) – Miłomłyn can be used as an example. Six variable message signs were installed as a safety improvement system. The section is 36.5 km long and comprises three exits, VMSs were installed before each of them. A document, "The Project of a Control System of the Information Displayed on Variable Message Signs" was created based on the detailed technical specification and the construction works. It contains information regarding kinds of symbols displayed for each lane. Such a solution allows to inform drivers about the traffic conditions, restrictions, dangers, and a possibility to manage a stream of cars on the lane covered by the system. An important condition for the proper system work consists in sending the information to drivers in a way described by the following scheme:

What happened? – Where? – What to do?

The basis to take action by the system operator consists of the threat identification (what happened?), after which the information is sent to the system regarding the threat. In the case of discussed traffic control system, it is carried out by the dispatcher, based on the information received from police patrols, medical units, search units, from the Rescue Information Centre, or other sources. Next, the event is localized (where?), this information is also given by the reporting services. The last step consists in defining the consequences evoked by the event, and its influence on drivers and their surroundings. The final effect is the message addressed to the users by strictly described messages, displayed on proper variable message signs.

4 Variable Message Signs in Traffic Management Systems – Regulations

The most important document that regulates the use of variable message signs in Poland is the European Standard PN-EN 12966-1+A1:2013 "Road Vertical Signs – Variable Message Traffic Signs – Part 1: Product Standard". This standard was developed by the European Committee for Standardization on 15 March 2005 with later amendments on 3 October 2009. According to the CEN's internal regulations, this standard is in force in the following countries: Austria, Belgium, Bulgaria, Cyprus, Denmark, Estonia, Finland,

France, Greece, Spain, Holland, Ireland, Island, Lithuania, Luxemburg, Latvia, Malta, Germany, Norway, Poland, Portugal, Czech Republic, Romania, Slovakia, Slovenia, Switzerland, Sweden, Hungary, Italy, and United Kingdom. It describes mainly the optical characteristics of variable message signs and their influence on the environment, which is relatively hostile. It is expected that VMSs, which task is to improve traffic safety, will function for 10 years. The standard presents parameters that must be tested on a testing module, and after that the manufacturer shall ensure that the final product, offered on the market, is fully consistent with the testing module. The optical characteristic contains information regarding the colour, luminance, beam width, uniformity, and the visible flickering.

An important elaboration that shows the road administrators the rules of using the variable message signs, is "The Technical Regulations of the Variable Message Signs – 2011". This document distinguishes three kinds of VMS:

- pictogram variable message signs,
- variable message text boards,
- variable message integrated boards.

Pictogram variable message signs are mainly signs from warning, mandatory, or prohibition groups. Those signs are made with a simplified background colour and symbols. They have black background, the symbols are white or yellow and the borders are usually red. In this this sign group an additional text line may be used to inform about the distance in kilometres to the event. For instance, the sign shows the A-33 symbol and 2 km underneath. Such configuration informs the driver that there is a traffic jam in 2 km. This gives the driver time to make a decision, whether to use an alternative route, if such exists. These signs can be created in two technologies: pre-defined, in which one can display an earlier defined number of symbols, and freely programmable, which allows displaying unrestricted number of signs.

Variable text boards are used to display text messages. They are made mainly in monochromatic free programmable technology. During the process of designing one must remember that big text boards will need the use of a larger supporting structure, which can ultimately lead to a lesser efficiency of the investment measured by the benefits to cost ratio. The text boards should contain no more than three lines, as such amount is justified by the eye perception of the driver. Moreover, reading a 3 line message takes about 2 seconds. Using an expressway at the speed of 130 km/h means that when reading the message just once, the driver covers the distance of 72 m with no control of the road and the surroundings.

Integrated variable message boards are a compilation of the two boards mentioned above. The key principle of designing such sign type is placing on the right side a field dedicated for the sign, and on the left a field used for displaying text messages.

Preparing investments that take into consideration the use of variable message signs requires the road administrator to have a great knowledge in this field. The main document that regulates such solutions is the aforementioned PN-EN 12966-1+A1:2013 standard, which shall be complied with in Poland. The use of this standard during the preparation of the technical specification, and the enforcement of it towards the contractors, results in improvement in the quality and functionality of the constructed traffic management systems.

