Research of the possibilities to increase the traffic capacity of streets in the central part of Irkutsk

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Abstract. The article presents the results of the research of the travel time of private cars and route passenger vehicles, depending on the presence or absence of cars parked along the street. The research is conducted in one of the busiest streets located in the central part of Irkutsk, where one-way traffic is organized. The increase in the level of automobilization and the development of the historic part of the city resulted in a sharp increase in the number of parked along the street cars. This situation caused a significant decrease in speed and, accordingly, an increase in the time spent on a trip. As a result of the research, it has been established that restricting or even a complete ban on parking (and corresponding control over its execution) in the busiest part of the street will increase significantly its traffic capacity and travelling speed of either private cars or route passenger vehicles.

1. Introduction

The level of automobilization in Russia is increasing despite any crises in the economy. This fact corresponds mainly to the situation in large cities where the most economically active part of the population live and the average wage level is higher (Figure 1).

![Figure 1. Dynamics of the level of automobilization in the USSR and Russia.](image-url)
In Moscow, St. Petersburg, Primorsky Krai, Kamchatka and other large Russian cities, the level of automobilization exceeds the figure of 300 cars per 1 000 citizens. However, the level of automobilization in Russia has not reached the level of developed countries of the world yet. For example, in the United States as early as the beginning of the 2000s, there were more than 800 vehicles per every thousand inhabitants, and in Western European countries - 500-600. Improving the economic situation of population results in a significant change in public infrastructure and increased mobility, and it is the reason for the automobilization of the population. However, it should be admitted that, in recent years, the growth in the level of automobilization has stopped. Moreover, in a number of economically developed countries, a reverse process is observed [1].

Certainly, the use of private cars to commute daily, to travel for work purposes during the business day, as well as for cultural, routine and other purposes, grows along with the growth of the level of automobilization [2]. A certain peculiarity of our mentality is imposed on this situation: the majority of Russians consider owning a private car, especially a large non-road vehicle, a sign of status and success. People wish to reduce the time spent on travel and increase their comfort. All mentioned above reasons increase level of congestion, in some cases, decrease the speed of vehicles and cause stoppage of traffic [3]. The following factors also adversely affect the transportation situation in cities:

- the peculiarities of the historical development of cities, especially the old ones: government bodies, offices of private, municipal and state enterprises, cultural institutions, trade facilities are located in the center, this situation causes centripetal transport and passenger traffic in the morning and centrifugal one in the evening;
- irrational modern development of territories: constructers often do not leave the area to develop transport infrastructure to organize route passenger traffic;
- unsatisfactory operation of urban route passenger transport in a general sense of the word: irrational route network of regular transportsations, low comfort of the trip, the need to walk for a long time to a bus stop and stand waiting for a bus, unpredictable waiting time, need to stand while a long distance trip, heat or cold in the vehicle, trip duration, including changing means of transportation;
- lack of priority for scheduled vehicles that perform regular transportation that forces them to wait in the same congestions or traffic jams like all other vehicles.

Everything can be explained by the fact that city authorities often do not have a clearly formulated long-term transport policy aimed at creating a city transport system that would give residents and visitors to the city opportunity to move comfortably and quickly [4].

In the aggregate, these factors lead to the situation when a person buys and after that operates a passenger vehicle with the aim of daily business trips in order to avoid problems arising while using the city route transport. And the already mentioned mentality of Russians plays the significant role.

The increase in the number of vehicles and the corresponding traffic in conditions of an objective increase in the mobility of citizens as well as the simultaneous lagging of the development of the road network (RNW) inevitably leads to a decrease in the speed of movement, an increase in the duration of the trip and the occurrence of congestion [5].

Thus, in a number of cases, a well-known paradox arises: the car was invented and developed rapidly precisely in order to increase the speed of travel, shorten the time of the trip (or, at the same time, increase the distance of the trip). However, at present, in large cities, the opposite situation is observed: the growth of automobilization causes a decrease in the vehicle speed and, consequently, an increase in travel time [6]. Hence the purpose of the research: to assess the possibility of improving the quality of transport services to the population by optimizing the policy of Parking on the street and road network of cities.

2. Materials and methods

All the aforementioned poses a very difficult and complex challenge to be solved by the city authorities: what can and should be done in order to ensure predictable, comfortable and fast transportation for residents and guests of the city in the conditions of continued growth of mobility. It is obvious that the
insufficient attention of the city authorities and society as a whole to the development of approaches to solving existing problems will only aggravate their solution in the future. The experience of a significant number of countries and cities that faced similar problems much earlier is known, indicating that the growth of automobilization (first of all passenger vehicles owned by citizens) led to a decrease in average speed, congestion and ultimately increased travel time [7].

In the city of Irkutsk as a whole, and especially in the central (historical) part, a similar situation has developed: a significant decrease in the speed of the transport flow is typical. Additionally, the problem is aggravated by the fact that private used for daily trips cars require a considerable amount of parking space. Private cars often park right along the traffic way and stay there for the whole day time (sometimes in violation of traffic rules). The result of such situation is that the accessible to transportation traffic way becomes more narrow, the capacity of the road and street network decreases; and, consequently and most importantly, reduction in speed, which in turn increases travel time, traffic fatigue and also harmful emissions [8].

