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Impact assessment of speed calming measures on road safety

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Abstract

Traffic calming and speed reduction are one of the core factors that influences traffic accident rate and severity. In the last decades a lot of speed calming measures were implemented in the Lithuanian roads of national significance and city streets. As it was foreseen the result was very effective. The paper presents research methodology and analysis of results of vertical traffic calming measures (speed bumps, speed humps, raised crosswalks), safety islands and speed cameras influence to the road safety on Lithuanian roads.

Peer-review under responsibility of Road and Bridge Research Institute (IBDiM)

Keywords: road safety; vertical traffic calming measures; speed cameras

1. Introduction

Excess speed is probably the most widely spread violation of Traffic Rules today. Based on data of Organization for Economic Co-operation and Development, 40–50% of drivers on the average drives faster than the posted speed limit. High speeds have negative effects on the safety of road users, the efficiency of the traffic system and the environment (Siegrist, Roskova 2001). The driving speed influences both the chance to be involved in a crash and the severity of the injuries when a crash occurs (Elvik et al., 2004).

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In order to maintain or reduce a permissible speed limit, to improve pedestrian and bicycle traffic conditions and a social climate of local inhabitants in the cities, towns and settlements of Lithuania that are crossed by the roads of national significance, since 2007 around 400 of vertical traffic calming measures have been installed on the roads of the country. On the roads of national significance of Lithuania in 2008–2009 151 fixed speed cameras were installed (Police Department under the Ministry of the Interior 2010).

After a certain time period from the installation of safety measures it is important to assess their impact on road safety. It is necessary to determine if road safety measures installed in particular locations give a positive impact.

In foreign countries the effects of vertical traffic calming measures on the change in the number of road accidents, severity have been evaluated in a number of studies. Based on that studies presented that implementing speed humps on roads reduces the number of injury accidents about 41% (Elvik, 2009). Chen et al. (2013) assessed the effect of various safety countermeasures implemented in New York City. The changes in average accidents per year per location from the before period to the after period on the sections where speed humps were placed showed that the number of fatal and injury accidents decreased by about 33%.

Li et al. (2013) has summarized many studies and the results showed that the implementation of speed cameras significantly reduced the vehicle speed and the number of accidents near camera sites. Pauw et al. (2014) evaluated the traffic safety effects of fixed speed cameras on highways in Flanders-Belgium and concluded that speed cameras are an effective measure to improve traffic safety at locations with a high number of speed violations. The evaluation showed that severe accidents, with severe injuries and fatalities, decreased with 29% from before to after.

It is mentioned, that it is important not only to evaluate the effect of safety measures on road safety, it is also important the way this is done. The effects of the speed camera program implemented in France on fatal accidents were estimated using interrupted time-series analyses (Carnis and Blais, 2013). The results revealed that introduction of the speed camera program was associated with a significant decrease in fatal accidents per 100000 registered vehicles in five out of six models (linear, logarithmic, inverse, quadratic, power, exponential). The propensity score matching method was applied to evaluate the effect of speed cameras on road accidents in the UK (Li et al., 2013).

In 2011, Lithuania prepared the National Traffic Safety Development Programme for 2011–2017. It envisages the aim seeking for which the number of accidents and the people killed and injured on roads will further reduce (Government of the Republic of Lithuania 2011). A strategic aim of this programme is by improving road traffic safety situation to achieve that Lithuania by the number of people killed during road accidents per 1 million population would become one of the top ten European Union member-states distinguished by the best results. In order to implement the above aims it is necessary to assess the effect of the already implemented traffic safety measures on the roads of Lithuania. Research results of the efficiency of measures implemented and detailed analysis of road traffic safety can discover the need for the development of traffic safety measures or the necessity to introduce the new ones.

