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THE PRINCIPLES OF A SUSTAINABLE STREET NETWORK AND SAFE TRAFFIC SYSTEM IN LITHUANIAN CITIES

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ABSTRACT

The number of personal passenger cars per 1000 inhabitants has been rapidly growing in Lithuania. A high level of car ownership and a low level of street planning in the cities cause a lot of problems: requirements for traffic safety, street capacity and the aesthetic view of the street surroundings are not satisfied. Therefore, traffic jams and the number of accidents on the city streets has been increasing every year; traffic conditions for the pedestrians and cyclists are getting worse. In order solve these problems the streets must be planned in a sustainable way.

KEY WORDS

- *accidents,*
- *traffic safety,*
- *street capacity,*
- *sustainable planning*

1. INTRODUCTION

A rapidly growing number of vehicles and a continuously increasing traffic volume cause more and more problems for the assurance of traffic safety in Lithuania. Since each community member is also a road user, traffic safety becomes a general problem. The high number of accidents in Lithuania is essentially related to irresponsible planning of the street network, imperfect legislation and the lack of personal responsibility in the behaviour of road users. The aim of this paper is to analyse the principles of sustainable a transport system, to determine the current situation in Lithuania and to compare it with other European Union countries, which have already introduced the principles of sustainable street network planning in their transport systems.

2. BASIC DATA IN LITHUANIA

Traffic safety has been treated as a problem of world importance for a long time. Today there are more than 600 million cars around the world, and every year more than 200,000 people are killed in road traffic accidents [1]. Traffic statistics vary from country to country. For example, the number of people killed per 1 million inhabitants in Malta, the Netherlands, Sweden and Great Britain is 50–60, whereas in Latvia and Lithuania – it is more than 200 (Fig. 1.). Thus, at present Lithuania takes first place among the EU countries according to the number of people killed in road traffic accidents. Moreover, the number has been continuously increasing: in Lithuania 641 people were killed on the road in 2000 and in 759 in 2006.

Although the number of inhabitants in Lithuania is decreasing, the level of car ownership is still increasing – from 2000 to 2006, car ownership increased by 38,6 percent. The growth in the vehicle fleet causes growth in the number of road accidents (Table 1). An analysis of road accident statistics in the past six years shows that along with an increase in the number of accidents, the number of people killed in road accidents has also been increasing.

Due to more intensive traffic, the number of accidents in urban areas is on average two times higher than in rural areas. However, the number of people killed on the streets of the cities is less than

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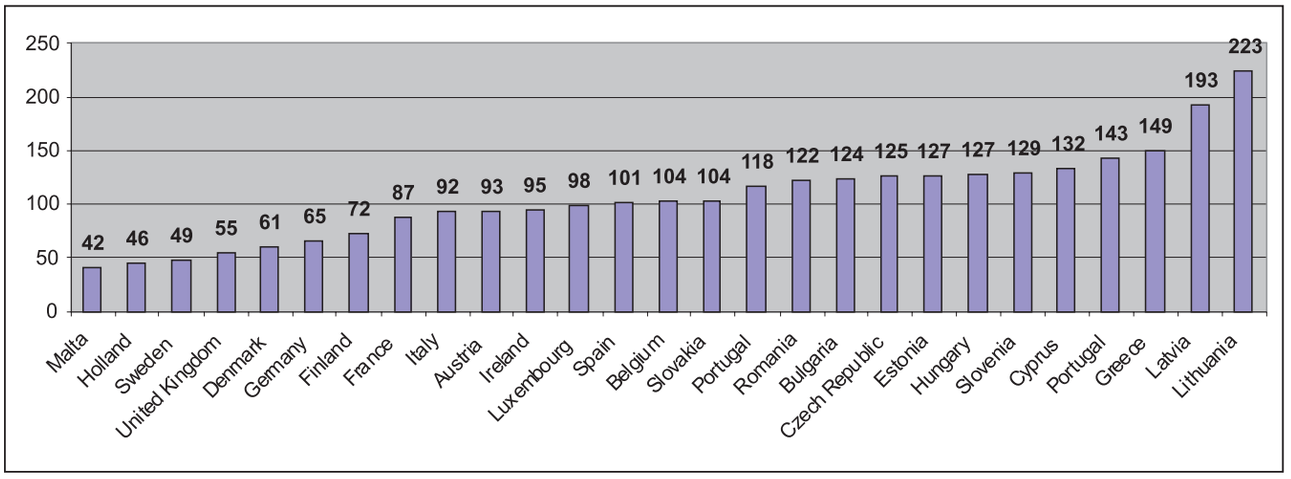

