

# Impact of Digital Technology on Improving the Environmental Status of Cities

Victoria Ilchenko, Vladislava Bondarenko, Oksana Koroliova, Svitlana Petrovska

*Abstract— The article substantiates possibilities of using digital technologies in a transport sector as the most important component that determines not only the economic, but also the ecological development of the city. In recent years, there have been changes in the formation of the economies of countries in recent years, especially in strengthening the environmental component. Sharing economy is a global trend that prioritizes use rather than ownership. Capitalization of the global market for online sharing services is growing rapidly and car sharing is one of the key sectors of the new economic model. Carsharing helps unload roads due to the rational use of cars, being a full-fledged alternative to buying a car for many citizens. Being an element of sustainable urban development, urban logistics defines and minimizes the negative impact of logistics activities on the environment of the city. In the framework of this article, an analysis of the carsharing system, a chronology of development, advantages and disadvantages, the process of interacting with the carsharing service have been made. It has been concluded that the carsharing system helps to improve the transport and environmental situation in megacities, thereby solving the problems of sustainable urban development, and digital technology is the key to this.*

*Key words: smart city, mobility as a service, digital assets, ecological state.*

## I. INTRODUCTION

Digitalization of the transport sector of the economy is by far the only possible way out of this difficult environmental situation in large cities of Ukraine and other countries. The technogenic human impact on the environment causes a number of environmental problems, first of all, in cities - it is air pollution due to the functioning of road transport. Transport is one of the most powerful factors of anthropogenic impact; especially air pollution and noise pollution are among the most serious technogenic loads on environmental components. An increase in the number of vehicles leads to an increase in traffic intensity, which leads to transport problems in urban conditions. Carsharing in big cities can be a good complement to public transport and bicycles, and the concept of sharing economy allows the motorist to free some of their money and time, and have an opportunity to use a car that meets modern environmental

**Revised Version Manuscript Received on October 15, 2019.**

**Victoria Ilchenko**, Department of Management (Kyiv), National Transport University of Ukraine, Kyiv, Ukraine; (e-mail: nika-ivg@ukr.net)

**Vladislava Bondarenko**, Department of Tourism (Kyiv), National Transport University of Ukraine, Kyiv, Ukraine; (e-mail: vladislava.b@gmail.com)

**Oksana Koroliova**, Department of Finance, Accounting and Auditing (Kyiv), National Transport University of Ukraine, Kyiv, Ukraine; (e-mail: korolovaokiv@meta.ua)

**Svitlana Petrovska**, Department of Economics (Kyiv), National Transport University of Ukraine, Kyiv, Ukraine; (e-mail: petrovskayas@ukr.net)

requirements. To realize the full potential of the digital technologies of the city's transport sector, it is necessary to conduct a well thought out economic policy of partnership between the state and private business, aimed at improving the environmental situation of megacities in general.

## II. LITERATURE REVIEW

The problem of using the system technologies at the city level has been worked on by such domestic scientists as V. Babayev, O. Batanov, E. Horyan, V. Dziundziuk, D. Koltsov, Y. Sharov and others. Meanwhile, there is still a lack of research in Ukraine to identify key principles and a local development methodology based on the Smart-City concept, which would allow the local economy to thrive in an extended global economic recession.

Many scientists have been involved in the analysis of urban landscape pollution. Determination of the degree of anthropogenic changes of separate components of cities landscapes undergoing technogenic geochemical loading is considered in the scientific works of V. Fesiuk, Y. Molchak, I. Myskovets, and H. Khodan. Scientifically substantiated information about the impact of vehicles and its infrastructure on environment of cities and settlements in Ukraine can be found in the scientific works of S. Murovskiy and V. Mateichyk. Scientists have paid considerable attention to the study of atmospheric pollution of the urban environment.

## III. METHODOLOGY

To achieve the stated goal of research and solving the set tasks, a set of well-known scientific methods and techniques has been used. The method of logical synthesis has been applied to theoretically substantiate the importance of studying the problems of digitizing the transport sector from the perspective of the environmental component. Using methods of analysis and synthesis has made it possible to show the importance of using modern achievements in digitalization of the transport sector of the Ukrainian economy. The method of extrapolating development trends has been used to demonstrate the possibility of providing new transport services. The method of constructing schemes and models has been used to visualize the results of the study and their schematic representation.

#### IV. RESULTS

Urbanization, rapid growth, and mobility of the population have put enormous strain on the environment, economic and social problems, but at the same time opened up new opportunities.

