Scientific Journals
of the Maritime University of Szczecin

Zeszyty Naukowe
Akademii Morskiej w Szczecinie

2021, 68 (140), 47–54
ISSN 1733-8670 (Printed)
ISSN 2392-0378 (Online)
DOI: 10.17402/486

Received: 08.07.2021
Accepted: 29.11.2021
Published: 31.12.2021

Reduction of the movement of individual vehicles in cities – a case study

Kamil Pędziwiatr[1]✉, Katarzyna Sosik-Filipiak[2]

[1] https://orcid.org/0000-0002-5856-9078
[2] https://orcid.org/0000-0003-1298-9955

Maritime of University of Szczecin, Faculty of Economics and Transport Engineering
1-2 Wały Chrobrego St., 70-500 Szczecin, Poland
e-mail: [1]k.pedziwiatr@am.szczecin.pl; [2]k.sosik@am.szczecin.pl
✉ corresponding author

Keywords: individual transport, restrictions of traffic, road traffic, urbanization, urban transportation, sustainable urban development, transport policy

JEL Classification: A1, R4, R5, O1

Abstract
The aim of the article is to indicate the best practices used to limit individual transport in selected European cities. Due to the dynamically progressing urbanization processes and the related development of cities, the demand for transport services is increasing. Individual transport has become a significant problem, which contributes to an increase in road traffic in urban transport networks, causing congestion, increasing air pollution, noise emissions, and road accidents, and affects the health and quality of life of residents by limiting their mobility and transport accessibility. Increasingly local authorities are deciding to implement traffic restrictions in cities, thus contributing to reducing the negative effects of transport. The methods of source analysis, descriptive analysis and the method of deduction were used to carry out the analysis in this paper. The results reveal that the constant search for new solutions to tackle transport problems is a challenge for city managers in the era of rapidly advancing urbanization processes. The implemented transport policies and the pace of implementing changes seem to be key aspects discouraging citizens from using individual road vehicles in cities.

Introduction

This article focuses on the question of how European city authorities are trying to reduce vehicle traffic in city centers. The subject of the research included are selected capitals of European countries, and an examination of solutions introduced to restrict the movement of individual vehicles. The article uses the methods of source analysis, descriptive analysis and the method of deduction.

The dynamic development of cities has created problems related to transport and road traffic. The growing demand for transport services and the need to satisfy them forces city managers to seek solutions. An efficient and effective transport system in the city should limit existing transport problems, mainly in the case of transport congestion. It is important as road congestion is a source of other problems, such as an increase in the emission of pollutants and noise, the number of road accidents and the impact on the safety of road users, as well as the deterioration of health and quality of life of inhabitants by limiting their mobility and transport accessibility. CO_2 emissions from car transport in European Union cities account for over 40% of emissions from the entire transport sector, according to data from the European Commission (European Commission, 2021). Individual transport means currently have an

advantage over public transport, because they are associated with relatively low costs of movement. The convenience associated with the use of passenger cars, which is ensured by door-to-door transport, makes individual transport more attractive for a potential user.

Transport policy at the cosmopolitan, national, regional or local level, as well as through the competition of cities, forces the search for solutions to improve the efficiency of urban transport systems. These solutions can be technological, technical and organizational. The implementation of technological solutions is associated with high financial outlays, hence the search for other good practices that bring us closer to achieving the set goal.

Literature overview

It is estimated that 68% of the world's population will live in urban areas by 2050. The trend of people migrating from rural to urban areas has continued since 1950 (United Nations, 2018). The dynamic development of cities and progressive urbanization processes are perceived as creating economic growth for countries and providing for the prosperity of citizens. Many countries around the world have taken steps to intensify urbanization processes (Pradhan, Arvin & Nair, 2021), which have an impact on changes in land use in cities and in neighboring zones, the dissemination of non-agricultural activities, and the acceptance and adoption of urban customs and standards (Szymańska, 2007, pp. 45–46).

