World Applied Sciences Journal 23 (8): 1112-1117, 2013
ISSN 1818-4952

DOI: 10.5829/idosi.wasj.2013.23.08.13130

System Approach to Elimination of Traffic Jams in Large Cities in Russia

Aleksandr Solodkij and Andrej Gorev
Department of Transportation Systems, Automobile and Transportation Faculty,
St. Petersburg State University of Architecture and Civil Engineering,
Vtoraja Krasnoarmejskaja ul. 4, St. Petersburg, 190005, Russia

Submitted: Jun 21, 2013; **Accepted:** Jul 17, 2013; **Published:** Jul 22, 2013

Abstract: The present article discusses a system approach to solving traffic problems in large cities in Russia, where traffic jams become more and more frequent. A complex of measures is described, which, if implemented systematically, will help efficiently improve the traffic situation, in particular: 1) increase in the throughput transport capacity of city streets and roads (using the entire width of the road for traffic, bringing the lanes' width to the values corresponding to the traffic velocity, using modern traffic-light regulation methods, sustaining the road usage coefficient at the value 0.7-0.8); 2) preventing massive violations of traffic rules (video monitoring, reforming the supervision authorities), 3) considering traffic requirements in urban development policies (altering urban development priorities), 4) increase in the quality of public transport operation (creating transportation hubs, introduction of separate traffic lanes and priority at crossroads, decrease in the loading of automobiles during the rush hour). It is emphasized that the desirable result can only be achieved through an integrated approach towards the above-listed measures, as implementation of just some of them, but not all, will not help to eliminate traffic jams.

Key words: Transport systems · Large cities · Traffic jams

INTRODUCTION

In this country, traffic organizing and safety problems in large cities have been topical for quite a few years due to the ever-growing number of cars and the inertia of infrastructure systems [1-2]. Lately, the problem of traffic organization has passed from specialists' discussion to the highest political level [3]. Many different ways of traffic jams elimination are being contemplated [4]; nevertheless, these discussions mainly deal with particular measures, which, however well-conceived, cannot ensure solving those problems when implemented separately [5]. The solutions to traffic problems in large cities in Russia are no secret know-how, or classified technical projects and schemes, by any means. We have an extensive experience from large cities in Western Europe, as well as technologies related to its implementation in Eastern Europe [6-8]. What is required is analyzing not separate solutions but the entire totality of political, economical and organizational measures that proved their efficiency and adapt those measures to the situation in this country.

MATERIALS AND METHODS

The present article is based on the long-term investigations of regularities of movement of a separate vehicle and the traffic flow in streets and roads in a large city. The example of the change of the actual throughput transport capacity in a trunk highway that the present article discusses is an easy-to-see demonstration of system modeling of traffic flows in a modern large city. The method of balanced development of transport systems is used. An integrated wide-scale analysis of the traffic control problem is discussed for saturated traffic flows in traffic jam situations. The scientific analysis is based on selection of the kind of transport on the economical basis - fuel cost, ticket price and the quality

Corresponding Author: Aleksandr Solodkij, Department of Transportation Systems, Automobile and Transportation Faculty, St. Petersburg State University of Architecture and Civil Engineering, Vtoraja Krasnoarmejskaja ul. 4, St. Petersburg, 190005, Russia, Tel: +7(921)7461671.

