Proceedings of the 11th International Conference "Reliability and Statistics in Transportation and Communication" (RelStat'11), 19–22 October 2011, Riga, Latvia, p. 327-334. ISBN 978-9984-818-46-7
Transport and Telecommunication Institute, Lomonosova 1, LV-1019, Riga, Latvia

THE ESTIMATION ON TRAFFIC SAFETY PROBLEMS IN ROADS ON LITHUANIA USING ITS

Aldona Jarasuniene, Laima Miliauskaitė

Transport Research Institute, Vilnius Gediminas Technical University
Plytines 27, LT-10105, Vilnius-16, Lithuania
Ph.: +370 2745076. Fax: +370 2699711
E-mail: ajarasuniene@yahoo.com

Competence Centre of Intermodal Transport and Logitics
Vilnius Gediminas Technical University
Plytinės g. 27, LT-10105 Vilnius, Lithuania
E-mail: mlaima@vgtu.lt

The Intelligent Transport System (ITS) works with information and control technologies providing the core of ITS functions. ITS services can make transport safer and more secure. The purpose of ITS is to collect information about traffic flows and conditions on roads and to present the obtained data for control systems.

The main part of the system that collects information consists of digital video cameras, video image detectors, vehicle control and incident detectors, weather monitoring tools, electronic toll collection detectors, electronic fee collection detectors, variable message signs, special crosswalk detectors, special video signals processing and transmitting cards installed in proper road sections, crossroads and crosswalks.

In the article the estimation on traffic safety problems in roads of Lithuania using intelligent transport system is examined. The main problems are identified and the problems are solved by the ways defined.

Keywords: traffic safety, intelligent transport systems, information, transport

1. Introduction

In Lithuania road traffic at winter time is aggravated due to difficult weather conditions, while in summer the main obstacle is road works. These determinants as well as increasing number of transport determine the increase in road traffic intensity, environmental pollution; very often they also become the reason of traffic accidents.

One of the measures, reducing the impact of road traffic, is ITS development. ITS includes many activities, among which the monitoring of road traffic conditions and informing of traffic participants about those conditions can be included.

ITS activities are based on systems, the basis of which are comprised of a well-developed monitoring equipment network of weather and traffic conditions, information centres and various driver information (variable message signs, radio, etc.). Automatic stations with built-in sensors that collect information about various parameters of weather and traffic conditions are used in order to get information about road weather conditions. Information about traffic intensity in a particular road and various traffic problems is obtained from automatic calculators of traffic intensity as well as from video cameras. All information, received both from outdoor stations of weather conditions and automatic calculators of traffic intensity, is sent to traffic information centres by using relevant means of communication. Those centres summarize the information and then disseminate it to the users. Information about weather and traffic conditions in roads, suggestions for drivers, regarding the choice of the most optimum route are placed in special websites. This useful information is also disseminated through media and other modern technologies.

2. Formulation of Traffic Safety Problem

Currently, the activities of intelligent transport systems, their possible links with other transport systems in Lithuania fall under the competence of Lithuanian Road Administration under the Ministry of Transport and Communications. Opportunities and directions for further development of national road

traffic information system and integration into the network for common European intelligent transport system are also provided.

National road traffic information system is being created and it will be the basis for further development of intelligent transport systems in Lithuania. Currently, there are 21 320 km of national roads. They need to have the infrastructure of intelligent transport systems which will be comprised of automatic outdoor stations for the estimation of air conditions and traffic record, signs of variable information, video surveillance systems.

However, currently the mentioned systems do not function properly and further development of intelligent transport systems requires a detailed analysis of the network of national roads and the experience of Lithuanian Road Administration and Europe in the sphere of intelligent transport systems. In addition, optimum number of automatic stations must be chosen, opportunities for the use of other equipment must be considered. Accident rate and traffic intensity must be also considered because they determine the arrangement of equipment in national roads and the use of communication technologies.