2. Analysis and assessment of the impact of vertical traffic calming measures on road safety

For the analysis of fatal and injury accident data on the road sections equipped with vertical traffic calming measures a selection of vertical traffic calming measures installed on the roads of national significance of Lithuania was carried out. The sites not relevant to the investigation were rejected, i. e.:

- speed humps the year of installation of which is not dated or known. Having no information about the time of installation of engineering measure there is no possibility to assess its effect on the change in the number of accidents over time;
- speed humps on the road sections of which no fatal or injury accidents were recorded before and after their installation.

The list of speed humps which were included to the investigation by their type consist of:

- speed humps of trapeze shape (8 pieces);
- raised pedestrian crossings (20 pieces);
- speed bumps (10 pieces);

- speed humps at the junctions (the humps of various types installed within the junction zone, 15 pieces). Junction zone is a 200 m long distance on the major road and a 150 m long distance on the minor road from the crossing point of the axes of roads (The Ministry of Transport and Communications of the Republic of Lithuania 2011).

Speed humps located at a distance larger than 600 m from each other (the sections do not overlap) were studied as separate objects since in case of such distance a stable driving speed is not maintained and the required effect of the measure is not achieved (LRA 2010). And vice versa, when the distance between the speed humps is smaller than 600 m (the sections overlap) the measures were studied together as one object.

Analysis of fatal and injury accident data on the road sections, where the speed humps of trapeze shape were placed, showed that the number of fatal and injury accidents decreased by about 36%, the number of people killed – by 100%, the number of people injured – by about 45% (Čygaitė, 2014). On the sections where the raised pedestrian crossings were installed the number of fatal and injury accidents decreased by about 65%, the number of people killed – by about 83%, and the number of people injured – by about 68%. On the road sections where the speed bumps were placed the number of fatal and injury accidents decreased by about 73%, the number of people injured – by about 77%. When studying accidents at the junctions it is comprehensible that they are influenced not only by speed humps but also by another complex traffic calming measures, i.e. separating safety islands, information shields, etc. Investigation showed that almost at all junctions the speed humps are installed only on the minor roads. Where speed humps are installed on the minor road the number of exits from the minor road decreases and situation on the major road is not sufficiently assessed. The driver, when reducing speed or coming to a full stop before the major road, has a possibility to assess the speed of upcoming vehicles on the major road and distance to them. If there are no speed humps the drivers often make an attempt to cross the junction before the vehicle coming by the major road and to avoid stopping or reducing speed. At the junctions where vertical traffic calming measures were installed the number of fatal and injury accidents decreased by about 44%, the number of people killed – by 75%, and the number of people injured – by about 29%. Fig. 2 gives the change in the number of fatal and injury accidents after installation of vertical traffic calming measures by their type.

speed humps of trapeze shape

raised pedestrian crossings

speed bumps

speed humps at the junctions

Fig. 1. Vertical traffic calming measures types on the roads of national significance.

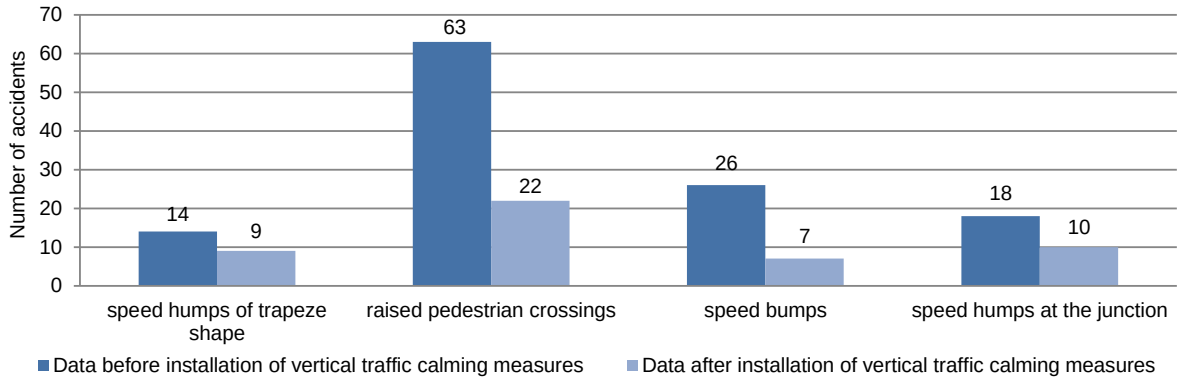

Fig. 2. Change in the number of fatal and injury accidents after installation of vertical traffic calming measures.