Fig. 1 *EU statistics on road traffic accidents in 2006*

Table 1. *The main traffic safety indices in Lithuania, 2000-2006.*

Index	2000	2001	2002	2003	2004	2005	2006
Number of inhabitants	3,512,074	3,486,998	3,475,586	3,462,553	3,445,857	3,425,324	3,403,284
Level of car ownership (number of cars/1000 inhabitants)	288	321	340	365	383	426	469
Number of people killed/ 1,000,000 inhabitants	173	202	201	206	219	223	224
Number of road accidents/ 1000 inhabitants	1572	1715	1759	1730	1860	1990	2001

in the rural areas, while the number of injuries is on average 1.5 times higher than in rural areas. Such a distribution is caused by the fact that the speed limit in an urban area is lower than in a rural area (Fig. 2).

Thus, Lithuania is the ”leading” country in Europe according to the number of those killed in road accidents per million inhabitants. Besides, contrary to most EU countries, the number of traffic accidents has been growing each year. This shows that the currently used traffic safety improvement measures in Lithuania are evidently insufficient or ineffective.

The existing network of city streets is not able to fulfil its functions and ensure the necessary traffic capacity and traffic safety. The situation gets even more acute when reconstructing the existing streets or constructing new ones and when, due to the large amount of traffic congestion, hasty, unconsidered and often unsuitable measures are implemented, which worsen the traffic safety situation even more. For example, frequently on streets where ”fast traffic”, i.e. where the speed limit is 80 km/h is allowed, incompatible measures are introduced: at uncontrolled pedestrian crossings, left turn lanes, bus stops, etc., the design speed is 100 km/h. Thus, the street parameters stimulate the driver to exceed the speed limit. Dangerous situations are caused with painful consequences. Thus, the function of existing, and new streets are not taken into consideration, nor is the characteristic infrastructure. Therefore, the first and most important thing needed in order to improve the existing communication system in Lithuanian cities is to create a sustainable network of streets, based on traffic safety principles. When creating a sustainable street network, it is necessary to use the long-term and already justified experience of foreign countries.

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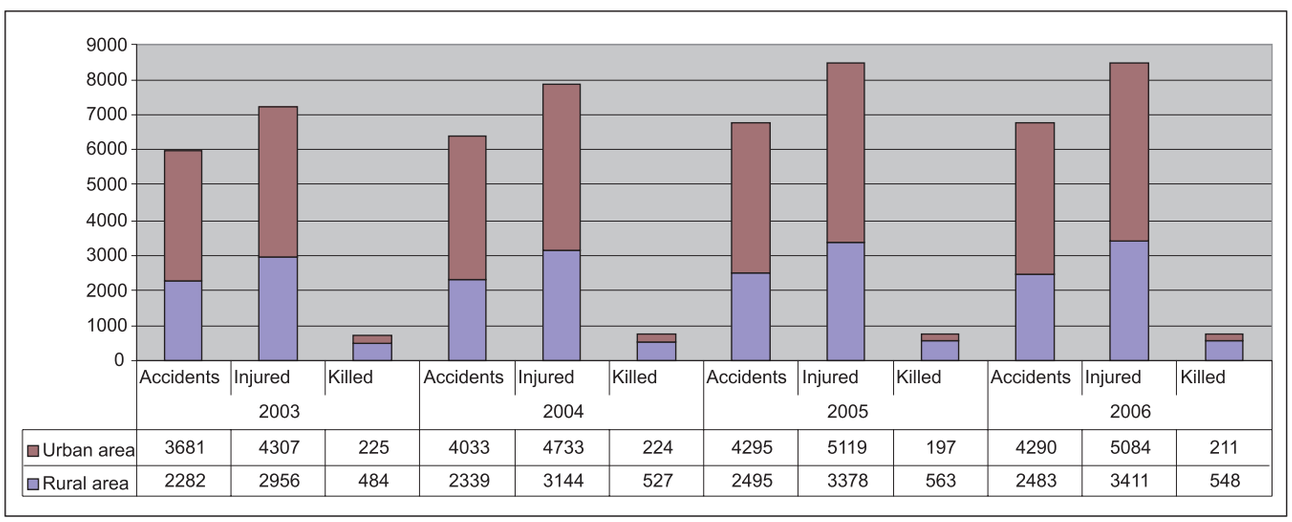