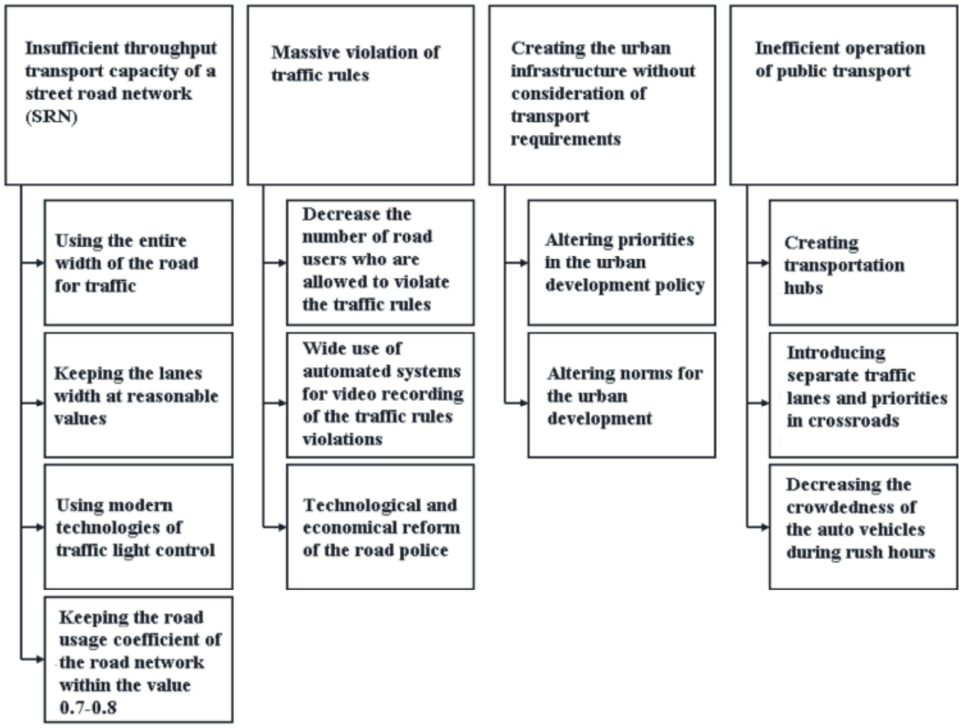

Fig. 1. Basic integrated methods for solving the problem of traffic jams

feature - convenience of door-to-door travel (time factor). A target function is given for estimating the efficiency of engineering projects depending on their role in decreasing the total travel time for inhabitants.

The Main Part: Let us consider the ways to solve transport problems on the example of St. Petersburg (Fig. 1).

Increase in the throughput transport capacity of SRN (street road network) can be achieved in the following ways:

- Using the entire width of the road for traffic. The Russian practice of using the traffic ways for parking in the road is inefficient, because the expenses for road building are three times as high as the expenses for creating parking spaces. The throughput transport capacity of street road network in urban areas being as deficient as it is, the current urban development policies are based on maximizing the areas taken for buildings and keeping the streets as narrow as possible. This aggravates traffic problems. It is noteworthy that limiting the vehicles access to the city center is best solved through organization of parking places [9].
- Keeping the lanes width at reasonable values. This is one of the necessary prerequisites for implementing automated systems for traffic control (ASTC) [10]. In a large city there are a lot of streets with motor-car traffic only; therefore, the lane width 3.5 m with the traffic velocity 40 km/h seems somewhat outdated.
- Using modern technologies of traffic-lights control. The co-coordinative, situational and adaptive control can ensure up to 20 % increase in the throughput transport capacity of the SRN. Besides the increase in the throughput transport capacity, the adaptive control methods alone make it possible to implement the safest mode “red to all” during the dark hours when the accidents consequences are the most severe.
- Ensuring the road usage coefficient of the SRN within 0.7 - 0.8. This allows efficient traffic regulating. As the throughput transport capacity is near the limit and the road usage coefficient is near the value of 1, even the most expensive ASTC becomes inefficient. Decreasing the SRN loading is achieved through separating local and through transit flows, transport specialization of streets and balancing the throughput transport capacity in different sections of

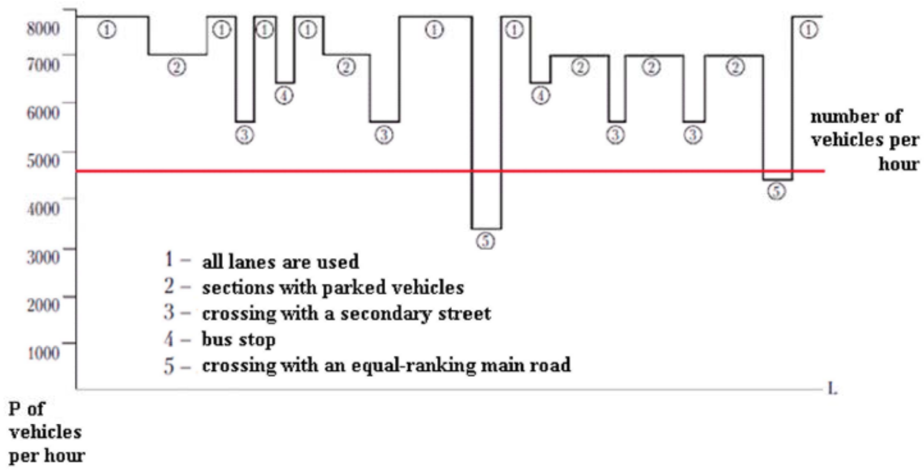

Fig. 2. A typical graph of the throughput transport capacity of a main road in the city

the road network. Creating bulges in the approaches to crossroads is one of the most widely-used and efficient methods to increase the throughput transport capacity of the SRN [11]. Widening the approaches to crossroads can be in the form of an additional lane for the traffic turning left, because it is those flows that create the most setbacks and often block one lane completely. In this case, there is an odd number of lanes, with the middle lane dedicated to the left-turning traffic in both directions. It is also desirable to create an additional lane for the right-turning traffic, as the vehicles that turn right have to give way to pedestrians and, therefore, they also block the lane. Ideally, the crossroads need to have the same number of lanes for going straight ahead as the number of lanes in the highway sections between the crossroads [12].