Considering statistics related to traffic safety in Lithuania and Europe, it is possible to note that traffic safety is slowly improving in Lithuania; however, comparing it to other EU countries, it still remains a big problem. This requires a more intensive implementation of traffic safety systems in roads. One of the measures of intelligent transport systems that gave best results was the implementation of speed gauges, however, even new gauges do not function as intended and traffic offenders are not always identified. Speed gauges should be preventive measures, not punitive, however, if offenders remain unpunished, this information is quickly disseminated in public, thus speed gauges are considered as being idle and no longer performing their functions.

Traffic safety has not been sufficiently secured so far, and this is related to the following problems:

- Usually speed gauges are not always effective;
- Accident rate and its causes have not been studied thoroughly;
- Lithuanian roads do not use modern and effective ITS, such as signs of variable speed, average speed gauge;
- Every ITS operates uncoordinatedly, its interaction with other systems is also uncoordinated.

Traffic safety problems in Lithuanian roads could be solved by the coordination of several measures. Average speed gauges should be used and regularized so that they could function together with variable message signs and with the already operating weather observation system KOSIS.

The foreign and Lithuanian practice has revealed that usually speed gauges are not as effective as they should be since drivers slow down in a particular stretch of road where speed gauges are known to be and when they pass that stretch they usually exceed the speed. Average speed gauges would force drivers to drive without exceeding the speed in the entire stretch of road where the speed is measured. Lithuanian roads have only simple road signs that, regardless of the situation, mean the same restrictions, while foreign practice revealed that the use of variable message signs that present restrictions, corresponding to traffic conditions, significantly reduce the number of road accidents. The use of the information obtained from the system KOSIS allows an effective traffic management because variable message signs would inform drivers about weather and road cover temperature; repressive measures could also be used in order to make drivers slow down or warn of dangers.

The expert survey was carried out, the aim of which was to find out the opinion of experts, and working in various Lithuanian institutions related to the use of intelligent traffic systems, about ITS that is implemented or will be implemented in Lithuania. The people whose work was related to ITS implementation and scientific research were asked to be the respondents.

The survey revealed that the most common cause for traffic accidents is unsafe speed, thus in order to provide relevant suggestions for ITS usage and prove their benefit for traffic safety increase, Lithuanian road with the biggest car flow and maximum speed allowed was chosen. That road is highway Vilnius – Kaunas – Klaipėda. Statistical analysis of traffic accidents due to unsafe speed was carried out in this highway and relevant measures for this problem where suggested as well as the places of the suggested measures indicated (theses concrete places where marked in maps).

Repressive measures best discipline Lithuanian drivers, thus, on the basis of foreign experience, it is advisable to use not only simple speed gauges but also average speed gauges. In order to reach bigger benefit and considering traffic features, it is also advisable to tie in average speed gauges with variable message road signs and road observation system KOSIS that still has not been applied in Lithuania. Such coordinated ITS application is not found in other countries as well because all measures are usually used separately, aiming at different results. Definitely, the main goal still remains traffic safety but often variable message signs are used not only to limit the driving speed and inform about traffic conditions but also to direct drivers in case of traffic jams or road works.

Table1. Arrangement of speed gauges in highway Vilnius – Kaunas –Klaipėda

No.	Kilometre	Distance between speed gauges, km
1.	19,3	
2.	41,3	22
3.	62	20,7
4.	78,9	16,9
5.	87	8,1
6.	95,1	8,1
7.	101,3	6,2
8.	127,1	25,8
9.	161,9	34,8
10.	181,2	19,3
11.	204,7	23,5
12.	222,9	18,2
13.	290,9	68
	Average distance between speed gauges, km	22,6

3. Research of Traffic Accidents in Highway Vilnius – Kaunas – Klaipėda and Suggestions for Traffic Safety Increase

According to the selected statistical data, many traffic accidents occur in highway Vilnius – Kaunas – Klaipėda and the majority of them are caused due to unsafe or exceeded speed. Table 2 presents statistics about the number of traffic accidents, people killed and injured during those accidents from the year 2006 up to the year 2009. This table also shows the number of traffic accidents, the cause of which was exceeded speed.