Analysis of fatal and injury accident data on the road sections where the vertical traffic calming measures were placed showed that the number of fatal and injury accidents decreased by 60%, the number of people injured decreased by 63%, the number of people killed decreased by 82%.

3. Analysis and assessment of the impact of safety islands on road safety

For the analysis of the impact of safety islands on road safety a selection of safety islands, installed on the roads of national significance of Lithuania, was carried out having rejected the following sites not relevant to the analysis:

- safety islands the year of installation of which is not dated or known. Having no information about the time of installation of safety island there is no possibility to assess its effect;
- roundabouts and their approaches. In order to assess the effect of roundabouts and directional islands, they shall be studied as a separate road structure or engineering measure, irrespective of safety islands;
- safety islands on the sections of which no fatal or injury accidents were recorded during the same period before and after their installation.

Safety islands were attached to one of 5 groups:

- installation of raised safety islands on major road with vertical elements in T, X junction (16 pieces);
- installation of raised safety islands on minor road with vertical elements in T, X junction (3 pieces)
- installation of safety islands with horizontal marking and flexible reflective posts on all crossing roads in T, X junction (20 pieces);
- milling of safety island perimeter and painting it in red on all crossing roads in T, X junction (2 pieces);
- raised safety islands for pedestrian crossing (2 pieces).

3.1. Raised safety islands on major road

The analysis of road accidents which occurred in ten years on the sections of raised safety islands on major road showed that within the limits of the safety islands under research 46 fatal and injury accidents occurred. It was determined during the analysis of the impact of safety islands on road safety that safety islands, installed on major road, had a positive impact on the decrease in the number of fatal and injury accidents as well as people killed and injured (Fig. 3).

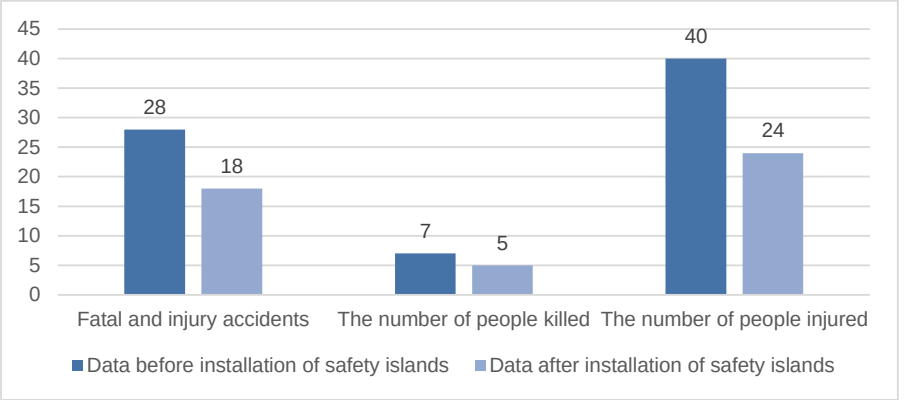

Fig. 3. Distribution of people killed and injured during fatal and injury accidents before and after installation of raised safety islands on major road.

After installation of raised safety islands on major road the number of fatal and injury accidents decreased by 35.7%, the number of people killed – by 28.6%, and the number of people injured – by 40.0%. Having made the analysis of the types of accidents, it was determined that before installation of raised safety islands on major road and after that the most often accident type was collision. Before installation of safety islands 17 collisions were recorded, after their installation – 10. The highest number of fatal and injury accidents on the sections of safety islands, installed on major road, was recorded in autumn – before installation of safety islands – 12 accidents occurred, after their installation – 7.

