Proceedings of the 10th International Conference "Reliability and Statistics in Transportation and Communication" (RelStat'10), 20–23 October 2010, Riga, Latvia, p. 79-83. ISBN 978-9984-818-34-4
Transport and Telecommunication Institute, Lomonosova 1, LV-1019, Riga, Latvia

THE SOLUTIONS TO VEHICLE TRAFFIC ORGANISATION PROBLEMS IN VILNIUS

Aldona Jarasuniene

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

Economic growth and increases in living standards are crucial factors influencing the growth of transport mobility in different countries. The people transport mobility is persistent high still now.

As one of the main economic centres in Lithuania, Vilnius requires a balanced and well developed communication system.

The number of different means of transport and the level of automobilization guarantee citizens' transport mobility, but at the same time, increasing traffic volume creates traffic congestion and delays at road junctions because the development of the transport infrastructure has not kept pace with the growth in the level of automobilization. Therefore, it is very important to analyze the communication system in Vilnius in order to recognize general problems and propose solutions.

Keywords: *traffic jams, traffic volume, communication system, automobilization level, control systems*

1. Introduction

The high level of automobilisation acts as a factor causing transport congestion. It is necessary to take steps to reduce this problem. With the increase of road vehicle flows, there is increasing demand for legal regulatory measures. Therefore it is important to establish a legal basis for the efficient functioning of road transport. It is necessary to observe this provision for the better implementation of well-organised and safe urban traffic. The main factors which constrain the efficient organisation of traffic are the high rate of automobilisation, increasing traffic intensity, poor transport infrastructure and insufficient traffic capacity of streets, transport congestion, the accident rate and the high level of pollution and noise emissions. All these problems are directly related to each to other. Therefore, it is necessary to solve them as a whole, as only such solutions will give effective results. Forecasts show that if measures are not taken in time, by 2020 there are likely to be over 1000 road vehicles per 1000 citizens (assuming that the population is likely to remain stable). In order to reduce congestion, it will be necessary to implement technical traffic solutions, and take measures which could, at least in part, reduce the level of automobilisation in Vilnius.

2. Principal Legal Documents Regulating Traffic Safety

With the increase in road vehicle flows there has been greater demand for legal regulation measures. Therefore it is important to establish a legal basis which will secure the safe and efficient functioning of road transport. Currently the following main legal acts relating to traffic organisation are in use:

- Road Traffic Regulations;
- Law on Road Traffic Safety of the Republic of Lithuania;
- Law on Roads of the Republic of Lithuania;
- Long-Term (until 2025) Development Strategy of the Lithuanian Transport System.

Each legal act has to be coordinated with European Union (EU) legislation and must conform to it. EU legislation can have a direct influence on the State and on municipalities. Therefore, before starting certain actions it is necessary to study the relevant legal acts in depth.

Road Traffic Regulations regulate road traffic in the Republic of Lithuania. All legal acts relating to road traffic safety can not contradict these Regulations.

One of the main laws applied to road transport is the *Law on Road Traffic Safety of the Republic of Lithuania*, which was adopted in the year 2000. On the basis of this law, traffic safety is ensured by the regulation of activities of natural persons and legal bodies in the field of traffic safety, by the adoption of

legal acts related to traffic safety, by allocations for the training of traffic participants, by the implementation of technical innovations, etc.

The *Law on Roads of the Republic of Lithuania*, adopted in the year 1995, defines the legal foundations of Lithuanian road development, maintenance and usage. This law indicates characteristics determining categories of roads, principal requirements for roads, methods of road numeration, etc.

The *Long-Term (until 2025) Development Strategy of the Lithuanian Transport System* pays considerable attention to urban transport organisation, i.e. defining the main objectives to be implemented.

3. Measures of Traffic Organisation

It is necessary to observe the following measures for the better implementation of well-organised and, in particular, safe urban traffic:

- Category and function of the street;
- Forecast traffic intensity and the structure of transport flows;
- General concept of traffic organisation;
- Results of traffic organisation solutions impacting concrete groups of traffic participants;
- Adjustment of traffic organisation solutions to the needs of people with reduced mobility (disabled persons);
- Increased traffic safety on streets;
- Protection of urban sensitive objects from intense transport flows.