Table 2. Statistics revealing the percentage of traffic accidents due to exceeded speed

Year	Causes of the accidents	Traffic accidents	Number of deaths	Injuries
2006	Speeding	453	17	98
	Total	1071	37	188
2007	Speeding	439	18	103
	Total	1267	48	184
2008	Speeding	320	4	63
	Total	695	18	104
2009	Speeding	338	5	50
	Total	*566*	16	73

Table 3 shows the percentage of all traffic accidents, the cause of which is exceeded speed. The majority of traffic accidents due to exceeded speed occurred in the year 2009; exceeded speed in this year was the main reason of the injured people as well. The biggest number of killed people due to exceeded speed was in 2006.

Table 3. Percentage of traffic accidents due to exceeded speed in comparison to all traffic accidents

Year	Traffic accidents	Number of deaths	Injuries
2006	42,30 %	45,95 %	52,13 %
2007	34,65 %	37,50 %	55,98 %
2008	46,04 %	22,22 %	60,58 %
2009	59,72 %	31,25 %	68,49 %

Results of the Research of Transcendence of Safe Speed Depending on Stretch of Roads

In order to thoroughly investigate the frequency of traffic accidents, the highway Vilnius – Kaunas – Klaipėda was divided into stretches every 10 kilometres; the accident rate of each stretch due to unsafe speed was studied. The majority of accidents in 2006 occurred in 100-110 km stretch – 40 traffic accidents. The minority of accidents – 4 accidents in each – happened in the following stretches: 130-140, 150-160 and 220-230. The biggest number of killed people was in 200-210 stretch and 280-290 km, while the biggest number of injured people (9 people) was in 160-170 km stretch.

It has been investigated that the most dangerous stretch of road, where the biggest number of accidents occurred in 2007, was 90-100 km. This stretch witnessed 40 traffic accidents. The safest stretch was 170-180 km. The biggest number of injured was in the same stretch where the biggest number of traffic accidents occurred, i.e., 90-100 km. 13 traffic participants were injured there. The safest stretch of roads without any injured people where these: 30-40, 70-80, 130-140, 160-180 km. The majority of accidents that resulted in people being killed were 290-300 km – 7 people.

The carried out research and statistical data revealed that in 2008 the biggest number – 23 traffic accidents – occurred in 90-100 km stretch of road, the smallest number – 3 accidents – in 130-140 km stretch. The biggest number of the injured (10) was also in the stretch 90-100 km. The safest stretches of road with no injured people were these: 40-50, 70-80, 130-180, 210-220, 230-240 and 290-300 km. The biggest number of killed people (2 people) was in the 190-200 km stretch.

In 2009 the most unsafe stretch of road was 80-90 km, 30 accidents were registered there. In addition, many traffic accidents were also registered in 90-110 km stretch, 25 accidents in every 10 km of the mentioned stretches. 7 people were injured in the above mentioned 90-100 km stretch, 2 people were killed in the 140-150 km stretch. The safest stretch of road was 10-20 km, stretches that had no injured people were 50-80, 120-130, 200-210, 220-240, 270-280 and 290-300 km.

Having studied the overall statistics of traffic accidents, it was noted that the number of accidents in the stretch of road 10-20 km declined significantly in 2009. However, in comparison to 2008, the accident rate increased in the stretch of roads starting with 40 km and ending with 120 km. It has been also noted that 130-140 km stretch of road witnessed an increasing number of road accidents since 2006, and in 2009 this stretch was registered as the most unsafe one. 150-160 km stretch of road also showed the same thing – increase in traffic accidents. A significantly big number of traffic accidents – the biggest accident rate during 4 years – were registered in 190-200 km stretch. A significant decrease was registered in the stretches 210-220 and 230-240 km. The biggest decrease in 2009 was recorded in the stretches 280-310 km (the dynamics of traffic accidents is graphically presented on Figure 1).