	Accidents	Injured	Killed	Accidents	Injured	Killed	Accidents	Injured	Killed	Accidents	Injured	Killed
	2003			2004			2005			2006		
Urban area	3681	4307	225	4033	4733	224	4295	5119	197	4290	5084	211
Rural area	2282	2956	484	2339	3144	527	2495	3378	563	2483	3411	548

Fig. 2. *Number of traffic accidents and injured and killed people in urban and rural areas*

3. PRINCIPLES OF A SUSTAINABLE TRANSPORT SYSTEM

The planning of a city street network should be based on the principles of a sustainable transport system. In Lithuania these principles have not been applied thus far, though in Europe they are not new. Such countries as Sweden, Norway, England and the Netherlands have already succeeded in becoming the leaders in the field of traffic safety. The streets of the most advanced countries look rather different at first glance. But if we carry out a more detailed analysis of the planning, design and individual engineering solutions for the streets of these countries, we can see that they use the same principles of traffic organization and traffic safety. Those principles are oriented towards the main human physiological and psychological features; therefore, the main traffic safety principles are universal and suitable for different countries.

A slightly different situation is related to the specific engineering measures and solutions which implement the traffic safety principles. Engineering measures to ensure the same principle in one or another country can differ, depending on the road users' thinking, traditions, traffic rules, etc. For example, it is safe for a pedestrian to cross the street if a low vehicle speed is ensured. In one country it will be sufficient to install a pedestrian crossing sign; in another it will also be necessary to erect speed bumps or CCTV cameras. In both cases the engineering measures are different, but the same principle is followed, and the same objective is achieved – to reduce vehicle speed and to create conditions for the pedestrian to safely cross the street.

A sustainable street network, besides its capacity and driving comfort, should meet the requirements for traffic safety - to minimise the probability of accident, and where the accident still occurs – to reduce its severity. It is expensive to ensure comfortable and safe traffic; therefore, in practise it is necessary to look for a compromise.

The concept of sustainable safety is based on the principle that the elements of traffic safety and a transport system are closely connected. Traffic is interpreted as the interaction between the street infrastructure, vehicles, legislation and road users (Fig. 3). The human being in this system is the weakest link; he has certain limitations (eyesight, reaction time, a limited amount of perceived information and inert thinking), and he is reluctant to change his habits. Taking into consideration human characteristics and shortcomings, sustainable and safe road design has the following principles [2]:

- an infrastructure that is adapted to the limitations of human capacity through proper road design;

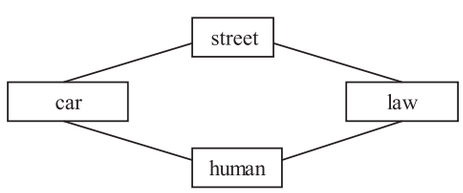

Fig 3. *The contact between a car, a human, the street and the law*

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- vehicles property equipped to simplify the task of driving and constructed to protect vulnerable human beings as effectively as possible;
- a road user who is adequately educated, informed and, where necessary, controlled;
- legislation for and enforcement of safe driving practices.

Thus, the result of any interaction between the components of the transport system creates a harmonized and sustainable traffic conditions where the human naturally and according to his own will chooses the right behaviour or is forced to behave safety.

A sustainable, safe traffic system in a city is where all the elements of traffic safety and transport are combined. At the same time, interaction shall be ensured between [2]:

- function: relates to the use if the infrastructure is as intended by the road authority;
- form: relates to the physical design and layout properties of the infrastructure;
- usage: relates the actual use of the infrastructure and the behaviour of the user, and the legislation relates to regulatory requirements for the use of the infrastructure.

All these elements must be attuned to one another within the concept of sustainable safety [2].