Road (traffic) signs. Road signs play a very important role in traffic regulation. They are intended to warn drivers of traffic changes, indicate the traffic direction and regulate the traffic.

According to the presently applicable *Road Traffic Regulations,* road signs are divided into seven groups:

- Warning signs;
- Priority signs;
- Prohibitory or restrictive signs (prohibiting or cancelling a prohibition);
- Directing signs;
- Regulatory signs defining or cancelling a certain traffic order;
- Information signs indicating road side dwelling territories, facilities, etc.;
- Service signs informing about service objects;
- Also additional tables are used, which supplement or restrict other road signs.

Road signs on streets and crossings have to be placed in such a way that they do not obscure visibility and can be seen easily by traffic participants.

Marking of roads. Road marking is a very important factor in the traffic system. The marking of roads should be planned at the initial stages of establishing a traffic system. There are two types of road marking:

- Horizontal marking (including lines, arrows, lettering or other symbols applied on the carriageway and pavement marking). These define the traffic regime and order.
- Vertical marking consisting of white and black stripes alternately applied on transport constructions and elements of road equipment. Such markings indicate dimensions and facilitate orientation.

Appropriate road marking enables traffic participants to be more orientated, thus increasing traffic safety. All road markings have to correspond with the requirements of the *Convention on the Road Traffic*.

Safety islands. These are used at crossings, street dividing lines and where roads have been widened. Safety islands present areas which are well-seen by drivers. This increases safety of pedestrians and drivers. Safety islands divide the flows of pedestrians and vehicles, thus increasing the safety of those pedestrians who do not manage to cross the street in time. Safety islands can be used both on regulated and non-regulated pedestrian crossings.

Other technical means. Apart from the above measures, there are more ways to enable the improvement of traffic safety, such as:

- Speed limiting bumps;
- Road reflectors and flashing feet;
- Traffic safety mirrors;
- Road screens, etc.

Speed limiting bumps are used in various places, particularly where there are high pedestrian flows. They are among the most effective measures used for the reduction of road vehicle speed.

Every year the demand for information technology is growing in all sectors. This is also true for transport. Increasing numbers of information systems for transport flows coordination are being developed.

Traffic light control. This type of regulation may have both negative and positive effects on traffic safety and transport flow management. The separation of transport flows on regulated crossings reduces the number of traffic accidents occurring when vehicles are moving on perpendicularly laid crossing roads. However, a greater accident risk is when vehicles hit the rear part of the vehicle traveling in front. This could lead to greater risks for pedestrians and cyclists. Traffic light control may increase transport flows on crossings. However, there may be better solutions for minor non-regulated roads and in situations in which vehicles want to join a main road from a side road. Traffic light regulation can cause delays in traffic flows in these situations.

Traffic lights operating in isolation can hinder the traffic, causing the decrease of vehicles' operational time, generating queues of vehicles in lines before traffic lights which are difficult to manage. Therefore it is better to regulate the operation of traffic lights in several adjacent crossings, i.e. to use coordinated regulation.

Coordinated regulation of traffic. This means the coordination of traffic lights on adjacent crossings, along a whole street, an part of a town, or even the whole town. According to its level of complexity, coordinated traffic regulation can be divided in the following way:

- Traffic coordination on one-way streets
- Traffic coordination on two-way streets where distances between crossings are equal;
- Traffic coordination on two-way streets where distances between crossings are not equal.

Centralised traffic management systems (CTMS). These comprise: traffic light controls, traffic lights, vehicle traffic sensors, systems of public transport priorities, traffic management centres, light boards for driver information, traffic monitoring systems, information systems and speed-metering systems. In this way the CTMS consists of all the different transport information systems joined into a united general network.

With the application of such systems the idle time of vehicles on crossings decreases, operational speed increases, and the negative environmental impacts of vehicles are lessened. However, to achieve tangible results in these areas it is necessary to coordinate all the above systems.

