

THE INFLUENCE OF THE CAR SHARING MARKET ON THE DEVELOPMENT OF GROUND TRANSPORT IN METROPOLITAN CITIES

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Abstract

The objective of this research is the study of trends in car sharing development and its influence on the performance indicators of ground transport in Moscow (Russia). The main methods of research are a comparative analysis of the performance indicators of the transport system of Moscow and other metropolitan cities of the world, a qualitative and quantitative analysis of the development indicators of car sharing in the capital. The results of the performed research have shown that profound transformations currently take place in the system of public transport in Moscow. In particular, since 2015 the innovation transport project of development of the car sharing services market has been implemented. It is aimed at reducing the number of private cars and increasing the mobility of ground city transport. The results of the two years of functioning of the car sharing market confirm the perspective of this type of services for improving the transportation comfort and mobility of the population of metropolitan cities. The main barriers for car sharing development are the limited transport infrastructure and persistent difficulties for fast movement of cars in the streets of the city, an insufficient number of cars of car sharing companies, high tariffs and their growth due to the increase in fuel prices.

Keywords: transport system, ground transport, metropolitan city, transport infrastructure, traffic, traffic congestion, traffic jams, car sharing.

1. INTRODUCTION

Currently, in many metropolitan cities of the world, there are a lot of problems related to the transport system itself and creating obstacles for improving the quality of life. One of the most important aspects of modern life in large cities is the overload of the transport system.

Moscow is among the top 15 agglomerations of the world with the population of 16.85 mln people (Demographia World Urban Areas 2018). Until 2010, the city authorities did not take any sufficient measures to correct the situation. As a result, the trips to the center of the city were difficult in the morning rush hour by almost any means of transport. This led to a significant decrease in transportation comfort for Muscovites. The largest part of day trips was made in the conditions of the peak load with long queues on the stops, overcrowded terminals, stairs and cash desks.

The main reason for the deterioration of transport mobility and an increase in the load on transport infrastructure and the street and road network of the city is the fast automobilization of the city. About 350-400 thousand cars are registered in Moscow annually. The annual growth is 8-10% of cars. According to the data of the Chief Highway Traffic Safety Administration of the Ministry of Internal Affairs of the Russian Federation, about 5.6 mln cars were registered in the capital of Russia in 2017.

In recent years, the authorities of Moscow have paid special attention to the solving of the problem of roads' congestion and have taken emergency measures to increase the transport mobility of the city. To create a safe, reliable and convenient transport system for all groups of population, in 2011 the Moscow Government developed the transport strategy that could bring the public transport of the city to the same level with the transport systems of modern metropolitan cities. The policy of the city authorities is aimed at limiting the access of private cars to the roads of Moscow and active development of public transport.

To optimize the work and comfort of passenger transportation in the central part of Moscow, the new route network "Main Road" was launched. Currently, the rail transport infrastructure is being massively constructed – metro stations, Moscow Central Circle (MCC), suburban traffic. The transport infrastructure is massively modernized; the ground transport fleet is renewed, etc.

The taken measures improved significantly the conditions of transportation in the city for inhabitants and guests of the capital: the demand for ground public transport grew among economically active passengers, the average speed of transportation increased, the number of traffic accidents reduced, the comfort, accessibility and quality of transport service improved.

At the same time, the problem of transport mobility in the metropolitan city is still urgent. Moscow is among the busiest cities of the world. According to the data of the research performed by INRIX in 2017, Moscow took the second place in the world among the cities with the biggest traffic jams (Inrix 2016). According to the calculations of the analysts, in 2017, a Moscow driver spent 91 hours in the traffic jams or about 26% of the total driving time. Besides, in Moscow there are many cars from the Moscow Region, people from the nearest towns go to work to Moscow every day and on weekends they come for shopping and entertainment in the center of the city.

The transport strategy of Moscow is still favorable for private cars in comparison with such cities as London, Stockholm, Milan or Singapore, Beijing, Bogota, where the measures to reduce the number of private cars are stricter. Car sharing can become one of the most promising forms of increasing transport mobility. This type of business is already widespread in the metropolitan cities of Europe, the USA and Japan. For Russia, it is a rather new model of business with untapped potential yet. Due to this, the study of the experience of car sharing projects' implementation and perspectives of development of this type of car rental is an urgent research problem.