The three main principles of a sustainable and safe road system are:

- functionality – preventing unintended use of the infrastructure. The streets are designed and used only for a certain type of traffic. Each road or street may only have one function. The access street should be unattractive to through traffic, while the through streets should not create conditions to access shops, yards, etc;
- homogeneity – avoiding significant differences in speed, driving direction and the mass of vehicles. On through streets with prevailing high speeds, slow driving vehicles should not be allowed; the traffic flows should mostly intersect at different levels. Pedestrians and bicyclists are separated from the motorized vehicles, and bicycle lanes are constructed. In places where traffic flows intersect, the driving speed is reduced (traffic-lights, roundabouts, etc);
- recognisability/predictability – to help road users recognize the category or type of street. A general view of the street should help the road user decide what sort of behaviour is expected. In order to facilitate a clear distinction between the road categories, the number of road classes should be restricted. Each category should have its own geometric parameters, which should be clearly different from other categories. When the street is ”recognizable”, the road user knows at which speed to drive, whether to expect traffic from side roads, and whether cyclists are likely to be on the road, etc.

Usually, streets are designed according to national standards and norms. There are many different classes, types and categories of streets, and the definition of these terms differs. The road user – the community - formulates two clear requirements for streets, i.e.:

- the possibility of drive fast and uninterruptedly, especially for long distances;
- the possibility of entering and leaving a street.

These two requirements correspond to two street functions, although they are very restricted. In order to ensure a sustainable street network, an intermediate link is necessary. Therefore, three street functions are defined, i.e. three different ways for different purposes and how the street is used [3] (Fig. 4):

- flow function – creates conditions for fast and uninterrupted movement (a speed limit of 50/70 km/h);
- distributor function – through intersections, collects and distributes traffic between different city districts and zones (a speed limit of 50 km/h);
- access function – using the exit roads provides entry to individual yards, shops, dead-end streets, etc. (a speed limit of 50/30 km/h).

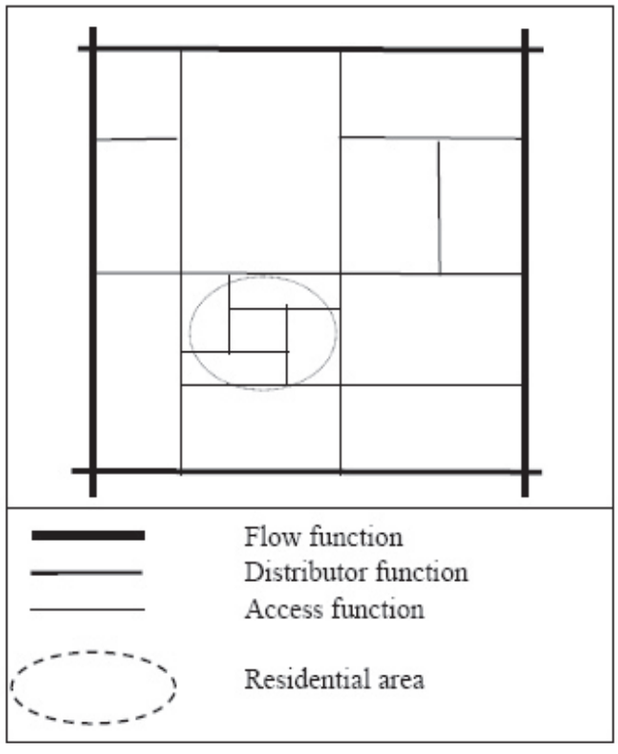

Fig 4. *Principal scheme of a city's street network*

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3. PROPOSALS FOR A SUSTAINABLE TRAFFIC SYSTEM IN LITHUANIA

When creating a sustainable and safe street network in Lithuania, it is necessary to follow a huge experience of foreign countries in the field of traffic safety and the above-mentioned principles of a sustainable traffic system. The realization of these principles would require a great deal of funds; thus, it is necessary to prepare a long-term national traffic safety strategy where the measures to improve traffic safety and reduce the number of accidents in Lithuania would be implemented step-by-step by setting priorities.

In Lithuania the street network should be divided into three functions. The ”fast traffic” streets should fulfil the flow function, the ”main” and ”service” streets should fulfil the distributor function, and the ”subsidiary”, other streets and dead-end streets, should perform the access function. If needed, the existing street type should be changed into another type depending on what function the street actually fulfils. After the street network scheme is devised each of the street functions should be regulated by clear and obligatory infrastructural requirements, which would ensure good traffic safety and street capacity.

