Results of parking survey in the central part of Moscow for new tariff determination

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Abstract. The need to conduct a study of the parking space in the center of Moscow was caused by a significant overload of paid parking lots and, thus, traffic jams due to car mileage in search of free parking spaces in the central part of the city, increased noise and air pollution. Excessive loading of parking lots also leads to numerous violations of parking rules. The demand for parking within the Boulevard Ring is determined by the concentration of historical monuments, government agencies, museums, exhibition halls, shops, leisure facilities and other facilities that are extremely attractive to residents and visitors of the city. The results of one of the survey stages included the following: the inventory of existing car parking within the territory in question and the indicators of the current level of the parking space system development in the territory under consideration. The inventory included the analysis of parking place location with the allocation of parking lots on the street-road network, in underground and elevated capital structures, and in courtyards. Simultaneously with the monitoring, they carried out mass surveys of drivers parking cars in paid parking lots of the road network.

1. Introduction
The rational use of the parking space of any city always implies the lack of influence on the throughput of the street-road network, an efficient use of the city territory and, as a basic requirement, the provision of the transport system easy use, of which parking is an integral part [1, 2, 5, 7, 8]. The introduction of paid parking is urgently needed in cases where the above conditions are not met. The high pace of motorization in Moscow, the underdeveloped network of streets and roads, the lack of opportunities for the construction of spacious modern parking lots force us to take measures constantly to improve the transport system of the city. Only the improvement of this system can provide a balance of interests between individual users. The development of the public transport system in combination with all components of the transport infrastructure will solve the transport problems of the city.

2. Inspection of the parking space of Moscow
The demand for parking is mainly influenced by the planning features of Moscow, the historical tendency for the development of residential areas in the peripheral areas of the city and the concentration of employment places in its central part.
The studies included the inventory with the allocation of parking lots on the road network, in underground and elevated capital structures, with the record of the following data for each parking space: parking address, its type, capacity, number of vehicles, number of violations and monitoring with the record of car parking filling on weekdays during the following periods: morning hours from 6:30 to 7:30; daytime hours from 12:00 to 16:00; evening hours from 21:00 to 23:00. For the convenience of inspection and control, the studied area was divided into 40 polygons in accordance with the planning boundaries of the plots with an average area of about 15 hectares.

Thus, the total number (17239) of parking spaces was determined with a breakdown into the territory of the road network and the territory outside it, as well as the number of parked cars in the morning and evening hours. The ratio of parking lot number in the courtyard territories and capital structures to the number of parking lots located on the road network determines the possibility of parking space provision for residents permanently residing in this territory. Of the total number of parking lots (17239) there are 7435 lots (43.1\%) on the road network and 9804 lots (56.9\%) outside it. The ratio by polygons is significantly different and ranges from 1 to 39\%.

The number of parking lots for disabled people on SRN is 2.46\% and, taking into account the number of lots in the courtyard areas, it complies with the standards.

The distribution of the number of parking lots by the criterion of charging a fee: 8322 lots (48.3\% of the total) – paid parking, 8917 lots (51.7\%) – free parking.

Minimum tariffs contribute to the maximum use of parking space, but the search time for free space will be maximum. The maximum tariff corresponds to private underground parking, but their occupancy rarely exceeds 40\% even during peak hours. In general, it is necessary to strive for parking space occupancy at the level of 85\% – the figure generally accepted throughout the world. With this load, the time to search for free space will be minimal and accessibility of social facilities (pharmacies, government agencies, hospitals, etc.) will be maximum for car owners.

Figure 1. Occupancy of parking lots on the road network during daytime, \%
The greatest occupancy of parking lots was noted during the daytime (Fig. 1). This indirectly confirms that the bulk of trips to the central part of the city are labor trips involving a significant period of parking space use. With an average occupancy of the parking space of the territory in question during the daytime equal to 78 %, the occupancy values for different sites vary from 27 % to 148 %. In the morning and evening (night) hours, the occupancy makes from 10 to 100 %, with an average occupancy of 46 %. Traditionally, a large occupancy of parking lots was noted at the borders of the territory bounded by the streets with high traffic intensity.