According to United Nations forecasts, by 2030, 60% of the world's population will live in cities, and by 2025, more than 35 cities worldwide will be gigantic metropolises [8]. This creates the need for new innovative solutions to improve the quality of life of people in large cities. As the first stage in the development of an ecosystem of standards for smart cities, scientists today consider mobility as a service (MaaS).

Mobility as a Service (MaaS) is a new concept for custom and eco-friendly mobility services. Mobility as a service provides consumers with flexible, efficient and convenient services covering multiple modes of single window transport. Also, MaaS makes it possible to provide new transportation services (e.g. carsharing, joint travel, etc.) in the context of strong IT support for new mobility services, access to services at any time and anywhere, and use real-time information time. However, the key issue for creating mobility as a service application is the availability of digital information from different urban sources [5].

Some experts [5, 7, 8, 10] are evaluating the prospect of MaaS already in the context of connected and autonomous transport (CAV) operation, which will use communication technologies to interact with the driver (or operator) and other vehicles on the road (vehicle-to-vehicle) V2V), infrastructure (V2I) and cloud. With high-quality roads and marking in Ukraine, it will be possible to build new models of urban traffic, facilitate transport infrastructure, and provide passengers with additional services [4].

The global automotive industry is now experiencing an unprecedented period of declining car sales. According to many experts, including the Deloitte audit company, if today the major income of car manufacturers is formed in the sales and service segments, then after about 10 years, about 80% of their earnings will be formed by digital services on board [8]. The influence of several factors caused this tendency.

First, the steady increase in environmental requirements for cars in the EU leads to the gradual transition of carmakers to the production of electric vehicles. Thus, over the last four years, the number of diesel modifications in the lineup has decreased by 3 times, and the share of diesel engines in the EU market has fallen to 31% [3].

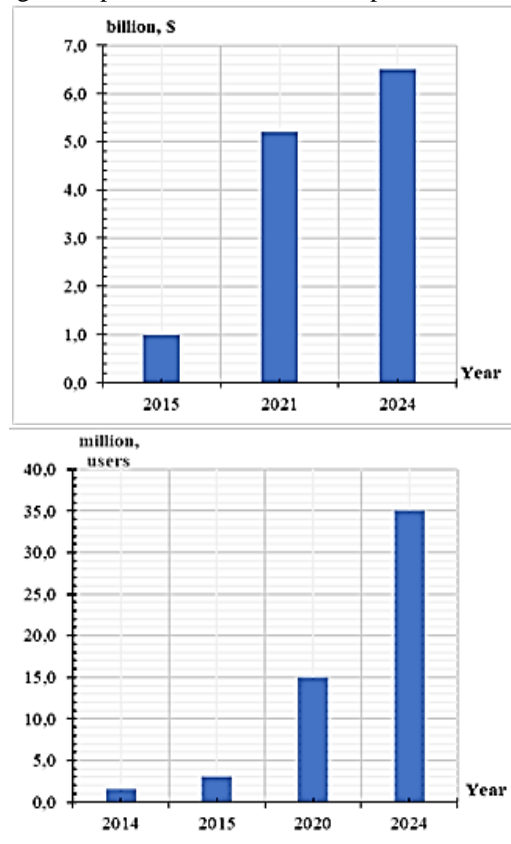
However, more technological and eco-friendly cars cost more. Without government grants, potential buyers are in no hurry to refocus on buying electric cars. The analysis of a study, conducted by the European Association of Automobile Manufacturers (ACEA) in 2018, showed the dependence of ECV sales on GDP in the EU Member States per capita. Thus, countries with an ECV market share of less than 1% (half of all EU Member States) have a GDP of below 29,000 euros per capita (e.g. Spain, Italy, Greece, Latvia, Lithuania, Poland, Bulgaria, and Slovakia). On the contrary, the ECV share is above 3.5%, only in countries with a GDP of over 42,000 Euros (e.g. Finland, the Netherlands, and Sweden). GDP in 2018 was less than \$ 3,000 in Ukraine. But the share of the electric car market was 0.69% for new electric vehicles and 0.84% for old ones. This is a terrific result when comparing the market share and GDP of Ukraine to Latvia or

Poland [3].

