

User interest in car sharing as an indicator of sustainable urban agglomeration development

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Abstract. The use of car sharing instead of owning a car minimises the negative impact of logistics activities on the urban environment. This research aims to show that sustainable development of densely populated cities is accompanied by an increase in Internet users' interest in sharing services. The research of Internet users' interest in car sharing services was based on Google Trends data on search queries originating from Russia, the United States and Canada over the past five years. In the course of this work, the hypothesis was confirmed that high user interest in car sharing is mainly observed in urban agglomerations with high population numbers and density, where the positive effects of car sharing are most noticeable. The paper emphasises the need to encourage the creation of new services in urban logistics, which will contribute to sustainable development and increase the competitiveness of cities. It also confirms the hypothesis that the growing interest of Internet users in the new service is accompanied by an increase in the market volume. User interest in established car sharing markets is at a stable level, except for the occurrence of significant events (e.g., the emergence of a new major player in the market) that stimulate an increase in interest.

1 Introduction

Car sharing is one of the most important segments of the sharing economy, an economic model based on the collective use of goods and services, barter and renting instead of owning. The sharing economy seeks a more efficient use of resources with positive economic, social and environmental consequences [1]. Abandoning possession in favour of temporary access to a good or service makes the system more economically and environmentally efficient [2].

Car sharing is already widely used in many cities around the world, minimising the negative impact of logistics activities on the environment there. The positive effects of car sharing are confirmed by numerous researches. These effects include: reduction in the number of car owners in densely populated urban areas [3, 4]; reduction in the average mileage of cars and greenhouse gas emissions [5], reduction in the demand for parking spaces [6], reduction in traffic congestion and harmful emissions [7].

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A research of the experience obtained by car-sharing service customers has shown that one of their motives is the desire to reduce consumer spendings [8] By choosing daily ways of moving, the urban residents of megacities are increasingly giving up from using their own cars [9] These factors stimulate the development of car sharing services and have a positive impact on the sustainable development of cities.

Short-term car rental (car sharing) services began to develop in the 1970s. ProcoTip was launched in Montpellier (France) in 1971, Witkar in Amsterdam (Netherlands) in 1973 and STAR in San Francisco (USA) in 1983. [8]. However, after a few years, such projects became unprofitable and were closed.

In the 1980s and the first half of the 1990s, the car sharing market continued to grow slowly. Small, non-commercial services emerged, many of them were in Switzerland and Germany, and on a smaller scale in Canada, the Netherlands, Sweden and the United States [11].

In the second half of the 1990s, companies with more successful business models were established in Europe. The fleet and the number of car sharing users began to grow more rapidly.

In the 2000s, there was a car sharing boom in the United States and Canada. The number of car sharing companies, their fleet and the number of users showed their exponential growth. [10, 12]

Thus, by the second decade of the 21st century, the U.S. and Canadian populations were already largely aware of the existence of car sharing.

In Russia, car sharing only appeared in 2012, when Russia's very first car sharing operator, Anytime, began operating in Moscow. The development of car sharing is very dynamic. According to RAEC and TIAR-Centre (<https://raec.ru/upload/files/raec-sharing-economy-2019.pdf>), the volume of transactions in the car sharing sector in Russia grew from RUB 13 billion in 2018 to RUB 20.5 billion in 2019, and the number of trips grew from 37 million to 78.24 million. In 2017, the volume of transactions was only RUB 5.1 billion and the number of trips was 12 million.

The rapid development of car sharing is explained by the benefits it brings to users. They are able to choose the car model most suitable for a particular trip, they do not incur the costs of car ownership (parking costs, etc.), and they do not have the time costs associated with car maintenance [13]. A car sharing operator providing an adequate fleet size, efficient car allocation, and a sufficient number of available parking spaces for its cars makes car sharing systems very attractive for many city dwellers [14].

Our research objective was to show that sustainable development in cities with high population densities is accompanied by an increase in Internet users' interest in sharing services.

The authors proposed the following hypotheses: 1) the regions with the highest user interest in car sharing are among the urban agglomerations with high population size and density; 2) the increase in market volume is accompanied by an increase in the interest of Internet users in the new service.