The whole CTMS is managed by a traffic management centre, the purpose of which is the regulation of traffic on the streets taking into account the actual traffic situation and the implementation of a selected traffic management strategy.

Intelligent transport systems (ITS) – This is a common term which incorporates integrated connections, and control and information processing technologies. ITS comprises the whole set of technological means created for the improvement of the quality, efficiency and safety of road networks.

At present such systems as electronic payment, accessibility control and regulation systems are also widely used. These facilitate:

- Road fees collection, including automated payment of charges and dues for transport congestion;
- Recognition of vehicles and restrictions;
- Systems of photo cameras intended for traffic signalling and speed regulation.

Consequently ITS makes it possible to integrate the transport management of an entire town. With the help of ITS traffic information is accumulated more effectively. It can be used for the efficient management of transport systems.

4. Problematic Issues of Vilnius Urban Transport System

The main reasons impeding the efficient organisation of traffic:

- ***High rate of automobilisation.*** This is the main problem in the town. It is the cause of the other traffic organisation problems.
- ***Increasing traffic intensity.*** The growth in the number of vehicles causes increased traffic intensity.
- ***Poor transport infrastructure and insufficient traffic capacity of streets.*** The growing automobilisation rate and insufficient density of streets, as well as poor transport infrastructure, have caused congestion and an increase in the accident rate.
- ***Transport congestion.*** One of the greatest problems in the town is transport congestion. This causes huge losses of time and increases in air pollution around crossings. Transport congestion is caused

not only by the high automobilisation rate and the low traffic capacity of the streets, but also by the lack of efficient traffic regulation equipment.

– ***Accident rate.*** High traffic intensity directly influences the increase in the accident rate in the town. Also, poor transport infrastructure contributes to the growth in the accident rate.

– ***High level of pollution and noise emission.*** This depends very much on the technical parameters of road vehicles and the number of road vehicles in the town. It is a well-known fact that the Lithuanian road vehicle fleet is quite aged. The poor traffic capacity of streets also affects the pollution level, as the concentration of vehicles on the streets is dense.

All the above problems are directly related to each other. Therefore it necessary to solve them as a whole, as only such a solution will give effective results.

5. Ways of Eliminating of Traffic Organisation Problems

At present the European Union allocates considerable finances for the improvement of the transport infrastructure of Lithuania and its towns. However, once the minimum standards of the old EU states have been reached this financing will discontinue and the Lithuanian state will have to develop its transport infrastructure from its own resources, and also support new members of the EU. Therefore it is necessary to start thinking as early as possible about resources for the development of transport infrastructure. At present such resources are collected from fuel excise duty, and from EU funds.

Currently the number of road vehicles in Vilnius is growing every year, but the age of the vehicle fleet is not getting any younger. Forecasts show that if measures are not taken in time, by 2020 there are likely to be over 1000 road vehicles per 1000 citizens (assuming that the population is likely to remain stable). The chart shows that the number of road vehicles is growing much more quickly than the development of the network of streets. Therefore traffic organisation problems will increase significantly. The problem of congestion will be particularly acute. Even now public opinion polls show that transport congestion is considered by people as the greatest problem of the transport system in Vilnius. In order to reduce congestion it is necessary to implement technical traffic organization solutions and take measures which could, at least in part, reduce the level of automobilisation in Vilnius.

6. Technical Solutions of Traffic Organisation

In order to spotlight traffic organisation problems and to elicit different possible solutions, it is very important to structure a formal questionnaire.

The transport infrastructure was rated by respondents to the questionnaire as average. The greatest number of negative responses concerned the condition of the roads. Indeed, the condition of roads in Vilnius is poor. Following the experience of other countries, on really problematic sections of roads the old surface should be removed and a fully new surface should be laid. This requires great financial resources; therefore this is unlikely to happen in the near future.

Data from the Ministry of Transport and Communications show that each year on the streets of Vilnius congestion costs more than LTL 1.5 billion. Of this, LTL 600 million is fuel costs and LTL 900 million is the cost of people's time spent in congestion. This does not take into account other factors such as pollution costs, damage to human health, etc.).