Secondly, the current generation of young people does not want to buy a car for ownership, and this trend is already evident. Among the reasons for refusing a personal vehicle, are the environment, the good work of public transportation, the desire to avoid problems with raising money (or credit) for the purchase of a car, for repair, for maintenance, and parking of their car. Unmanned vehicles will also reduce the desire to own a car. As soon as such transport becomes mainstream, the "emotional" component of driving a car will disappear. An unmanned trip does not differ from a taxi or bus trip.

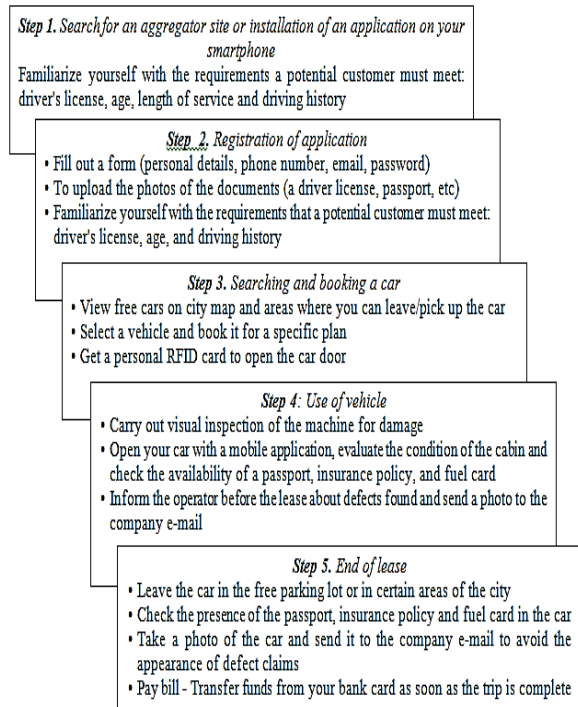
Thirdly, carsharing is becoming increasingly popular around the world when many people use one car. Particularly successful since the beginning of the 21st century, it has developed in large urban agglomerations of developed and developing countries (Fig. 1). Morgan Stanley estimates that in 2015, the use of carting, including Uber services, accounted for 4% of the length of all trips, by 2030 this figure will exceed 25%. During this period, the total duration of trips to the Chinese market will increase by three times, to one third - in the USA and practically will not change in Europe [10].

The term "carsharing" appeared in the mid-1970s during the oil crisis in 1973, but only in the late 1990s due to the emergence of GPS navigation and the development of innovative security systems, the service of short-term car rental began to spread in the US and Europe.



**Fig. 1. Trends carsharing in the world (millions of dollars, millions of people).**  
Source: created by authors on the basis of [10]

Carsharing is a model of a short-term minute or hourly car rental. Car search and contract signing are done through the app on a smartphone. The service is as simple as possible: the user books the car with the application, finds it on the map, and once the trip is done, the car can be left in the city or on the marked parking (Fig. 2). Payment is only made for the actual use of the vehicle. The driver requires a driving license and experience only.



**Fig. 2. The process of interaction with the service of carsharing**

Source: created by authors on the basis of [2, 9]

Currently, there are three main types of carsharing [2]:

1) Free-floating. This is a short-term rental that involves trips within one locality. In this case, the consumer can pick up and leave the car in different parking places, which is very convenient. The booking of the car is made through mobile applications or at the companies engaged in the carsharing.

2) Peer-to-peer. The consumer rents transportation from owners or companies specializing in rental services through aggregator sites. The main advantage of such a service is its low cost;

3) co-ownership of transport. A group of residents or colleagues buys a car for sharing. This is often done by large organizations, homeowners' cooperatives, etc.

Often such services are residents of cities that can not afford a purchase of a personal car and do not want to bother themselves with loan commitments; do not require the daily use of their own vehicle and wish to minimize the cost of maintaining it; constantly faced with dense road traffic and difficulties with parking; care for the environment in their city.

*The benefits of carsharing include:*

a) possibility to rent transport for a short time, the payment is made for actual use;

b) 24/7 access to cars of different makes, classes, body types or capacity;

c) location of vehicles parked in all areas of the city;  
d) simple booking - no need to go to the office of the company and sign a contract;

e) comprehensive service - fuel, washing, insurance, and transport depreciation are included in the price of the service;

f) the ability to leave the car in the nearest parking lot - you do not have to go strictly to the site of the company;

g) most of the rental vehicles are of the latest generation, equipped with systems to reduce exhaust toxicity and save fuel costs (for example, hybrid electric cars and electric cars);

h) the use of telematics systems to monitor the vehicle and analyze driver behavior in real-time. Smart driving can also be attributed to MaaS services. Among the key performance criteria for telematics systems are the following [1]: improved driving safety; control of fuel consumption and emissions (including CO<sub>2</sub>) in transport; timely service of a vehicle; on-the-go optimization; reducing the risk of car theft and more.