3.2. Raised safety islands on minor road

The analysis of road accidents which occurred in eight years on the sections of raised safety islands on minor road showed that within the limits of the safety islands under research 5 fatal and injury accidents occurred. 2 accidents were recorded before the safety islands were installed and 3 accidents – after their installation. During the mentioned accidents 5 people were injured and 1 road user was killed (before installation of safety island.

3.3. Safety islands with horizontal marking and flexible reflective posts

The analysis of road accidents which occurred in ten years on the sections of safety islands with horizontal marking and flexible reflective posts showed that within the limits of the safety islands under research 28 fatal and injury accidents occurred. It was determined during the analysis of the impact of safety islands on road safety that safety islands with horizontal marking and flexible reflective posts had a positive impact on the decrease in the number of fatal and injury accidents as well as people killed and injured (Fig. 4.).

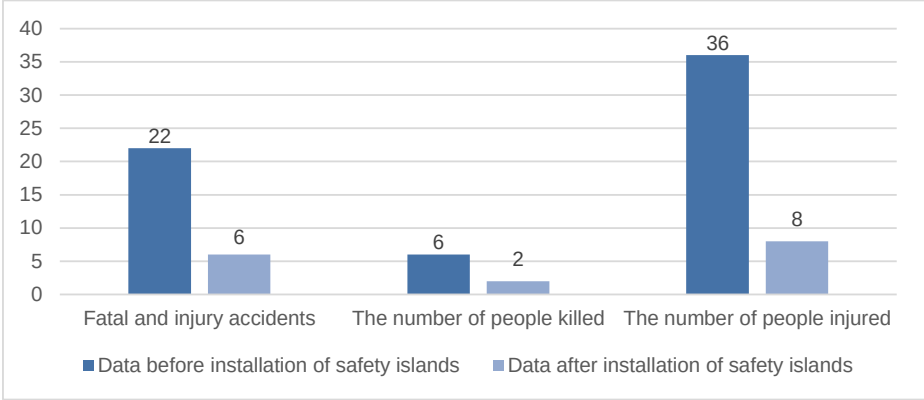

Fig. 4. Distribution of people killed and injured during fatal and injury accidents before and after installation of safety islands with horizontal marking and flexible reflective posts.

After installation of safety islands with horizontal marking and flexible reflective posts the number of fatal and injury accidents decreased by 72.7%, the number of people killed decreased by 66.7%, and the number of people injured decreased by 77.8%. Having made the analysis of the types of accidents, it was determined that before installation safety islands with horizontal marking and flexible reflective posts and after that the most often accident type was collision. Before installation of safety islands 10 collisions were recorded, after their installation 3 collisions were recorded. Having made the analysis of the distribution of accidents by a season, it was determined that the number of accidents, recorded during all four seasons of the year, was similar.

3.4. Safety islands with the milled perimeter painted in red

The analysis of road accidents which occurred in seven years on the sections of safety islands with the milled perimeter painted in red showed that within the limits of the safety islands under research 3 accidents occurred. All the accidents were recorded before installation of safety islands. During the accidents 3 road users were injured.

3.5. Raised safety islands for pedestrian crossing

The analysis of road accidents which occurred in seven years on the sections of raised safety islands intended for pedestrian crossing showed that within the limits of the safety islands under research 4 fatal and injury accidents were recorded of which 3 accidents occurred before installation of safety islands, 1 – after installation of safety island. During the mentioned accidents 2 road users were killed and 2 – were injured. After installation of raised safety islands for pedestrian crossing the number of fatal and injury accidents decreased by 66.7%, the number of people killed remained the same (1 road user), and no people were injured after the safety islands were installed.