An example of changing the actual throughput transport capacity of the main road (Fig. 2) [13]. The example is a main road with four lanes in each direction; the graph illustrates the throughput transport capacity in one direction. The road is built along the universally-used scheme: four lanes in each direction without changing the road width and the number of lanes. The maximum throughput transport capacity is in the straight sections where there are no obstacles (Fig. 2 they are marked with the digit 1). If parked vehicles are present (sections marked with 2) the throughput transport capacity is decreased, similarly with the sections with public transport stops (sections 4). At the crossings with secondary streets (sections 3), the decrease in the throughput transport capacity will depend on the ratio between the traffic flows in the main and the secondary streets, which determine the traffic-light operation. At the crossings of roads with similar traffic densities (sections 5) the throughput transport capacity in the corresponding direction is less than a half of the throughput transport capacity in straight sections of the highway and, if the left-turning traffic is significant, this can be even more decreased. In order to simplify the initial conditions, let us assume that the traffic in this direction is approximately uniform in intensity (a red line in the illustration). In such a road, there will be sections of quite diluted and comfort traffic flows (sections 1 and 2) and the locations with constant traffic jams - at the crossings with equal-ranking streets (5), where the traffic flow exceeds the throughput transport capacity. This is typical for most of our cities. The traffic movement regime is very erratic, which causes increased negative impact onto the environment - higher output of exhaust gases in the acceleration-deceleration regimes and in the idle-running regime; traffic safety is also compromised. The time losses in the traffic jams at the crossings of equal-ranking streets will also be significant. This causes negative impact onto the social-economical situation for the SRN users and the society as a whole [14].

For this particular example, the most efficient solution could be projecting a road that has not four, but three lanes in each direction, but with increased throughput transport capacity due to using layout solutions that increase the throughput transport capacity in sections with more difficult traffic conditions. An example of improving the throughput transport capacity is shown in

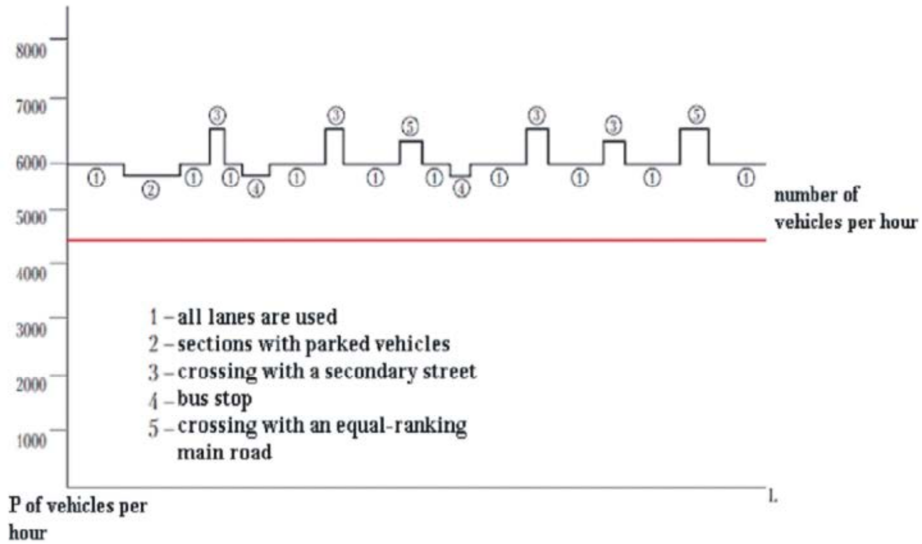

Fig. 3: A graph of the throughput transport capacity of a main road in the city with improved traffic conditions

Fig. 3. In the sections (2 and 4), where there are parked vehicles and public transport stops, there are "draw-ins" ensuring sustained traffic in all the lanes. At the crossings with secondary streets (3), in the approaches to the crossroads, there are additional lanes for the traffic turning left and right. At the crossing with equal-ranking roads (5), there is a partial interchange, where the straight-going flow on one of the main roads is passed onto a viaduct, the turning flows have their own dedicated additional lanes and they are separated by traffic lights. The maximum throughput transport capacity of such main road is decreased, but it is quite uniform along the entire length of the road, without nodes that have traffic jams. The same volume of traffic will be moving with better comfort. There is a possibility to coordinate the operation of traffic light points. The velocity of traffic is increased twice, with similar decrease in the negative impact onto the environment and traffic safety. Therefore, the cost-efficiency of SRN development is improved [10].