2 Research methods

Research of car sharing is often hampered by the fact that official statistics and data from car sharing companies are fragmented. Therefore, one possible source of data on car sharing could be the search statistics provided by Google Trends (<https://trends.google.ru>).

Google Trends is a public web application that shows the popularity degree for keywords among Internet users of the Google search engine on different topics, in different languages, and in different regions of the world.

The tool is often used by researchers to monitor macroeconomic conditions [15], research demand in service markets [16, 17, 18], and investigate sustainable development initiatives [19, 20].

Google Trends normalises the resulting data for easy comparison of search queries, taking into account the time and place of sending the query. Each data item is divided by the total number of search queries in a particular region over a certain period of time, giving an indication of their relative popularity. The results obtained are ranked on a hundred-point scale according to the number of queries for the topic to all queries for all topics ratio.

The use of Google Trends provides a wide range of information about Internet users with a high frequency of updates [21]. At the same time, this method is not without its drawbacks. Among them are the fact that the geographical distribution of search data may not be accurate because IP addresses may not always be correctly located; keyword meaning may vary over time and across regions, which reduces the usability of data for analysis; and Google search engine rankings change over time, which can distort data, as various forms of censorship can [21].

The research was conducted in February 2021. The material for the research was statistical data from Google Trends on search queries originating from Russia, the United States and Canada for five years: from February 2006 to February 2021. First, the countries and sub-regions with the highest relative frequency of searches for "car sharing" and "karshering" (Russian pronounce for "car sharing") were identified. The relative frequency of searches in the Canadian, Russian and US agglomerations with the highest frequency over the last five years was then analysed.

3 Results and discussion

The positive effects of car sharing are most noticeable in urban agglomerations with high population densities. Table 1 shows the most populated urban agglomerations in Canada, Russia and the US, according to Wendell Cox Consultancy (<http://www.demographia.com/db-worldua.pdf>).

Table 1. The most populous urban agglomerations in Canada, Russia and the USA.

Country	Name of an agglomeration	Population in 2020, thousand people	Population density in 2020, people /km ²
Canada	Toronto-Hamilton	6871	2757
Russia	Moscow	17125	2908
Russia	St. Petersburg	5230	3810
USA	Phoenix-Mesa	4602	1188
USA	Atlanta	5361	633
USA	Philadelphia	5684	1022
USA	Miami	6144	1661
USA	Houston	6406	1073
USA	San Francisco - San Jose	6425	2051
USA	Dallas - Fort Worth	6830	1072
USA	Boston-Providence	7302	727
USA	Washington-Baltimore	7518	1254
USA	Chicago	9014	1288
USA	Los Angeles	15402	2310
USA	New York	20870	1700

Let us consider in which regions Internet users' interest in car sharing is the highest based on the popularity of the relevant queries on the Internet.

Table 2 shows the sub-regions of Canada, Russia, and the United States where Internet users most frequently searched for "car sharing" and "karshering" in the last five years. Queries are assigned to points from 0 to 100, where 100 points indicate a location with the highest share of popularity for the query, and 50 points indicate a location with half as many popularity as in the first location. The higher the score, the higher is the proportion of relevant queries of all queries, rather than the absolute number of queries. Therefore a region where queries containing the word "car sharing" represent 80% of all queries will be awarded twice as many points as a region where only 40% of all queries contain the word.

The sub-regions of Canada, Russia, and the U.S. are ranked in descending order by the popularity of "car sharing" and "karshering". For the U.S. sub-regions, Google Trends rankings show the agglomerations within them.

Table 2. Popularity of search queries by sub-regions in Canada, Russia and the US.

Country	Sub-region/city	Popularity of the search query "car sharing"
Canada	Vancouver	100
Canada	Toronto	58
Russia	Moscow	100*
Russia	Moscow region	69*
Russia	Saint Petersburg	58*
Russia	Krasnodar region	43*
Russia	Leningrad region	41*
USA	D.C. / Washington DC	100
USA	New York	46
USA	Maryland/ Baltimore	38
USA	Michigan/Detroit	36
USA	Massachusetts/Boston	36
USA	Colorado/Denver	34
USA	Washington / Seattle Tacoma	32
USA	Illinois/Chicago	28
USA	California/San Francisco, San Jose, Los Angeles, Sacramento, San Diego	28
USA	Oregon/Portland	27
USA	Virginia/Washington	27
USA	Hawaii/Honolulu	25
USA	New Jersey/New York, Philadelphia, Pennsylvania	20
USA	Arizona/Phoenix	19
USA	Georgia/Atlanta	18
USA	Utah	18
USA	Connecticut	17
USA	Florida/Orlando, Miami, Tampa	17

* Popularity of the search query "karshering" in Russian

As Table 2 shows, relative interest in car sharing has been highest mainly in the most populous urban agglomerations listed in Table 1.