The analysis of the impact of different type of safety islands on road safety showed that the largest effect on road safety was achieved by installing safety island with milled and painted in red perimeter. However, a small sample of the investigation of this type of safety islands does not show represent a reliability of the results obtained. Having made the analysis of fatal and injury accidents before and after installation of the safety islands under investigation, it was determined that the effective safety islands are those with horizontal marking and flexible reflective posts, raised safety islands for pedestrian crossing and raised safety islands on major road (Fig. 6.). After installation of raised safety islands on minor road the number of road accidents increased. However, a small sample of the investigation of this type of safety islands does not show represent a reliability of the results obtained.

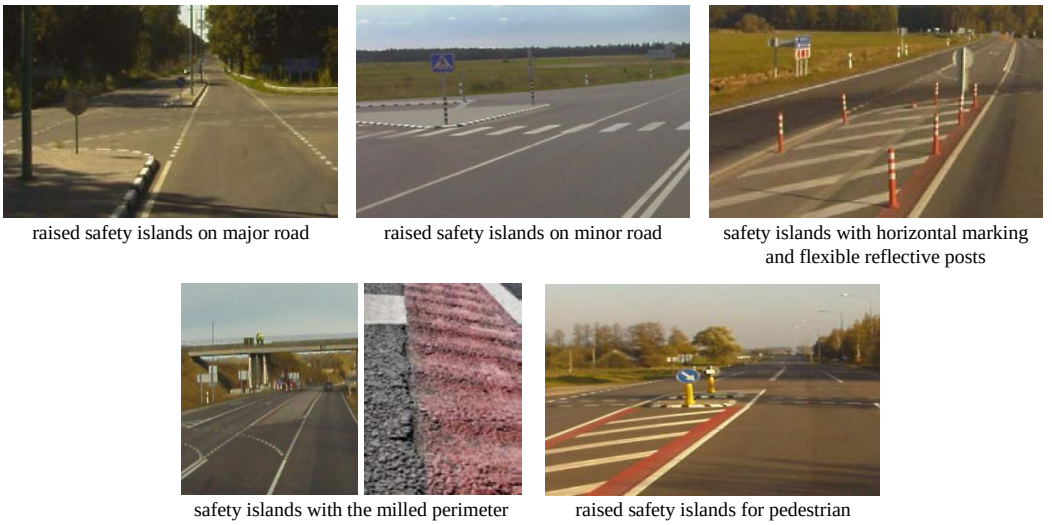

Fig. 5. Safety islands types on the roads of national significance.

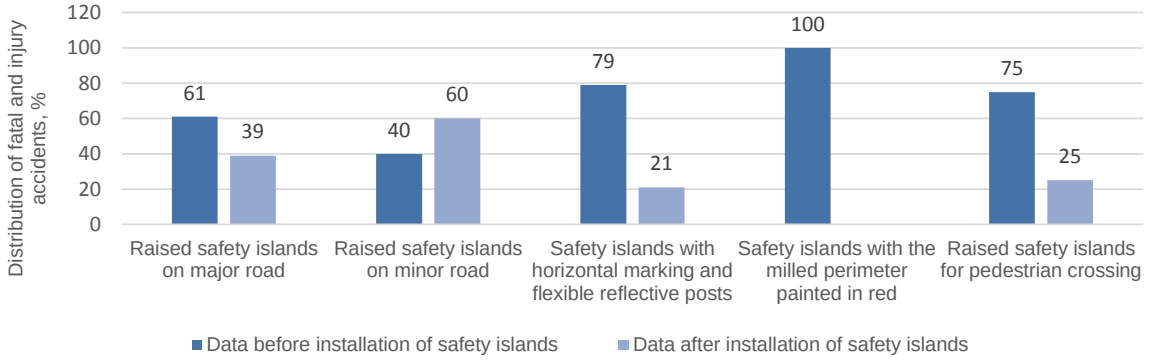

Fig. 6. Change in the number of fatal and injury accidents after installation of safety islands.