The methods of enforcing the traffic rules (TR) are widely-known and are paid special attention in the countries with a large number of vehicles. In order to ensure observance of TR in Saint Petersburg, at least the following measures must be taken:

Making the Traffic Rules Compulsory for All the Road Users, Without Exception: The traffic rules are there to make traffic safe for all the road users. The world experience shows that the main factor in traffic rules observance is the public opinion. In order to improve the situation, the elite of the society must play an important role, which is not going to happen as long as they do not obey the traffic rules.

Automated Recording of Rules Violations: Field investigations showed that, in some crossroads, about a third of drivers pass the crossroads under the red light and installing an automated video recording system will pay back in six months' time even without considering a decrease in the number of accidents.

Road Police Reform: The main work for ensuring road safety shall be done during forming the public opinion directed at safety problems, access to the job, access to the transportation market and supervising the transporters' operation.

Urban Development Policy: In the sphere of urban development policy, the following measures must be implemented: First of all, the transport planning level must be improved, with its priority over the interests of the development organizations. At the present moment, the "Center for Transport Planning in Saint Petersburg" has been created; a transport model for the city has been created and is under further development.

The assessment of transport infrastructure objects must be done not according to the minimum cost, but along the universally-used world methods that take transport efficiency into consideration, but not the costs

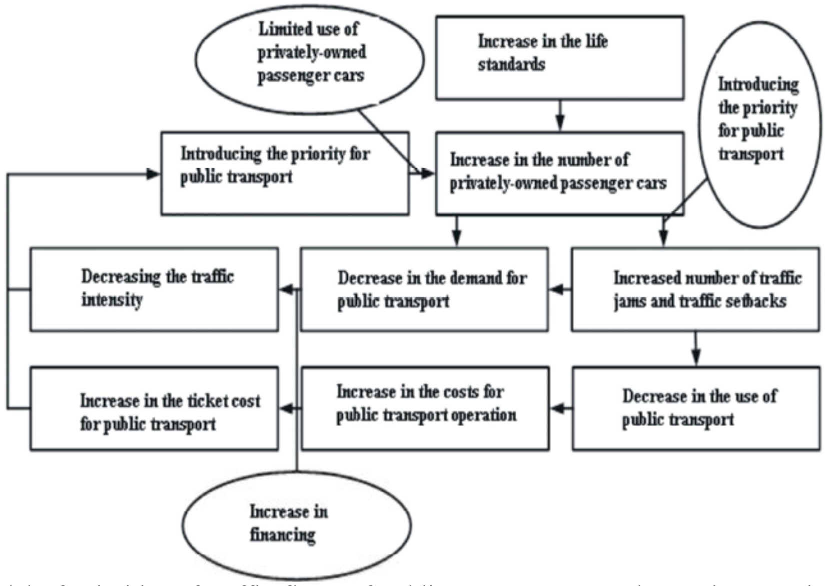

Fig. 4: A structural model of priorities of traffic flows of public transport as an alter-native to using private-owned passenger cars

alone. For the transport system working in the interests of the population, the target function is calculated by the minimum required time for all the travels and it will have the following form:

$$F = \Sigma (Q_{ij} T_{ij}) \rightarrow min,$$

where Q_{ij} is the number of travels, in people per hour; T_{ij} is the time required for travel, in hours.

Therefore, the project for the city will be efficient if it helps decrease the total time spent for travels [11]. In the process of projecting the urban development objects, the actual capacity of parking spaces shall be taken into consideration.

Development of Public Transport: The most important tasks in this sphere are the following [15]:

- Observance of traffic time-schedules and increase in the traffic velocity due to introduction of separate traffic lanes for road transport and separated lanes for rail vehicles.
- Introducing the traffic-light priority for public transport. This is not only the necessary prerequisite for quality of service, but a condition for efficient use of the automobiles park and a practical alternative to increasing the number of public-transport vehicles [16].
- Lanes for urban passenger transport (UPT) is the most cost-efficient variant for developing public transport in a large city. A structural model of such process is shown in Fig. 4. When creating a high-priority lane, it is necessary to ensure actual absence of obstacles along the entire path in the main routes from the initial to the terminal point.
- Creation of transportation hubs makes it possible to greatly decrease the time required for passenger travel. For economical and comfort reasons, the public transport velocity is to be kept within 25 km/h. Respectively, the decrease in the time required for travel can be achieved through decreasing the time required for transshipment. Such transportation hubs need to be created as soon as possible [17].