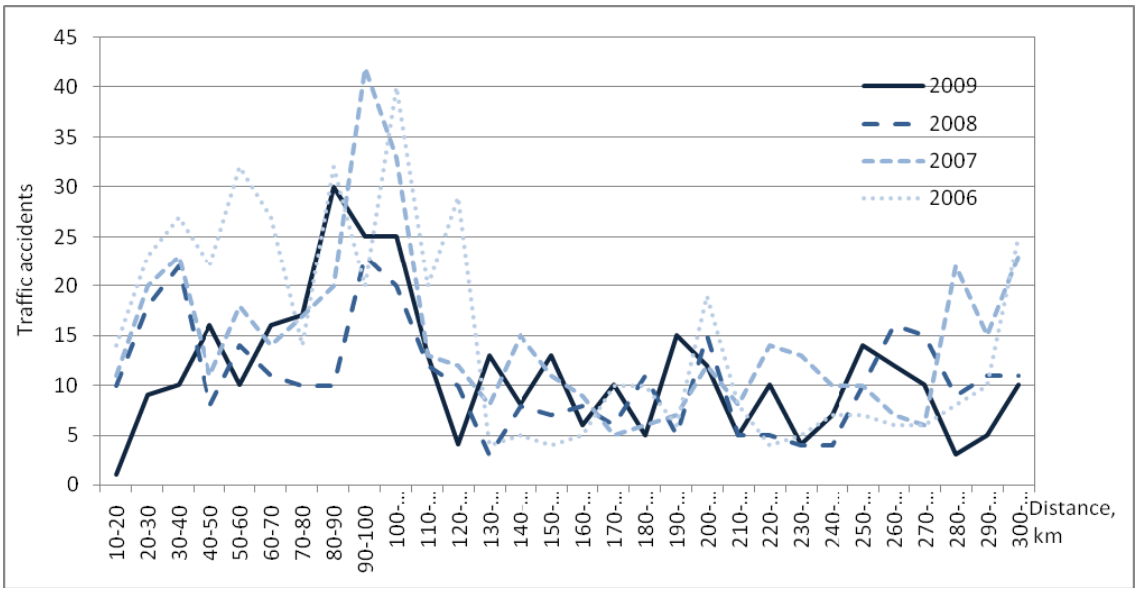

Figure 1. Fluctuation of traffic accidents in highway A1 in 2006-2009

The statistical research showed that the biggest accident rate due to exceeded safe speed on the right road side of highway Vilnius – Kaunas – Klaipėda in 2009 was recorded in the following stretches:

10-20 km – 1 traffic accident with 1 injured person was registered there, 30-40 km – 6 traffic accidents with 2 injured people; 40-50 km – 7 accidents with 2 injured people. 80-90 km stretch of road witnessed 19 traffic accidents during which one traffic participant was injured; 17 accidents resulting in injuries occurred in 90-100 km stretch of road, 100-110 km stretch recorded 20 traffic accidents with one person being injured. Another very dangerous road place was 140-150 km stretch, where 7 accidents were recorded with 2 people being killed and 2 – injured. 4 traffic accidents occurred in 160-170 km stretch of road and 1 person was injured there. 2 traffic accidents with 1 injured person were recorded in 180-190 km stretch of road. 190-200 km stretch of road witnessed 9 traffic accidents with 2 people being injured. 240-250 km stretch of road was also very dangerous because 4 traffic accidents with 5 injured people occurred there. 250-260 km stretch of road recorded 9 accidents with 1 person being injured. 260-270 km stretch of road also recorded 9 traffic accidents with 2 injured people. 3 traffic accidents with 4 injuries occurred in 280-290 stretch of road. A very dangerous stretch with 1 person being killed was 300-310 km. There 8 traffic accidents with 2 people being injured were also registered there.