In Ukraine, a telematics device (the so-called "black box") is being installed on the car by transport companies wishing to improve the efficiency of their service. But in the European Union, the installation of a "black box" will become mandatory since 2022. In 2020, Uber will launch the Uber Movement digital tool in Kyiv. Uber Movement will show the average travel time from one area of a city to another based on billions of trips from Uber. This will allow city leaders and residents to more effectively address transportation and the needs of urban systems.

i) reducing the number of cars in the population, which has a positive impact on the ecology of large cities. On average, one carsharing 6-20 replace personal cars. For example, in Seoul, one vehicle of a carsharing service replaces 8-9 private cars, and the service as a whole can reduce emissions of harmful substances by 486 tons per year [9];

j) incentives to reduce car use. People who use short-term rentals reduce the number of unnecessary trips, walk more, and cycle more often.

A study from the University of California found that Car2Go customers traveled 7% fewer miles than when using their cars or taxis. GHG emissions have fallen by an average of 10% as Car2Go users either sell their cars or refuse to buy new ones [10];

k) the cost of a short-term car rental is cheaper than a taxi (in the European Union - 2-4 times cheaper).

Carsharing appeared in Ukraine in the summer of 2017 and has not gained much popularity. The service is available only in Kyiv and Odesa, but the car can be taken from a few companies. For the further development of this service, a high-quality mobile application is not enough. This requires a significant investment in a great increase in the fleet of eco-friendly vehicles, arrangements with insurance companies, and owners of car parks where you can pick up or leave your car.

Shared trips are becoming more common in the world, including:

• typically, this occurs through the mediation of firms that specialize in this field and charge for their services fee.

The people who would like to rent as well as to rent out the car register their accounts on the website of the carsharing company. The fare depends on the type and time of use of the vehicle;

- ridesharing. With the use of a mobile app (like Uber), drivers can share trips with other companions to any place (e.g. work, home, business trips);
- shared taxi. With the help of a modern smartphone app, a customer of a transportation company can find other passengers heading in the same direction. The travel time will increase, but the cost will be greatly reduced;
- route on demand. It is the average between a taxi and a regular bus. Passengers pre-book a ride on a smartphone, reserve a seat, and receive fair payment, and the possible time of arrival of the bus at their chosen seat. Their booking is then compared to other passengers who wish to travel to the same (or close) destination. A smart technology platform calculates the shortest and fastest route for picking up or disembarking all onboard customers instead of following a fixed route. The service is as personalized as possible, passengers receive text messages indicating their arrival time, bus number, and their driver's name [6].

In Ukraine, this model is being implemented by Uber. In May 2019, the Uber Shuttle service was officially launched in Kyiv. Currently, it is a pilot project for Europe. The Uber Shuttle is a comfortable commuter group taxi, a convenient way to avoid public transport crushes, without paying a regular taxi fare. This service will help reduce urban congestion and harmful emissions by providing consumers with a safe, secure, and affordable alternative to private vehicles. It should be noted that buses leave the lowest carbon footprint per passenger in comparison to all other modes of motorized transport.

Realizing that "new mobility" – carsharing services – is a product of the future, global carmakers, leasing and transportation companies are increasing their investment in the market every year. Thus, the company called Daimler has opened a new route of their business, the service Car2Go; BMW has launched DriveNow, and Volkswagen has started its Quicar solution. Industry giants such as Ford, Toyota, PSA, and Renault are also developing the direction of carsharing [10].

There are several reasons why automakers may cooperate with carsharing companies:

- 1) to better understand the psychology of people who do not want to buy a car;
- 2) the opportunity to sell your new models not only to carsharing companies;
- 3) perspectives on the development of unmanned technologies. The convenience of an autonomous on-demand taxi - cloud transport - will quickly become the dominant form of transportation, displacing not only private cars but also public transport. Car manufacturers are interested in being the first to enter the market of such taxi services.

Car sharing will become the basis of transportation for the future. Shortly, the main customers of the auto business will not be private individuals, but the corporate sector and car services, and the strength of the brands that brought up the previous generations have been weakened. This trend is already quite evident in the US and Europe, and Ukraine is on this path of development.