Let us look at how Internet users' interest in car sharing has changed in the agglomerations in Canada, Russia and the United States where it has been highest over the last five years.

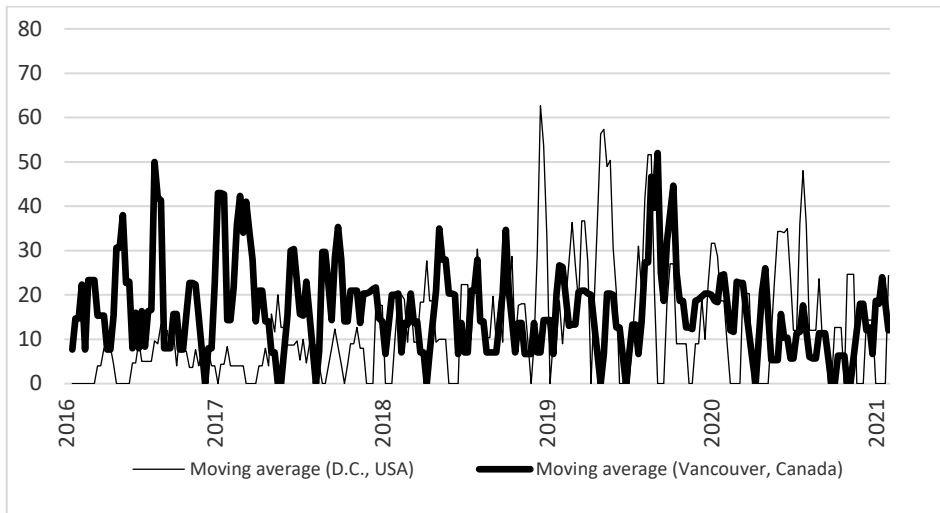


Fig. 1. Popularity of the search query "car sharing".

Fig. 1 shows the dynamics for the popularity of the query "car sharing" in D.C. (USA) and Vancouver (Canada), as well as the dynamics for the popularity of the query "karshering" in Moscow.

Vancouver is one of the most densely populated cities in Canada, where the main fleet of Canadian car sharing companies is concentrated. As can be seen from Fig. 1, the popularity of the search query "car sharing" in Vancouver does not have a pronounced trend. This may be due to the fact that the vast majority of the Vancouver population is well aware of the existence of car sharing, as this service has been in high demand for many years.

The popularity of the search query "car sharing" in D.C. (USA) was trending upwards until 2019, and then it reversed. A possible reason for this is the entry of a French company PSA's division into the US market. The launch of Free2Move car sharing in D.C. in 2018 was the first step in a 10-year plan to bring the French group back to the North American car market.

In Russia, the last few years have seen rapid growth in the volume and geography of the car sharing market and an increase in the audience size [22].

In Moscow, the popularity of the search query "karshering" (Fig. 2) had a pronounced upward trend from 2017 to 2019. At the same time, the number of active users from 2015 to 2016 increased from 15 thousand to 150 thousand. In 2017, according to the Moscow government (<https://www.mos.ru/mayor/themes/2299/4189050>), it reached 350 thousand people, and 1 million people already by 2019 (<https://rg.ru/2019/09/13/reg-cfo/chislo-polzovatelej-karsheringa-v-moskve-dostiglo-1-mln-chelovek.html>).

The number of requests and demand for car sharing has a seasonal component. According to the car sharing company Belkacar, the interest of Internet users increased seasonally from the beginning of the year until September and decreases in October-January. This is explained by the fact that in September, Muscovites return to the city, work trips and shopping trips increase. In October, demand is strongly influenced by weather conditions. In December, there are heavy traffic jams in the city and the numbers start to go down. From March, with the improvement in the weather, there is a new upswing, which continues until July.