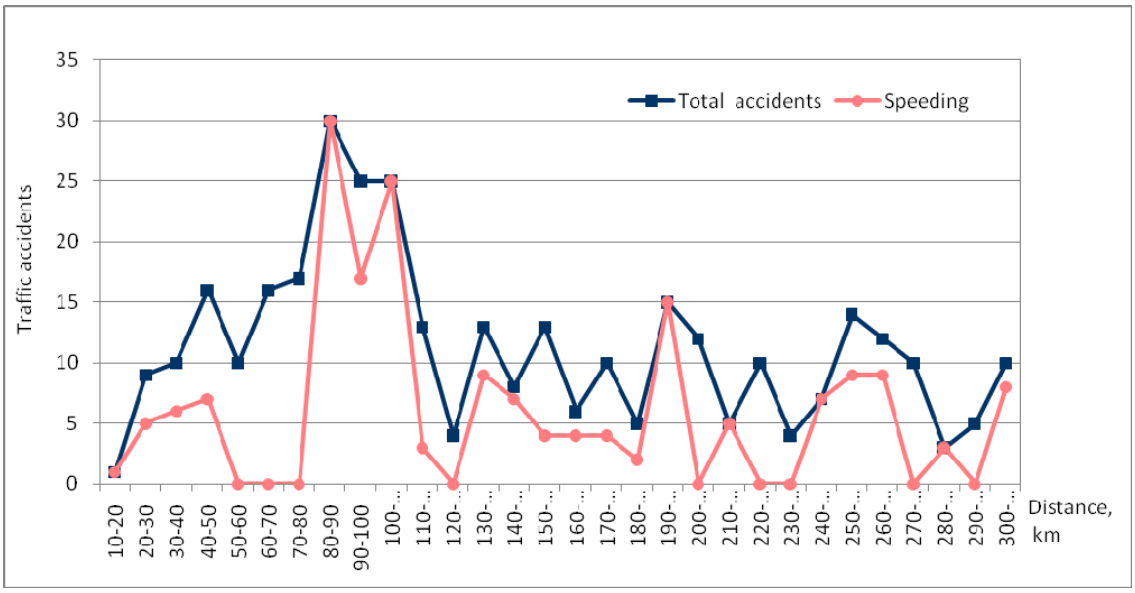

Figure 2. Fluctuation of traffic accidents in the highway A1 in 2009

On the left road side the first stretch, starting from Vilnius and going to Klaipėda, where 1 person was injured, was 20-30 km. 5 accidents in all occurred there. 11 traffic accidents with 3 people being injured were recorded in 80-90 km stretch of road; 100-110 km stretch of road witnessed 5 traffic accidents with 3 injuries. 3 traffic accidents with 2 injuries were recorded in 110-120 km stretch of road. Many traffic accidents – 9 – were recorded in 130-140 km stretch of road; 1 person was injured there. 4 traffic accidents with 2 injured people and 1 killed person occurred in 150-160 km stretch of road. 170-180 km stretch of road witnessed 4 traffic accidents with 1 person being injured. 1 person was killed and 1 injured in 190-200 km stretch of road (6 traffic accidents). 5 traffic accidents with 1 injury were recorded in 210-220 km stretch of road. 1 injury was also recorded in 240-250 km stretch of road but there fewer accidents – 3 – occurred.

The summary of traffic accidents due to exceeded safe speed in highway A1 Vilnius – Kaunas – Klaipėda in 2009 revealed that on the right road side 34 people were injured and 3 killed, while on the left side – 16 people were injured and 2 people were killed. The highway was divided into 60 stretches every 10 km. It is possible to conclude that there were 25 stretches that could be named as the most dangerous ones because they witnessed injured or even killed people. 10 of those stretches (with 55 traffic accidents) were on the left road side, while 15 (with 125 traffic accidents) – on the right road side.

On the basis of foreign experience, where average speed gauges were equipped, the number of traffic accidents was reduced by up to 85%. Lithuania could also place average speed gauges every 10 km where average speed would be measured. Average speed gauges are effective when installed in the distance of 300 m up to 10 km. The arrangement of gauges is presented in the map on Figures 3 and 4. The spots for gauges are chosen according to the accident rates of stretches of road.