4. Analysis and assessment of the impact of speed cameras on road safety

For the analysis of fatal and injury accident data on the road sections equipped with fixed speed cameras the fatal and injury accidents were selected for each road section with the equipped speed camera. It was assumed that the relevant section length is 2.00 km – 1.00 km to each side of the speed camera.

In a study period, before the installation of fixed speed cameras, within the sections of their operation 276 fatal and injury accidents occurred where 68 people were killed and 355 were injured. Having installed speed cameras the number of fatal and injury accidents decreased to 166 (40%), the number of people killed – to 41 (40%), the number of people injured – to 195 (45%).

At present more than 22 thousand km of roads of national significance are maintained by 11 state enterprises, i.e. Automagistralė, Alytaus regiono keliai, Kauno regiono keliai, Klaipėdos regiono keliai, Marijampolės regiono keliai, Panevėžio regiono keliai, Šiaulių regiono keliai, Tauragės regiono keliai, Telšių regiono keliai, Utenos regiono keliai and Vilniaus regiono keliai (Fig. 7). Analysis of fatal and injury accident data on the road sections of national significance equipped with speed cameras showed that the largest reduction in the number of fatal and injury accidents

after installation of speed cameras (Fig. 7) took place in Vilnius district – 70%, in Šiauliai district – 44% and in Alytus district – 71%.

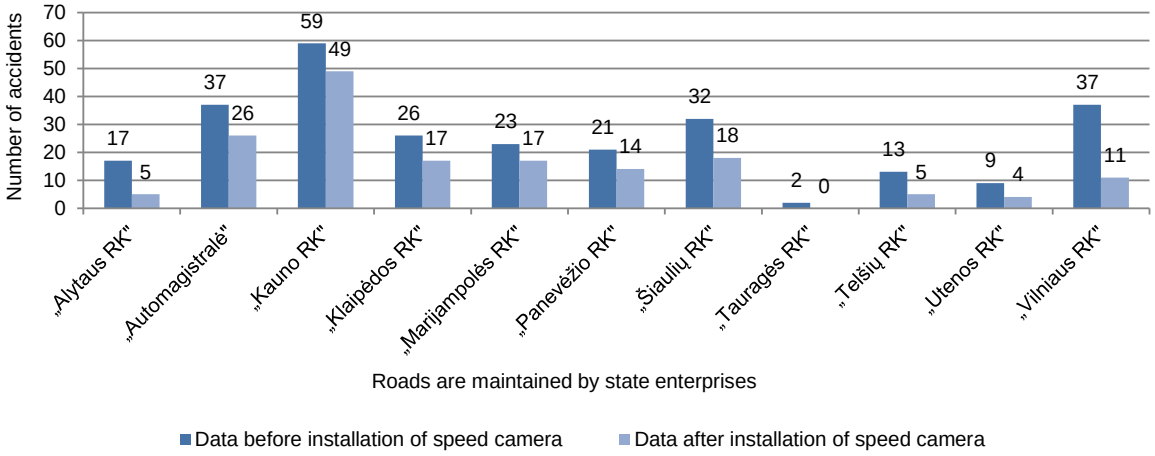

Fig. 7. Change in the number of fatal and injury accidents after installation of speed cameras.

Eliminating fatal and injury accidents that occurred due to additional factors (driving under the influence of alcohol, having no legal right to drive, animal–involved accidents) after installation of speed cameras on the sections of the roads of Lithuania the number of fatal and injury accidents decreased by 32%, the number of people killed decreased by 33%, the number of people injured decreased by 36%.