CONCLUSIONS

For implementing the complex of measures discussed herein for Saint Petersburg, the main setback is absence of a clearly-defined transport policy, unclear division of responsibility in the sphere of traffic organization and safety between different levels and power authorities. The main causes of transport problems (firstly, the traffic jams) at the moment can be grouped in the following main directions:

- Insufficient throughput transport capacity of the road network.
- Massive violation of traffic rules.
- Creating of the urban infrastructure without consideration of transport requirements.
- Inefficient operation of the public transport.

REFERENCES

1. Gol'ts, G.A., 2002. The road-transport industry during explosive motorization: Tendencies, patterns and forecasts. Studies on Russian Economic Development (Problemy Prognozirovaniya), 13(4): 387-393.
2. Eijbergen, B., L. Thompson, R. Carruthers, K. Gwilliam and R. Podolske, 2004. Russia: The transport sector. In World Bank Policy Note. World Bank, Washington, US. Report No. 33902, pp: 110.
3. Road safety performance: National peer review. Russian Federation. In European Conference of Ministers of Transport (ECMT). 2006. Paris, FR: ECMT Publish. pp: 141.
4. Carpintero, S., G. Camos-Daurella and R. Barcham, 2010. Relieving road congestion through motorway concessions in Moscow. In The sustainable city VI: Urban regeneration and sustainability (WIT Transactions on Ecology and the Environment. Vol. 129). Eds. by C. Brebbia, S. Hernández and E. Tiezzi. Southampton, UK: Boston, US: WIT Press, pp: 71-82.
5. Filina, V., 2008. Competitiveness problems of the national transportation system. Studies on Russian Economic Development, 19(3): 248-261.
6. Litman, T.A., 2012. Smart congestion relief: Comprehensive analysis of traffic congestion costs and congestion reduction benefits. In the Transportation Research Board (TRB) 91st annual meeting. Washington, D.C. January 22-26, 2012. Paper P12-5310. Victoria, CA: Transport Policy Institute, pp: 46.
7. Paniati, J., 2004. Operational solutions to traffic congestion. Public Roads, 68(3): 2-8.
8. Traffic congestion in Europe. Report of the hundred and tenth round table on transport economics, held in Paris on 12th-13th March 1998. In European Conference of Ministers of Transport (ECMT). Paris, FR: Economic Research Centre, pp: 238.
9. Lam, W.H.K., M.L. Tam and M.G.H. Bell, 2002. Optimal road tolls and parking charges for balancing the demand and supply of road transport facilities. In: Transportation and traffic theory in the 21st century. Proceedings of the 15th International Symposium on Transportation and Traffic Theory, Adelaide, Australia, 16-18 July 2002. Ed. M.A.P. Taylor. Amsterdam, London, UK: Pergamon, Elsevier, pp: 561-582.
10. Schnabel, W., D. Lohse, L. Lätzsch, *et al*., 2011. Grundlagen der Straâenverkehrstechnik und der Verkehrsplanung (Beuth Studium) [Fundamentals of traffic engineering and transport planning]. Band 1: Straâenverkehrstechnik [Vol. 1: Road transport technology]. Berlin, Wien, Zuerich, DU: Kirschbaum, Beuth Verlag, pp: 619.
11. Solodkij, A.I., 2013. Projecting cost-efficient road networks in cities. Zodchij, 1: 80-82.
12. Litman, T.A., 2012. Mobility management solutions to transport problems around the world. In Cars and carbon: Automobiles and European climate policy in a global context. Ed. by T.I. Zachariadis. New York, US: Springer, pp: 327-354.
13. Gorev, A.J.E., 2006. Increase in transport accessibility in the territory of St. Petersburg. Bulletin of Civil Engineers, 3: 45-48.
14. Solodkij, A.I. and V.V. Kalinina, 2012. Increase in the efficiency of road networks in cities (on the example of St. Petersburg). Road Power, 40: 32-36.
15. Gorev, A.J.E. and A.M. Dacjuk, 2004. Managing the complex of road passenger transport in St. Petersburg. Bulletin of Civil Engineers, 1: 30-33.
16. Ortuzar, Ju. D. and L.G. Willumsen, 2011. Modelling transport. Oxford: Wiley-Blackwell Ltd, pp: 606.
17. Gorev, A.J.E., 2002. Optimizing the system of passenger transport management in St. Petersburg on the basis of information technologies. In The collection of reports International scientific and practical conference "Reconstruction of St. Petersburg - 2003". Vol. 2. St. Petersburg, RU: State Architect. Civ. Engin. Univ. Press, pp: 120-122.