5 Examples of Variable Message Signs in Austria

Asfinag is the company that takes care of planning, building, administrating and toll collecting for the highways in Austria. It was established in 1982 and is owned only by the Republic of Austria; the total amount of roads it administers is 2,175 km. Its main tasks are to optimize the traffic flow, to improve safety on roads and to increase the roads availability. Since 2005 traffic control systems were implemented in 13 different sections of the highways in Austria, on a distance of 750 km. In Vienna, there is a National Traffic Management Centre, which takes mainly care of:

- the central management of traffic control systems,
- traffic and network management,
- traffic data analysis,
- monitoring of the current road situation,
- improving the traffic management systems,
- development of the on-road safety increasing strategies.

Apart from the tasks mentioned above, the Asfinag continues developing technical standards and guidance for designs. The tender procedures regulate, among other things, the amount of used road signs, they point out different stages of planning and building the traffic control system in Austria. The main elements that need to be taken into consideration by the Employer when preparing a tender specification for the system containing variable message signs, are:

- variable message signs must be readable far enough by the drivers, so they can adjust the driving manner in proper time. The VMS should be visible from 250 meters,
- important content that informs, i.e. about the danger on the road, must by readable from at least 150 metres, and additional signs form 75 metres,

- sign supporting structures must maintain the vertical gauge of no less than 4.5 metre, whereas the maximum height of the gauge should not exceed 5.50 metre,
- if, for some reason it is needed for the height gauge to be bigger than 5.50 metre, one must remember about the proper angle of the light beam emission, so that the sign readability remains unchanged,
- the line control signs should be put directly above the lane.

The figure below represents an example of defining the amount and types of the signs on the section covered by the traffic management system.

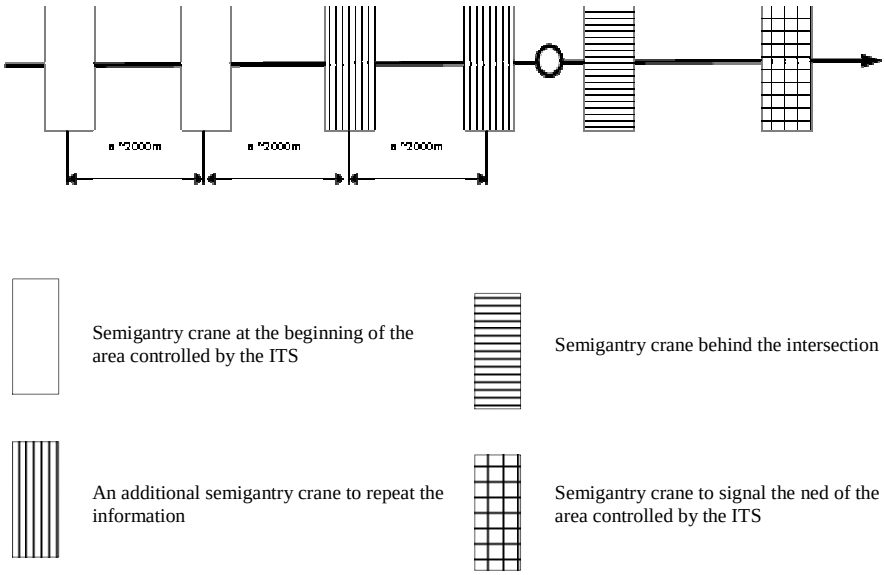

Fig. 2. Example of installation of variable message signs on the section of road covered by a traffic management system

Designing the location of variable message signs according to this scheme will give the driver a proper amount of information in proper time. The traffic participants are informed about the current situation on road, as well as about the best route on the section covered by this system. When entering, the driver is informed that he has entered an area controlled by an intelligent traffic management system. Then, after the suggested 2 km, he can read an information regarding the possible difficulties. After the next 2 km the information is repeated, so the driver can take proper actions (for example, exit on the next junction, reduce the speed, change the driving lane). The final message is that the toll section is over.

Such actions allow a systematic reduction of fatalities on Austrian roads. When analysing fatalities statistics in the years 2001-2011, the number of fatalities was reduced by 47%, while in Poland, in a similar period, the number was lowered by 28%. Such information shows the legitimacy of implementing a properly thought traffic management system.

6 Conclusions

Variable Message Signs have an important influence on the safety improvement on roads. The intelligent choice of proper devices that fulfil the dreams of the European Union will also help in increasing the transport efficiency. However, until in Poland will be available the existing regulating standards, location and choosing of proper signs, as long our ITS systems will be less effective than in other countries.

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