Poor transport infrastructure in the town is indicated also as one of the reasons for the negative impact of transport. With the growth in vehicle numbers, the road network should also be developed. However, in many areas of the town, apartment buildings are in very close proximity to the streets. Therefore there are no possibilities for extension and development. Contact trolley-bus networks also cause one of the problems, as the requirement to move these would increase the costs of road expansion. For these reasons such works are usually avoided on these streets. Street expansion work should be carried out with regard to the results of the research on traffic intensity.

A reduction in congestion can be made not only through the expansion of roads, but also by using ITS. At present Vilnius has implemented CTMS on six transport corridors. Almost 80 % of polled people had a good evaluation of CTMS. Most respondents had noticed a reduction in the time spent in transport congestion. These positive opinions should be an incentive for the development of these systems.

Implementation of CTMS should improve the characteristics of traffic organisation. Overpasses for pedestrians or underground passages should also be constructed. This will enable the uninterrupted flow of transport.

Transport flow in the Old Town is also very heavy. The best solution should be to limit the transport flow. The poll showed that the taxation of vehicles entering the Old Town would reduce

transport flows. Only a little more than 3 % of respondents said they would drive via the Old Town if high taxes were introduced. The introduction of such taxes/fees would require the construction of parking sites in areas close to the Old Town. This would enable people working in the Old Town, or spending their leisure time there to leave their vehicles for a longer time.

Road charges. The high level of automobilisation acts as a factor causing transport congestion. Therefore it is necessary to take steps that could reduce the number of vehicles in Vilnius. One of the principal methods for this is the introduction of overall road charges. The introduction of road charges should stimulate Vilnius citizens to:

- Use public transport;
- Use motor-less means of transport;
- Dispose of old, non-economic vehicles.

Road charges should be differentiated. On the basis of the experience of other countries, the road charges could be calculated regarding the following:

- Vehicle mass (kg);
- Type of fuel (petrol, diesel fuel, gas, electricity);
- Amount of exhaust gas (CO_2 g/km);
- Distance of journey;
- Coordination of all the above methods together.

7. Conclusions

1. In the year 2009, the level of automobilisation in Vilnius was 576 (individual) cars per 1000 citizens. The total vehicle fleet in town reached 390.1 thousand, of which cars comprised 322,000, i.e. cars in Vilnius make up 83 % of the total number of vehicles in the town.

2. 66.7 % of Vilnius citizens have private cars. 48.7 % of Vilnius inhabitants have one car, 14.8 % own two, 2.6 % have three and 0,6 % have more than three cars. Theses cars comprise 88 % of the entire transport flows.

3. The largest transport flow has been registered on the main urban speedway of Vilnius, Geležinio Vilko Street in the central part of the town; 10,350 thousand cars/hour in either direction, or 141,800 thousand cars per 24 hours.

4. In 2008, 14.7% of the total number of accidents in Lithuania, and 8.4% of the total of deaths occurred within the Vilnius

5. Analysis of the Vilnius urban transport system shows the main problems: high traffic intensity, low density of street network, congestion, high accident rate and environment pollution.

References

1. Jarasuniene, A. The Importance of Development of new technological systems in Transport means. *Proceedings of International conference "Transport means".* 28–29 October, Kaunas: Technologija, 2004, p. 233–236.
2. Jarašūnienė, A. Research into intelligent transport system (ITS) technologies and efficiency. *Transport*: *Journal of Vilnius Gediminas technical university*, Lithuanian Academy of Science. ISSN1648-4142, Vol. XXII, No 2, 2007. Vilnius, p. 61–69.
3. Button, J. K., Hensher, D. A. *Handbook of transport systems and traffic control.* Amsterdam: Pergamon.602 p. ISBN 0080435955, 2001.
4. Slinn, M., Guest, P., Matthews, P. *Traffic engineering design: principles and practice.* London: Elsevier. P.208.ISBN 0750658657, 2005.
5. *Current situation and problems of vehicle flows in Vilnius* – http://www.vilnius.lt