The access function streets should have a low volume and be designated for a limited circle of users: the streets of residential quarters, access streets to multi-storey houses, etc. The streets should be used only by those drivers who have to enter a certain structure on the street. Under different circumstances unfavourable conditions for through traffic should be created. The optimum speed should be set at 30 km/h. Since the access function streets are in closest proximity to residential areas, the infrastructure of these streets should first satisfy the needs of pedestrians and bicyclists. Pedestrians and bicyclists do not have to be separated from the traffic. The streets should be provided with unregulated at-grade intersections or ”raised” at-grade intersections. Also, various speed reduction measures should be implemented on those streets (speed bumps, plateaus, raised or narrowed pedestrian crossings, safety islands, etc).

The distributor function streets should connect residential quarters and create the possibility to reach the city centre. The network of these streets should form the main street network and ensure an average degree of comfort communication for small and medium distances. The streets would have a limited, and as small as possible, number of intersections with through streets and more intersections with access streets. Much attention should be paid to the infrastructure of the intersections; the priority should be made to use roundabouts or traffic light intersections. The speed limit should not exceed 50 km/h. Due to the relatively high speed limit and high volume, it should be necessary to separate the pedestrians and bicyclists. In order to maintain safe traffic conditions, engineering speed reduction measures should be implemented, with regulated or raised pedestrian crossings, safety islands, and pedestrian islands.

The flow function streets are those designated for fast, comfortable and safe traffic. They are continuations of important rural roads through cities, or high volume roads connecting different parts of the city. Depending on the circumstances, the speed limit could rise to 70km/h. It would be necessary to separate the directions of the opposing traffic. Due to the high speed limit, the streets should be subjected to the highest requirements and restrictions: closed to pedestrians and bicyclists, unregulated intersections, bus stops, left-turn lanes, etc. The priority should be to have grade-separated or traffic light intersections and roundabouts.

The main problem of traffic safety in Lithuania is that almost all drivers go faster than is permissible. Lithuanian practise to reduce the speed of vehicles in residential areas is to use traffic signs. However, the experience in many countries shows that speed reduction with the help of traffic signs is a very ineffective measure. The drivers could be effectively stopped not by the traffic signs, but by the road infrastructures or enforcement measures. Various solutions could be used to reduce the speed: roundabout or traffic light intersections, raised pavements, various forms of islands to curve the moving trajectory and to reduce speed at the same time [4].

Obviously, the three functions mentioned would create rather different traffic conditions. Thus, a street will be safe if it is designed and used for one function. Naturally in practise this is rather difficult to realise, and it is necessary to look for various combinations. When combining various solutions, it is necessary to avoid such combinations which would have a significantly negative effect on traffic conditions. An especially dangerous combination is when the through street fulfils the distributor or even the access function. Therefore, when planning a street it is necessary to make a detailed analysis as to what function the street should fulfil and to choose engineering solutions which will correspond to the required street function and prevent the street from improper use [3].

4. CONCLUSIONS

1. Lithuania is one a few European Union countries where more than 200 people are killed in road traffic accidents per 1 million inhabitants. Based on the international statistics on traffic accidents, Lithuania takes first place among the EU countries according to the number of people killed in road traffic accidents;
2. Contrary to most EU countries, the number of road traffic accidents in Lithuania has been increasing each year. This shows that the currently used traffic safety improvement measures are evidently insufficient or ineffective. The high number of

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accidents in Lithuania is essentially related to irresponsible planning of street networks, imperfect legislation and the lack of responsibility in the road users behaviour;

3. According to the foreign countries that are advanced in the field of traffic safety, sustainable traffic safety is the result of interactions between the street infrastructure, legislation, vehicles and road users;
4. In order to ensure safe traffic in Lithuanian residential areas, a sustainable street network should be created, the basis of which will be three traffic functions: the flow, the distributor and the access functions. When planning a street, it is necessary to make a detailed analysis as to what function the street should fulfil and choose engineering solutions which will correspond to the required street function and prevent the street from improper use;
5. It is important that the street elements correspond to a city speed limit of 50 or 30 km/h. Various street functions are characterized by them own infrastructure;
6. A residential area is primarily a concentrated site for pedestrians and bicyclists. Therefore, these road users shall be separated from the traffic flow where the speed is higher than 30 km/h. In order to make a pedestrian crossing as safe as possible, measures and engineering solutions are necessary to reduce vehicle speeds.

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