In the first half of 2020, the volume of searches for 'karshering' in Moscow began to decline rapidly, probably due to a drop in demand for car sharing and the temporary

suspension of car sharing services in connection with the coronavirus epidemic. In June, the number of requests rebounded to a peak due to the reopening of car sharing services.

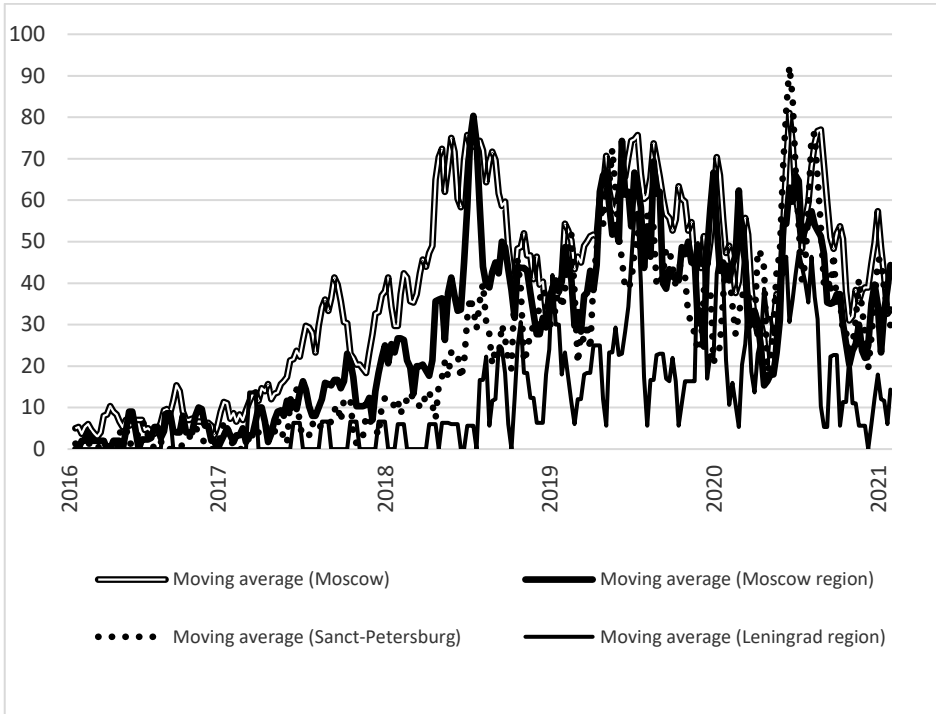


Fig. 2. Popularity of the search query "car sharing".

In other Russian regions, car sharing services were launched later and, accordingly, the growth of Internet users' interest occurred at a later date.

The research confirmed both hypotheses. The relatively high interest of Internet users in car sharing is mainly observed in urban agglomerations with high population and density, where the positive effects of car sharing are most visible.

Stimulating the creation of new services in the field of urban logistics will contribute to sustainable development and increase the competitiveness of the city.

The growing interest of Internet users in the new service is accompanied by an increase in market volume. For example, in a region where car sharing was underdeveloped, the surge in Internet enquiries related to car sharing was accompanied by explosive market growth.

User interest in established car sharing markets is at a stable level, but important events for users (e.g. the arrival of a new major player) stimulate an increase in the number of Internet queries related to car sharing. Changes in the seasonality of demand correspond to changes in the seasonality of the number of Internet queries related to car sharing.

The growing interest in car sharing as a sharing service has a positive impact on the sustainable development of urban agglomerations. The use of car sharing ensures economical consumption and a reduction of harmful emissions into the atmosphere.

Google.Trends is an excellent tool for researching the processes on service markets, forecasting sales volume, evaluating the effectiveness of advertising campaigns and other purposes related to researching consumer behaviour, including responsible consumption.

A research limitation was the interest of users from urban agglomerations defined by Google.Trends as regions with the highest share of "karshering" queries in the total set of

queries. Therefore, the field of research did not include urban agglomerations, where car sharing is not developed, but the presence of other shared-use services is possible.

Further research should focus on identifying urban agglomerations that have the greatest potential in terms of the sharing services development, and in particular, of car sharing services.

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