## V. DISCUSSION

The dynamic development of the digital economy, technologies, and methods that analyze and process vast amounts of data, as well as the innovative concept of "mobility as a service", are fundamentally changing the transport field. Sharing services such as carsharing, ridesharing, and shared trips play an essential role in providing on-demand mobility.

Over the last decade, the increased popularity of carsharing services is related to the environmental problems of major cities in North America, Europe, and the Asia-Pacific region.

Rapid urbanization puts a huge strain on the infrastructure of Ukrainian cities and the quality of air. To solve the problems of optimal transportation of people and goods, the transformation of urban transport infrastructure through digital assets is needed.

Carsharing as a digital transport service can be a good addition to public transport. To improve air quality, the leaders of large cities of Ukraine need to develop a technological and environmental mode of transport (eg, electric vehicles). For the ecology of metropolitan areas, a dozen advanced transportation companies that offer electric car services are much better than the millions of vehicles sold individually.

## VI. CONCLUSIONS

The technological advances associated with the development of connected and unmanned vehicles, as well as the proliferation of the digital economy and sharing patterns, are dramatically transforming the transport sector. These changes are related to the development of the Mobility as a Service (MaaS) concept.

With the help of the MaaS program, customers can make the best case for moving and use any type of transport with equal probability (taxis, public transport, rental cars, bicycles, and scooters). The line between individual and public transportation is being eliminated, and this applies not only to passengers but also to goods. Already today, there is a change in the paradigm of the use of transport in general. It involves not buying a vehicle but buying time and service.

The rapid urbanization of the Ukrainian population, the increasing demands of people for personal mobility have led to a great burden on urban road networks and the environment, economic and social problems. The implementation of innovative digital solutions will help urban development, address transportation, and the needs of urban systems. But it should be noted that Ukraine's digital transformation can be achieved through partnerships between the state, business, and citizens.

**Practical implications.** The results of the study can be used as a source of information for the implementation of the digital transformation of the infrastructure of large cities of Ukraine to improve their environmental status.



## REFERENCES

1. Car control systems: putting smart driving technologies into practice, 2018. KR.RU. Available at: <https://www.kp.ru/guide/sistema-kontrolja-avtomobilja.html> (accessed October 29, 2019)
2. Carsharing, features, costs and benefits, 2019. Maanimo.com. Available at: <https://maanimo.com/en/helpful/142866-karshering-serviceability> (accessed 29 October, 2019)
3. How Europe will force car owners to switch to electric cars, 2019. AUTO-Consulting. Available at: <http://www.autoconsulting.com.ua/article.php?sid=44986> (accessed October 29, 2019)
4. Ilchenko, V., Petrovska, S. Approaches to evaluation of quality of city passenger transportation by automotive transport. Eastern Europe: Economics, Business and Management, 3(20), p. 219 – 226, 2019. Available at : <http://www.easterneurope-ebm.in.ua/20-2019-ukr>
5. Kupriyanovsky, V., Akimov, A., Pokusaev, O., Alenkov, V., Namiot, D., Sinyagov, S. Intellectual mobility and mobility as a service in Smart Cities. International Journal of Open Information Technologies, 12, p. 77-122, 2017. Available at: <https://cyberleninka.ru/article/v/intellektualnaya-mobilnost-i-mobilnost-kak-usluga-v-umnyh-gorodah>
6. Mobility as a Service: The Future of Passenger Transport, 2019. Octobus.Magazine. Available at: <http://journal.octobus.io/mobilnost-kak-usluga-budushhe-passa/> (accessed October 29, 2019)
7. Road to the future: how to understand the driver of tomorrow. Analysis of autonomous vehicles embedded in car technology, car sharing and ride sharing systems in the USA, 2017. PwC. Available at: <https://www.pwc.ru/ru/automotive/assets/pwc-autotech-rus-eversion.pdf> (accessed October 29, 2019)
8. The world's population is growing, aging and moving to cities, 2019. United Nations. Available at: <https://www.un.org/development/desa/ru/news/population/commission-on-population-and-development52.html> (accessed 29 October, 2019)
9. Who said “car”, 2019. RG.RU. Available at: <https://rg.ru/2019/01/30/kak-rabotaet-karshering-v-raznyh-stranah-mira.html> (accessed October 29, 2019)
10. Why do car manufacturers invest in car sharing ?, 2017. AUTO-Consulting. Available at: <http://www.autoconsulting.com.ua/article.php?sid=38004> (accessed October 29, 2019)