The violations of parking rules are caused not only by the attempts to refuse to pay for the service, but can also be caused by the urgent need for short-term parking in the conditions of a significant shortage of parking spaces. Confirmation of this circumstance can be found during the analysis of violations when cars are parked at each of 40 allocated sites. The main conclusion: the busier the parking lot is, the more cars are parked with violations.

With an average relative number of cars parked with violations – 20.2 % (daytime hours) and 11.8 % (morning and evening hours), the number of cars parked with violations varies from 0.0 to 91.8 % (daytime hours) and from 0.0 to 26.9 % (evening hours) (Fig. 2).

Mass surveys of drivers parking cars at paid parking lots of the street road network were carried out simultaneously. The purpose of the questionnaire was to study the motivation of drivers during a parking lot selection and the difficulties this choice causes.

The questionnaire contained the following questions: frequency of paid parking lot use at the SRN; the purpose of the trip; the location of departure and destination points; time to search for a parking spot; the assessment of tariff level; source and amount of financial costs for parking.

To achieve statistical reliability of the survey results, the number of respondents amounted to more than 2500 people, from 50 to 70 questionnaires at each of the sites on average.

The analysis of driver questionnaire results on the issue of paid parking use frequency (Fig. 3) indirectly indicates that 58 % of respondents accurately use parking for business trips (weekdays and almost every day in the questionnaire), although other categories of drivers may also use parking for business trips. Quite a lot of respondents (17 %) use paid parking lots during visits no more than once a month.

The vast majority of respondents (70 %) answered the following to the question about the purpose of the trip to the central part of the city – the working one (Fig. 4). A working trip, as a rule, implies
that a car occupies a parking space for a long time, which is not released for a long time and the number of parking users during the day is negligible. Such a parking lot is only vacated in the evening hours. This state of affairs is unfavorable for other users and leads to the fact that the share of trips for tourism (4 % of respondents), cultural (13 %), sports (2 %) and other purposes (11 %) is small in the central historical part of the city. This is also due to the fact that the drivers who use parking for business trips occupy it earlier than drivers who use parking for other purposes.

Figure 3. Frequency of paid parking lot use (% of respondents)

Figure 4. Distribution of trips by purpose during paid parking application

Figure 5. Parking lot search time
One of the main characteristics of parking space use is the time spent by drivers to find a free parking lot. Among the respondents, 69% of drivers spent up to 10 minutes searching for a parking spot (Fig. 5). Due to the fact that the parking space is mainly occupied for a long time by parking lots associated with business trips, the question arose about the source of payment for parking. 39% of surveyed drivers said that their parking lot is paid by the employer.

The key point during paid parking consideration is the ratio of real (non-potential) users to the level of tariffs for parking. 47% of surveyed drivers rated the existing tariffs as high and 45% as satisfactory. Only 5% of respondents consider the tariff level to be low.

3. Conclusions
Based on the foregoing, the following conclusions can be made:

1. The results of the parking space inspection with a constant number of parking spaces in the central part of the city can be considered stable enough to carry out forecasts on the establishment of new tariffs for parking lot paying.
2. The main purpose of the trip to the city center is a working one, with a considerable duration associated with a low parking payment rate and the fact that up to 40% of parking is paid by the employer. Thus, the frequency of travel is directly related to the goal.
3. The duration for a parking place search in the vast majority of cases does not exceed 10 minutes, and in about half of cases – no more than 5 minutes.
4. About 50% of surveyed drivers rated paid parking rates as high and 5% as low. From 10 to 12% of surveyed drivers rate the tariffs as low – these are the drivers who have purchased subscriptions and use parking lots only on weekends.

4. Summary
Based on the study, the following proposals were made to change the payment rates for parking on the road network within the Boulevard Ring of Moscow:

- to increase the cost of parking;
- to limit parking time to 2 hours;
- to apply a progressive scale of payment for parking with a simultaneous increase of tariff for the second and subsequent hours of parking.

During preparation of the proposals, we proceeded from the fact that the use of paid parking should remain accessible to most residents of the city, and everyone should be able to come to the city center by car freely and park it when parking is really necessary.

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