To conduct experimental research, located in the central part of Irkutsk Dzerzhinsky Street from its intersection with Lenin Street to the intersection with Litvinov Street was chosen. One-way traffic is organized in this street. The analysis showed that, on average, 203 cars parked in the street along the traffic way during the day. The distribution of parked cars in the street is uneven, but the results of research showed clearly that the accessible to vehicles’ movement traffic way is reduced from three to two lanes, and in some sections to one lane.

This street was chosen for the aims of the study due to the following reasons:

- the traffic is heavy in the street, either private cars or route vehicles;
- a large number of retail space, office buildings, which are places of attraction;
- a large number of parked along the street cars.

Experimental studies were conducted on working days:

- During peak hours, when the intensity of movement of cars and passenger vehicles traffic is maximum, as well as the maximum number of parked along the street cars.
- In the evening after 09:00 pm, when the street was free of parked cars.

The time for trip through the street section by a route passenger vehicle was recorded. In the same way, the travel of a private car time for the same section was recorded.

3. Results and discussion

The research results are presented in figure 2 and figure 3. Here, on the left, the diagrams indicate the travel time during peak hours, and on the right, in the evening after 09:00 pm. The ordinate axis shows the time of the travel through the section in minutes, the abscissa shows the date.

Analysis of the collected statistical data allowed one to conclude that the travel time in relation of the street section, passed either by a private car or by a route passenger vehicle, depends significantly on the number of parked cars and a number of other factors. They follow the normal distribution law (figure 4 and figure 5).
Figure 2. Results of Measuring the Travel by a Car Time.

Figure 3. Results of Measuring the Travel by a Route Passenger Vehicle Time.
Figure 4. Time Distribution of Travel by a Private Car: (a) peak time (cars parked along the street); (b) post-peak time (cars not parked along the street).

Figure 5. Time Distribution of Travel by a Rout Passenger Vehicle: (a) peak time (cars parked along the street); (b) post-peak time (cars not parked along the street).

In parallel with the study of the travel along the street section time, traffic intensity was estimated. Intensity was measured by counting vehicles travelling through this section at the morning and evening peak hours, as well as during the inter-peak times. The average traffic intensity was: for cars, 903 cars/hour, and for buses, 222 buses/hour.

The results of statistical data processing are presented in Table 1 and Table 2.
Table 1. Results of Statistical Data Processing, min

| Indicator                  | Private Car | Rout Passenger Vehicle (Bus) |
|---------------------------|-------------|------------------------------|
|                           | Post-peak time (cars not parked along the street) | Peak time (cars parked along the street) | Post-peak time (cars not parked along the street) | Peak time (cars parked along the street) |
| Minimum value             | 2.56        | 2.97                         | 4.02                               | 4.12                                |
| Maximum value             | 2.97        | 3.21                         | 4.38                               | 4.61                                |
| Average value             | 2.78        | 3.07                         | 4.19                               | 4.41                                |
| Dispersion                | 0.01246     | 0.00324                      | 0.006856                           | 0.016632                            |
| Standard Deviation        | 0.361337    | 0.093947                     | 0.198817                           | 0.482337                            |

Table 2. Results of Experimental Data on the Travel along the Street Section Time

| Description | Average Travel along the Street Section Time, min | Increase in travel time at peak times, min. |
|-------------|-----------------------------------------------|------------------------------------------|
|             | Post-peak time (cars not parked along the street) | Peak time (cars parked along the street) |                                      |
| Private car | 2.78                                           | 3.07                                     | 0.29                                  |
| Rout Passenger Vehicle (Bus) | 4.20 | 4.41 | 0.21 |
| Difference, min. | 1.34 | 1.42 |
| Difference, % | 43.70 | 51.00 |

If we take into account the average capacity of a private car of 1.3 people, and of a bus - 40 people, the duration of parking along the street from 08:00 am to 08:00 pm, then the daily total time lost per only one section of the street will amount to:
- for private cars: 68 hours;
- for route passenger vehicles: 373 hours.

4. Conclusion
The following conclusions can be made on the basis of presented results:

1. The travel along the section of the street by a private car time is almost 50% less than by a route passenger vehicle one. If no appropriate measures are taken, the increase in the level of automobilization and, consequently, in both the intensity of traffic and the number of parked cars, will ensure the leveling of this difference [9].

2. Parked along the street cars have a more significant impact on private cars than on route passenger vehicles (as they actually move at a lower speed).

3. A further increase in the level of automobilization in the conditions of a lag in the development of route public transport will lead to a decrease in the traffic capacity of streets and an even greater loss of time for passengers.

4. Restricting or even a complete ban on parking along the street (and monitoring its implementation) will increase significantly its capacity, especially in terms of the number of passengers. This provision can be applied to streets with heavy route passenger vehicles traffic, but is also important for private cars.

In order to solve many existing and emerging issues, the relevant authorities should develop a promising transport policy [11] aimed at optimizing the use of limited urban spaces in order to create more favorable living conditions. Measures aimed at the priority development of route types of urban passenger transport, in particular, rail ones should be object of special attention. Additional attention should be paid to the increase in speed and traffic safety provision. Carefully planned urban transport
systems should enable urban residents to lead a socially active lifestyle, stimulate economic development, and promote the growth of labor productivity through their mobility [12].

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