2. REVIEW OF LITERATURE

In recent years, many works have been published that were dedicated to the research of the problem of modern metropolitan cities. Most studies distinguish that transport is one of the main problems of agglomerations all over the world, in the auto-dependent regions of the USA or Australia and in more transit cities of Europe or Latin America, China, India and Africa with their giant, fast-growing metropolitan cities (Kenworthy 2017).

The trends in the field of transport and urban development in different regions of the world were studied by Kenworthy (2013, 2014), Buehler and Pucher (2009), Buehler et al. (2017), Newman et al. (2016) and others. The environmental problems of the metropolitan cities related to the congestions on the roads are considered in the works of Cheewaphongphan et al. (2017), Gordon and Richardson (1989), Mishra et al. (2016).

The results of the research of Müller show that the innovative concept of public transport integrated into the long-term strategy of the urban development can transform completely the large metropolitan city (Müller 2014).

With an increase in urbanization, restricted availability of parking places and stricter environmental norms, service providers start learning the concepts of exchange of cars and trips as the potential alternatives (Fikar, & Hirsch 2018).

Ait-Ouahmed et al. (2018) notice that the car sharing system is a rather convenient service for the urban transport system that allows users to take the car in any convenient place and rent it for a short period of time (Ait-Ouahmed, Josselin, & Zhou 2018). Car sharing is a model of business that means the rent of the car for a short period of time and one of the most popular trends in the development of the sharing economy or the economy of shared use (Boldrini, Incaini, & Bruno 2018). Car sharing is an innovative mode of urban transport where a car sharing company offers its car fleet to provide short-term access to the car for driving around the city (Xu, & Ji 2018).

Some scientific studies of Cheng et al. (2018), Sun et al. (2018), Heinrichs et al. (2017) contributed to the development of the car sharing theory.

Di Febbraro et al. mention that car sharing companies face difficult problems of movement of cars to satisfy as many booked trips as possible. The authors offer a methodology of movement when users can agree to leave the car in an alternative place in exchange for the discounts for future trip orders. This will allow decreasing significantly the number of rejected bookings and increasing the profit of the operator having a relatively small number of transportation means (Di Febbraro, Sacco, & Saeednia 2018).

In the opinion of Standing et al., despite the existing growth of general services, the impact of the sharing economy on transport is not clear. Car sharing, probably, will be a part of solution of transport problems and congestion and may be used in combination with other technologies such as unmanned transport means. The authors also warn about the danger of excessive regulation and underregulation of the car sharing market. The future will require complete transport strategies that consider the possibility of exchange of variants and will require the joint work of the governmental authorities (Standing, Standing, & Biermann 2018).

Some studies aimed at estimating the impact of the environmental aspects of car sharing on the development of the metropolitan cities confirm that car sharing shall contribute to a decrease in greenhouse gas emission also due to the replacement of a private car with a car with more power efficient gas consumption and a decrease in the number of cars (Jung, & Koo 2018).

It should be mentioned that in recent years the attention to car sharing as an innovative model of urban transport development has been growing constantly and it causes the necessity of the further research of problems and determination of the perspective vector of car sharing development in large cities of Russia.

3. METHODS

The objective of this research is to determine the perspective directions of the car sharing market development to solve the problems of ground transport in Moscow as one of the largest metropolitan cities of the world.

To achieve the set objective, some problems are solved within the framework of this work:

- To analyze the modern state of the transport system in Moscow in comparison with other metropolitan cities of the world;
- To study the Moscow car sharing market and estimate its impact on the transport situation of the city;
- To study the foreign experience, the opinions of market experts and to determine the further actions for car sharing market development in the largest cities of Russia.

The methodological work is based upon the comparative analysis of the statistical indicators characterizing the state of the transport availability in Moscow and other metropolitan cities of the world such as population density, road density, and the level of automobilization.

The informational sources are the open data of the official sources such as the Federal State Statistics Service, the Government of Moscow, the International Association of Public Transport (UITP), the resources of the united transport portal "Moscow Transport", etc.

4. THE MODERN STATE OF GROUND TRANSPORT IN MOSCOW

Currently, Moscow is not only the capital of the Russian Federation; it is also one of the most developing metropolitan cities of the world.

The population density of Moscow exceeds the similar indicators of such metropolitan cities as Washington, Shanghai, Berlin, Beijing, Sidney, Rio de Janeiro, etc. (Geogoroda n.d.; Vasilev, Sazanov, & Ishkinyaeva 2016). At the same time, at the high population density and the impressive growth of automobilization of the city population, the density indicator of street and road network of Moscow is significantly lower than the indicators of the other metropolitan cities of the world (Table 1) (Geogoroda n. d.).