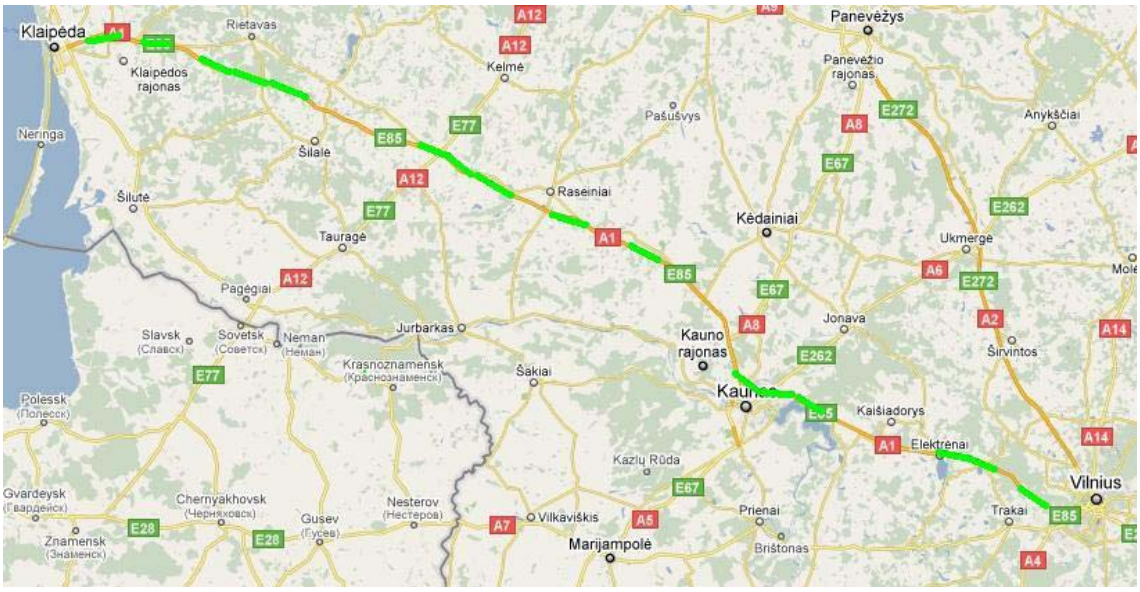

Figure 3. The arrangement of average speed gauges on the right road side

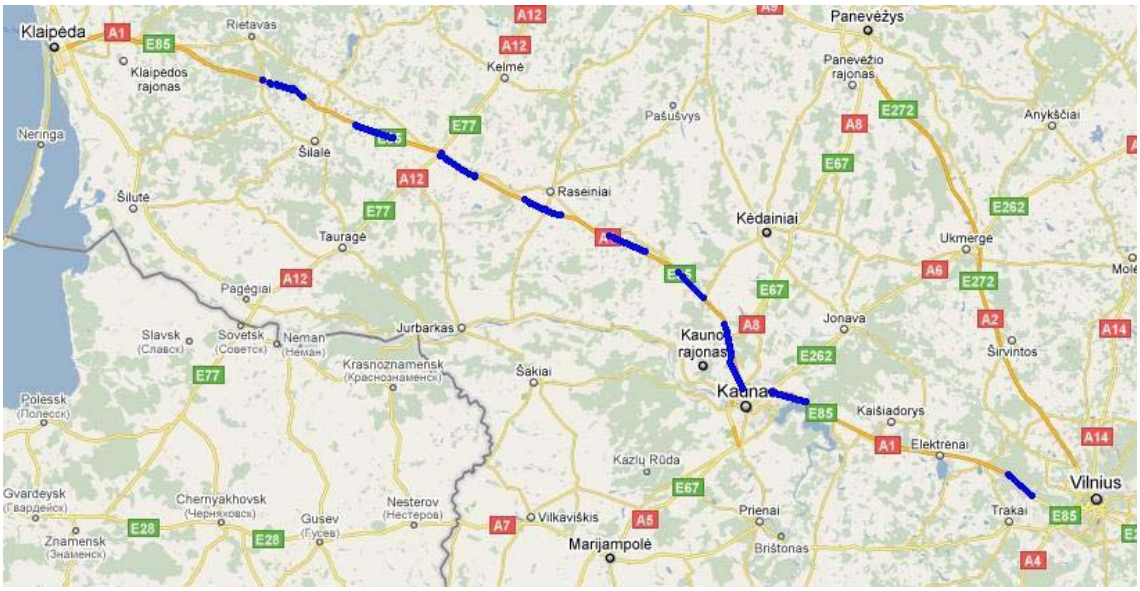

Figure 4. The arrangement of average speed gauges on the left road side

Having linked the weather observation system KOSIS, which already is in use, with variable message signs, it would be possible to reduce the accident rate even more. It has been proved that such systems reduce the number of traffic accidents by 30%. In case of a slippery road surface, this information could be displayed on variable message signs, the allowed speed should also be reduced then. The same thing could be done in case of other dangers: road works, traffic jams, fog, traffic accidents. In addition, variable message signs can be used in order to close one lane and direct all cars to another. Variable message signs are located behind every bigger entrance to the road. It is necessary to join all ITS into one unit, thus average speed gauges, that would respond to speed changes, are an inseparable part of such system.

Variable message signs are placed next to bigger entrances to the road. In highway A1 variable message signs should be placed on both traffic directions beside Grigiškės, Vievis, Elektrėnai, Žiežmariai, Rumšiškės. In the territory of Kaunas city 3 variable message signs should be placed by Niveronys, Savanorių pr., Western bypass. Variable message signs should also be placed next to Sitkūnai, Cinkiškiai, Girkalnis, Kryžkalnis, Stungaičiai, Gargždai and the first Klaipėda roundabout. In total – 17 pairs (places are indicated on Figure 5).