5. Conclusions

- Analysis of fatal and injury accident data on the road sections with vertical traffic calming measures showed the significant decrease of fatal and injury accidents after installation of these measures. The number of fatal and injury accidents decreased by 60%, the number of people injured decreased by 63%, the number of people killed decreased by 82%.
- Analysis of the data on the road sections where safety islands with horizontal marking and flexible reflective posts were placed showed the significant decrease of fatal and injury accidents after installation of these measures. The number of fatal and injury accidents decreased by 72.7%, the number of people injured decreased by 77.8%, the number of people killed decreased by 66.7%.
- Analysis of the data on the road sections where raised safety islands on major road were placed showed that the number of fatal and injury accidents decreased by 35.7%, the number of people injured decreased by 40%, the number of people killed decreased by 28.6%.
- Analysis of the data on the road sections where safety islands with the milled perimeter painted in red and raised safety islands for pedestrian crossings were placed showed positive effect. But lack of experimental research data don’t allow to make final conclusions on that.
- Eliminating fatal and injury accidents that occurred due to additional factors (driving under the influence of alcohol, having no legal right to drive, animal–involved accidents) after installation of speed cameras the number of fatal and injury accidents decreased by 32%, the number of people injured decreased by 36%, the number of people killed decreased by 33%.

References

Carnis, L., Blais, E., 2013. An assessment of the safety effects of the French speed camera program. Accident Analysis and Prevention 51, 301–309.

Chen, L., Chen, C., Ewing, R., McKnight, E.M., Srinivasan, R., Roe, M., 2013. Safety countermeasures and crash reduction in New York City-Experience and lessons learned. Accident Analysis and Prevention 50, 312–322.

Čygaitė, L., Lingytė, I., Strumskys, M., 2014. Analysis of Vertical Traffic Calming Measures in Impacts on Road Safety and Environment in Lithuania State Roads, The 9th International Conference "Environmental Engineering". Vilnius, Lithuania, elSSN 2029-7092 / elSBN 978-609-457-640-9.

De Pauw, E., Daniels, S., Brijs, T., Hermans, E. & Wets, G., 2014. An evaluation of the traffic safety effect of fixed speed cameras. Safety Science 62, 168–174.

Elvik, R., Christensen, P., Amundsen, A., 2004. Speed and road accidents. An evaluation of the Power Model 740/2004. Oslo: Institute of Transport Economics. ISSN 0802-0175.

Elvik, R., Hoye, A., Vaa, T., Sorensen, M., 2009. The Handbook of Road Safety Measures Second Edition. Emerald Group Publishing Limited, Howard House, Wagon Lane, Bingley BD 16 1WA, UK. 1124 p. ISBN 978-1-84855-250-0.

Li, H., Graham, D.J., Majumdar, A., 2013. The Impacts of Speed Cameras on Road Accidents: an Application of Propensity Score Matching Methods, Accident Analysis and Prevention 60, 148–157.

Lietuvos automobilių kelių direkcija prie Susisiekimo ministerijos (LAKD) [Lithuanian Road Administration under the Ministry of Transport and Communications (LRA)], 2010. Inžinerinių saugaus eismo priemonių projektavimo ir naudojimo rekomendacijos R ISEP 10 [Recommendations on the Design and Use of Engineering Safety Measures]. Vilnius, 123.

Lietuvos Respublikos Susisiekimo ministerija [The Ministry of Transport and Communications of the Republic of Lithuania], 2011. Avaringumo ruožų nustatymo valstybinės reikšmės keliuose metodika [Methodology for Identification of Accident Concentration Places on National Significance roads]. Vilnius.

Lietuvos Respublikos vyriausybė (LRV) [Government of the Republic of Lithuania]. 2011. Valstybinė saugaus eismo plėtros 2011–2017 metų programa [National Traffic Safety Development Program for 2011-2017]. Vilnius, 12.

Policijos departamentas prie Vidaus reikalų ministerijos (PD VRM) [Police Department under the Ministry of the Interior], 2010. 2009 metų veiklos ataskaita [Annual Report 2009]. Vilnius, 17.

Siegrist, S., Roskova, E., 2001. The Effects of Safety Regulations and Law Enforcement. Traffic Psychology Today. Ed. by Barjonet, P.-E. Kluwer Academic Publishers. ISSN 0-7923-7479-7. 377.