TABLE 1 - THE INDICATORS OF THE TRANSPORT SYSTEM OF MOSCOW AND OTHER METROPOLITAN CITIES

Metropolitan cities	Population density, people per sq.km	Availability of motor roads, m/car	Number of cars, mln units	Availability of cars, cars per 1000 people
Moscow	4,834	1.5	5.5	440
London	5,173	5.4	2.6	295
New York	7,033	5.3	2.2	259
Hong Kong	6,645	3.6	0.56	77
Singapore	8,190	18.3	0.61	109

By 2010, the situation in the transport system of Moscow had been close to critical. The actual load of all types of public transport when moving to the center of the city in the morning hours reached 1,020 mln people that exceeded the transportation capacity by 22%. The load of the road network exceeded the transportation capacity by 42%. The trip time by the public transport was in the average 67 minutes. The fifth part of Muscovites spent more than 3 hours on the way to work and back home.

The additional load on the road and street network of Moscow was created by the unregulated number of transport means of private commercial carriers. Every day more than 4.5 thousand buses of low passenger capacity drove along the main loaded roads of Moscow. The passengers waiting for a bus at bus stops obstructed the movement of cars and public transport.

In 2012, the Government of Moscow started implementation of the strategical program of transport development in the city (Resolution of the Government of Moscow No. 408-PP 2011). The main tasks of the program are the following: increasing the availability, safety, and predictability of work of public transport; improving the quality of transport service; increasing the speed of movement on the roads; introduction of innovative technologies into the urban transport system.

In 2015, all private carriers started to use the new model of passenger transportation that integrated private carriers into the general transport system of the metropolitan city. Private carriers can operate only on the base of the contract concluded with the city.

As a result of the planned modernization measures of the transport infrastructure, 90% of the total public transport fleet were renewed from 2010; 9,416 transport vehicles (trams, trolleybuses and buses) were introduced. Currently, the rolling stock of the Moscow ground transport is one of the youngest among the European metropolitan cities.

The suitability degree of the rolling stock of the ground urban passenger transport for the groups of population with limited mobility grew from 29% in 2010 to 82% in 2016. The measures are taken to develop a new route network in the center of the city. Meanwhile, 148 new routes of ground transportation were introduced and by 2017 there had been 1,007 routes.

Within the framework of the Main Road program, 19 main road routes, 16 district routes and 8 social routes were launched. To provide the 24/7 transportation, 11 night routes were organized and they cover about 25% of Moscow. 28 bus lanes of the total length of 287 kilometers work in the city. Every day, 1.5 mln people use bus lanes. Due to bus lanes, city carriers observe 94% of the timetable and passengers can get faster from any point of Moscow and predict more accurately the travel time (Results of Work of the Moscow Transport Complex in 2010-2016 2017).

5. CAR SHARING DEVELOPMENT IN MOSCOW

Moscow became the first city in the territory of the Russian Federation developing the car sharing services. In August 2015, changes were made into the Resolution of the Government of Moscow No. 289-PP issued on May 17, 2013 "Organization of Paid Urban Parkings in Moscow" that gave car sharing operators the opportunity to acquire parking passes at a reduced price. The cost of parking passes at a reduced price is 20,000 roubles per year, the validity is 3 years.

To receive the permission for parking passes, operators shall correspond to the set standards:

- Emission standard of cars Euro-4 and higher;
- Transport vehicles shall be equipped with the GPS/GLONASS system;
- Automobile third party liability insurance;
- The car should be not older than 1 year old since the date of application of submission for the benefit;
- The color scheme according to the approved branding;
- Rendering of services and support of clients 24/7 and every day;
- Free access to software for booking of cars.

The first car sharing company launched in Moscow was Anytime company, having the vehicle fleet of 150 cars. Currently, the vehicle fleet consists of 720 cars; the company renders services to 15,000 clients registered in its application. In June 2015, the car sharing company YouDrive was established and in September 2015 the launch of Delimobil was accompanied by the powerful marketing activity. Currently, 8.3 thousand cars are involved in the car sharing system, the number of registered users is 1,000 people (Table 2).