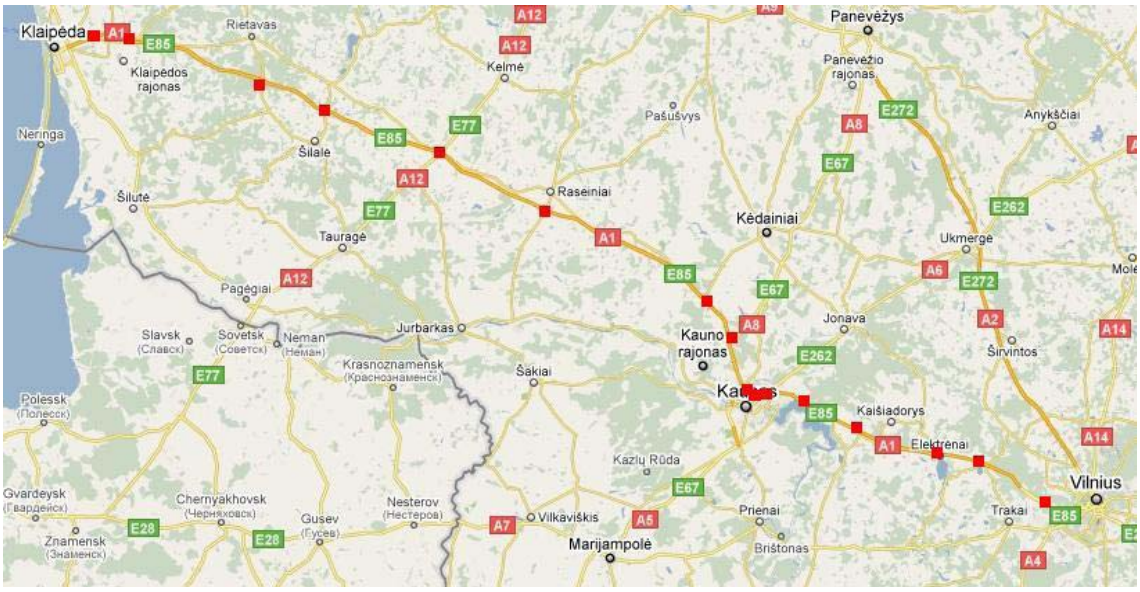

Figure 5. The arrangement of variable message road signs

Calculating that one system of variable message signs costs 277 500 Lt, 17 such systems would then cost 9 435 000 Lt, while their maintenance – approximately 5 950 000 Lt annually. It seems quite expensive, but, on the basis of foreign experience, where the number of injuries and deaths decreased by 30%, and having in mind that one person's death costs 1 400 000 Lt for the country and person's injury costs 150 000 Lt, we may conclude that it is not so expensive as it seems from the first sight. In 2009 highway A1 recorded 16 deaths and 73 injuries, thus, the economic damage for the country was 3 085 000 Lt. In the first year this system would not pay dividends, but in the second year it would already give benefit and be very useful.

4. Conclusions

– One of the major problems of a slow improvement of the situation in Lithuanian roads is that ITS implementation is insufficient because the already implemented ITS parts operated uncoordinated. Another reason is quite a large number of unexecuted projects.

– Though ITS appeared only several decades ago, its benefit has been already proved. Having carried out the analysis of good foreign practice, the hypothesis that Lithuanian roads should use average speed gauges that would operate together with variable message signs and weather observation system KOSIS was raised.

– The results of experts' survey confirmed that the most effective ITS measures in Lithuanian roads would be average speed gauges and variable message signs. Furthermore, the experts noted that ITS development is obstructed by the lack of finance, and ITS used in Lithuania is not as effective as they are in other European Union countries. Considering the results obtained from the research, more ITS should be implemented in highways.

– The statistical analysis of the most bustling highway (A1) Vilnius – Kaunas – Klaipėda revealed that approximately more than 45% of road accidents occur due to unsafe speed. 34% of people are killed and 59% of people are injured due to the same reason (A1 highway was divided into stretches every 10 km in order to study all traffic accidents that occurred there; stretches of road with the highest accident rate (people were killed or injured there) were established).