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TABLE 2 - THE INDICATORS OF CAR SHARING DEVELOPMENT IN MOSCOW

Indicator	2015	2016	2017	2 nd quarter of 2018
Number of cars	350	1,500	2,650	8,340
Number of registered users, thousand people	15	150	350	1,000
Number of trips, thousand	35	1,600	5,600	1,500

Some factors of economic, technological and social and psychological character impact significantly the development of the market. The dynamic growth of the car sharing market is explained to a great extent by the economic advantages of this type of services in comparison with the use of a private car.

The cost of car operation consists of some components: fuel, insurance, current repair, maintenance, taxes. At the same time, the main expenditure item is fuel and insurance. According to Rosstat, during the two years of car sharing development, the price for fuel AI-95 in Moscow grew by 10.14% from 36.7 to 40.5 roubles per liter.

Table 3 shows the comparative analysis of costs when using a private car and a shared car. The model trip of a Muscovite to work from home by Hyundai Solaris was taken as an example, the car was located in the area of the Garden Ring (Center of Moscow) at the distance of 25 km from the place of residence, the approximate time of active use of the car was 50 minutes taking into account traffic jams, 5 days per week.

TABLE 3 - THE COMPARATIVE COSTS FOR USE OF A PRIVATE CAR AND CAR SHARING SERVICES

Economic factors	Private car	Shared car
Fuel (calculated as: consumption of 7.8 liters per 100 km; driving distance 50 km per day, fuel cost 0.57 euro/l)	11.1	0
Third party liability insurance	1.9	0
Comprehensive and collision insurance	11.8	0
Depreciation (calculated on the basis of the depreciation period of 5 years)	25.3	0
Maintenance	2.6	0
Transport tax	0.9	0
Parking pass	45.3	0
Payment for using a car (calculated as: driving distance for 5 days – 250 km, planned time of one trip for 25 km taking into account traffic jams - 50 minutes, 0.11 euro/minute)	0	55
Total costs, euro	99	55

It should be mentioned that all costs for car maintenance are increased by 5-10% annually (depending on the model). It is evident that for rare trips or short distances around the city, car sharing is economically more efficient than a private car. At the same time, due to parking limitations, car sharing will not suit the residents of the districts located far from metro stations.

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Also, some factors of the social and psychological and technological character can be distinguished that restrict the involvement of users in car sharing services (Table 4).

TABLE 4 - FACTORS RESTRICTING THE INVOLVEMENT OF USERS IN CAR SHARING SERVICES

Factors	Private car	Car sharing
Social and psychological factors		
Availability and preservation of necessary auto accessories	Guaranteed	Not guaranteed
Psychological feelings	Familiar own space, confidence of safety of the car and passenger compartment	It is unfamiliar to use the car control mechanisms after many other strangers
Prohibitions (on oversize cargo, animals, smoking in the compartment, towing of other cars, leaving of personal belongings, etc.)	No	Available
Restrictions on the driving experience	No	Most car sharing companies require the driving experience from 2 years or increase the cost of the lease
<i>Technological factors</i>		
State of car health	The owner takes responsibility for the state of car health	The state of car health is guaranteed by the operator
Dependence upon the Internet and mobile services	No	Available. Supporting service can fail. Failures can be different: from insignificant when car rent cannot be canceled to the penalty for the actions that the client did not make.
Area of use	Unlimited	Limited
Availability and prompt use	Always available	Often there is no vacant car of any operator or it is necessary to walk for 10-15 minutes to the car. Besides, some additional time is necessary to inspect the car and to make photos of defects available

Currently, the car sharing service in Moscow is represented by 15 companies: Delimobil, AnyTime, YouDrive, Car5, BelkaCar, Rentmee, Carenda, Lifcar, EasyRide, Car4you, Carlion, Carusel, TimCar, Yandex.Drive, Matreshcar.

The comparative characteristic of car sharing operators in Moscow by the number of cars, rent area and cost of rent is shown in Table 5.

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TABLE 5 - THE COMPARATIVE CHARACTERISTIC OF CAR SHARING OPERATORS IN MOSCOW

Car sharing operator	Number of cars	Lease area	Lease (per minute)
AnyTime	720	Moscow and all suburban points, max. distance 200 km	Solaris and Rio: 0.11 euro; Rio, Kaptur and Kangoo: 0.04 euro (from 6 to 12 hours); Kaptur and Octavia: 0.12 euro; Qashqai: 11p; Audi A3/Q3: 0.18 euro.
BelkaCar	2,325	Moscow and Moscow Region	0.11 euro (BelkaCar economy-class cars); 0.12 euro (BelkaCar X middle-level cars); 0.19 euro (BelkaBlack business-class) Dynamic pricing
Delimobil	2,120	Moscow and Moscow Region	0.1 euro or 0.11 euro depending upon the tariff, from 6 till 12 – 0.04 euro
Car4you	150	Moscow and suburban roads, max 50 km from the city	0.11 euro
Car5	250	Moscow and Moscow Region	0.07 or 0.1 euro depending upon the car model
Carenda	30	Moscow	Ravon R2 – 0.08 euro; Solaris, Rio – 0.1 euro
Carlion	8	Moscow and suburban roads, max 50 km from the city	0.11 euro
EasyRide	50	Moscow and suburban roads, max 50 km from the city (additional charge for distance increase)	0.16 euro
Carusel	250	Moscow within 250 km from the city	0.05 euro and 0.1 euro depending upon the tariff. Age and driving experience restrictions: 0.11 euro and 0.14 euro, if the driver is under 21 or has less than 2 years of experience
Lifcar	250	Moscow and Moscow Region	Standard tariff is 0.08 euro, if the driver is under 21 and/or has less than 2 years of experience – 0.14 euro
Rentmee	200	From Saint Petersburg to Moscow (actually from Vyborg to Tula, Ryazan and Yaroslavl, about 1,000 km)	0.07 euro
TimCar	250	Moscow and Moscow Region	0.1 euro. On Monday – 0.09 euro. Discounts for some cars 0.07-0.08 euro.
YouDrive	900	Moscow and 250 km from Moscow Ring Road	0.11-0.19 euro/min depending upon the car model. BMW i3 – 0.2 euro/min. 15-50% discount for cars that are not leased for a long time
Yandex.Drive	750	Moscow, airports	0.07-0.08 euro in the morning, 0.1-0.11 euro in the afternoon and in the evening
MatreshCar	140	Moscow within 250 km from the city	0.12 euro – Smart ForTwo and ForFour 0.19 euro – Mazda 3 0.22 euro – BMW 3

BelkaCar is the leader of the car sharing market in Moscow in 2018. The operator has 2,325 cars and this allowed it occupying 27.9% of the Moscow market.

Delimobil takes the second place; currently, its car fleet is 2,120 cars, that is, 25.4% of the Moscow market.

The third place is taken by YouDrive with a significant margin from the leaders with the car fleet of 900 cars (10.8% of the market).

As a result of the performed reforms including the implementation of the car sharing project, the state of the ground transport of Moscow improved, the popularity of the urban ground transport increased and the quality of the transport system improved. According to the statistics, 1 car of car sharing service substitutes 10 private cars and this leads to a significant reduction of traffic jams. Thus, according to the data of TomTom, in 2017 the traffic congestion in Moscow decreased from 57% in 2010 to 44% in 2017 (The TomTom Traffic Index n. d.).

In 2016, the average speed of transport on the main roads in the morning and evening hours increased from 17 km/h to 26 km/h. The average speed of public transport in the rush hours increased from 14.85 km/h to 22.3 km/h (Fig. 1).

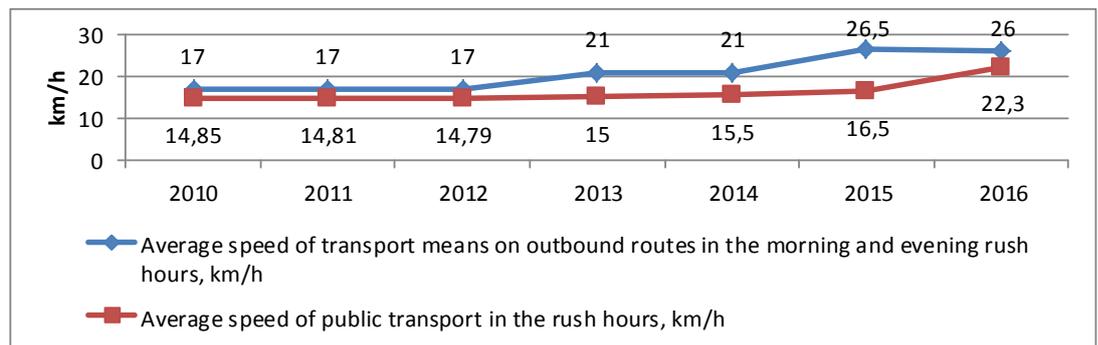


FIGURE 1 - DYNAMICS OF SPEED CHANGE OF TRANSPORT AND PUBLIC TRANSPORT IN MOSCOW IN 2010-2016

The average time of trip on public transport from the Moscow Ring Road to the center of the city decreased by 15%, from 67 to 57 minutes. Also, the level of observing the timetable of urban public transport increased from 76% of the total number of trips to 95%. The average traffic interval of the ground urban transport decreased from 7.7 minutes in 2010 to 6.2 minutes in 2016 (Figures and Facts, Transport 2016).