– Regarding traffic safety problems, it has been recommended to install average speed gauges in the stretches of road with the highest accident rate. The best punitive measures for drivers are repressive, not informative. The recommended average speed gauges would force drivers to slow down not only before the very gauge, but also in the entire stretch of road. Currently, drivers slow down only driving through stationary speed gauge. In addition, variable message signs have also been recommended due to quickly changing traffic conditions. All measures should operate co-ordinately, so that the maximum effectiveness would be ensured.

– All recommendations were economically evaluated using forecasting method and the experience of foreign countries. Average speed gauges would pay dividends in the period of one year,

while variable message signs – in the period of two years. The economic benefit of both systems during the first year would be 11 761 250 Lt

References

1. Jarasuniene, A., Baublys, A. Statistical probability evaluation of operating ITS, *Transport*, Vol. XXV, No 2, 2010, pp. 163-170. ISSN 1648-4142 (Journal of Vilnius Gediminas Technical University, Lithuanian Academy of Science).
2. Jarašūnienė, A. Research into intelligent transport system (ITS) technologies and efficiency, *Transport*, Vol. XXII, No 2, 2007. pp. 61-69. ISSN 1648-4142 (Journal of Vilnius Gediminas Technical University, Lithuanian Academy of Science).
3. Jarašūnienė, A. Analysis of possibilities and proposals of intelligent transport system (ITS implementation in Lithuania. *Transport*, Vol. XXI, No 4, 2006. pp. 245-251. ISSN 1648-4142 (Journal of Vilnius Gediminas Technical University, Lithuanian Academy of Science).
4. Button, J.K., Hensher, D.A. *Handbook of transport systems and traffic control*. Amsterdam: Pergamon, 2001. 602 p. ISBN 0080435955
5. Slinn, M., Guest, P., Matthews, P. *Traffic engineering design: principles and practice.* London: Elsevier. 2005, 208 p. ISBN 0750658657
6. http://www.lsd./standarts/activity plans/LS