In general, car sharing in Moscow proved to be a service of high demand. During the first year of work, the indicators were achieved that could be compared with the cities where car sharing has been developing for many years already (Department of Transport and Development of Road and Transport Infrastructure of the City of Moscow 2016).

6. DISCUSSIONS

The participants in the car sharing market estimate it as a very perspective direction of the transport system development not only in Moscow but also in other large cities of Russia (Department of Transport and Development of Road and Transport Infrastructure of the City of Moscow 2016). In the opinion of the Operational and Chief Financial officer of "Yandex" Greg Abovsky, in 2018-2019 Moscow can become the largest car sharing market in the world (Interfax 2018). According to the Mayor of the

city of Moscow Sergey Sobyenin, by the end of the year, the total car fleet for the short-term rent will be at least 10-15 thousand cars. Moscow companies have already beaten all European cities by this indicator (Sobyenin 2018).

The experts distinguish the following main obstacles for the development of the short-term rent of cars in Russia:

- Transport infrastructure and congestions in the roads.

Congestions make difficulties for car sharing operators when planning and managing the car fleet as the users cannot return the car to the parking in time. To neutralize somehow this unbalance, the operators of congested cities often use the volumetric car fleet that provides the users with cars even in the period of traffic jams. Certainly, it leads to overexpenditures and downtime of cars in the interpeak period. Besides, traffic jams create the difficulties of planning their expenses for clients: some companies charge penalties for the delayed return.

To eliminate such problems, it is reasonable to consider the practice of Brazil and China where car sharing operators offer the tariff options to the clients with flexible time intervals or special terms of refund for unused hours.

- Lack of cars available for booking.

To stimulate the investments into the growth of the car fleet of car sharing operators, supportive measures of the city are required. Earlier, the subsidies were paid to support the legal taxi and compensate for part of expenses of rent of cars used for cabbings. In 2017, the Government of Moscow adopted a resolution according to which car sharing companies could get subsidies for the purchase of new cars (Resolution of the Government of Moscow No. 518-PP 2017).

The requirements for cars purchased for car sharing are stricter than for the taxi. The budget funds can be spent on purchasing a car not older than 3 years old (in comparison with 5-year-old cars for the taxi). Cars shall be assembled in Russia, the emission standard should be Euro-4, the maximal price –1.5 mln roubles.

- High tariffs and their growth due to the increase in fuel prices

Electric car sharing can become a perspective direction of development of ground transport. Thus, in 2019 the launch of the first joint project of electric car sharing of the Russian Direct Investment Fund (RDIF) and the international energy company Enel is planned. Electric cars

are becoming widespread in the countries of Europe and Asia where the car sharing market is developed already. The car fleet of Moscow operators can be extended due to the new models. The example is a two-seat electric car SEV, the serial production of which has been started in China. The car was developed especially for car sharing services. As a result, up to 4 SEV cars can be parked on one standard parking place. One charge of SEV is enough for 100 km of driving. The maximal speed of the car is 45 km/h. The characteristics for convenient driving in the large cities are sufficient. The price in China is 40,000 yuan (4,804 euro at the current exchange rate).

Thus, car sharing will contribute to the idea that a private car will not be accepted as something necessary any longer. The measures aimed at developing such an alternative way of movement around the city will allow decreasing the private car fleet, reducing the load on roads and improving the public transport movement.

7. CONCLUSIONS

The results of the research performed allow making the following conclusions:

Public transport is especially important for everyday life; the growth of automobilization creates new problems in the field of mobility and the sustainable development of the city.

The growth of atmospheric pollution caused by the exhaust gases, congestions on the roads and lack of parking places are the main driving forces of the car sharing market in the metropolitan cities.

The car sharing market is enlarging fast in the volume due to high flexibility that the companies rendering the car sharing services offer in comparison with the taxi.

The results of the first years of car sharing in Moscow confirm the reasonability of development of such services. Due to the reduction of trips by private cars, transport congestion in the center of the city and the main roads is decreasing. This contributes to an increase in the speed of transportation of cars on the roads, regularity, and quality of work of ground transport.

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