Social needs evolve along with the intensification of migration of people from rural to urban areas. The evaluation of needs does not change their type, but their level (Szołtysek, 2005, p. 12). As a result of urbanization progress, there is an increasing need for transport services (Noussan, Hafner & Tagliapietra, 2020). Due to the essence of the urban system, the purpose of which is to serve its users, this can be a challenge for city managers. When imitating cities in highly developed countries, the emphasis is on the quality of transport services used.

The implementation of tasks within urban transport is possible thanks to the transport infrastructure, means of public transport, transport offer, as well as the integration and coordination of networks of all modes of transport in the area of a given agglomeration. Infrastructure in cities occurs in three dimensions: physical, information and communication technologies (ICT), and services. Physical infrastructure is called the only unintelligent infrastructural component of cities, and is a linear and point infrastructure (Mohanty, Choppali & Kougianos, 2016). The elements of a linear infrastructure include, among others, road, rail, and inland waterways, and in point infrastructure there are stops, end stations/loops, transfer nodes, parking lots, vehicle inspection stations, passenger service stations and others (Wyszomirski, 2008).

The means of transport in urban areas have specific design solutions that can determine the way they are used. All means of urban transport can be divided depending on a variety of factors: the way they are used, the type of energy used to drive mobility, and the type of routes on which they travel. Due to the way they are used, the means of transport can be divided into individual, group and collective. Selected means of urban transport can be classified into several categories, depending on how they are used at a given time (Wyszomirski, 2008). Table 1 shows the most important means of transport currently used in European cities, taking into account the functional variable of the way they are used.

Table 1. Functional classification of means of urban transport

Means of transport in urban transport		
Individual:	Group:	Collective:
bicycle, passenger car, moped, taxi	passenger car (including carsharing), taxi	bus, trolleybus, tram, metro, railway, ship

A car is of particular importance in the transport services of cities, as it provides the greatest spatial accessibility and allows for the movement of people and goods in door-to-door relations (Giannopoulos, Panou & Tyrinopoulos, 2010). At the same time, it is the main source of congestion in cities. Traffic jams result from the mutual obstruction of traffic by vehicles as a result of the collapse of flow fluidity and the restriction of traffic speed. Congestion occurs when the utilization rate of the transport system's capacity is close to being exhausted. The consequences of transport congestion have a direct impact on the functioning of the urban system, as well as on the environment and quality of life (Iwan, Kijewska & Lemke, 2016). They determine the increase in emissions of pollutants and noise and road accidents, thus contributing to the safety of road users, as well as negatively affecting the health of citizens and their quality of life, hindering the mobility of residents and reducing transport accessibility (Hammami, 2020). The increasing number of individual combustion-powered vehicles has a negative impact on the occurrence of transport problems.

However, thanks to the use of alternative fuels, in particular with regards to electromobility, it is possible to reduce greenhouse gases and pollutant emissions (JRC, 2021).

The development of contemporary urban agglomerations requires a constant search for new solutions in urban transport that would improve the quality of traveling in the city. New solutions may concern many spheres of activity. However, in the coming years, as indicated by global trends, the implemented solutions will be focused on the following areas (CATI, 2012):

- planning, organization and management of transport systems;
- transport techniques and technologies;
- financing of transport both in terms of its maintenance and modernization of existing resources, as well as the implementation of new infrastructure investments;
- limiting individual transport in favor of new alternatives, especially in the centers of large European cities.

The aim of these measures is, on one hand, to make better use of the potential that already exists, and on the other hand, to use the new transport potential. Urban transport is highly susceptible to changes, but is limited by high implementation costs (Janczewski & Strzelczak, 2009). In addition, due to the spatial limitations of cities, the expansion of infrastructure is difficult, and work on its modernization does not keep up with the pace of people's migration to cities (Pradhan, Arvin & Nair, 2021). Additionally, it seems important to act outside the city's physical layer, but also to focus on the social dimension. For this purpose, it seems important to promote sustainable mobility that takes over the negative effects of transport, thus creating a living environment (Gonzalez et al., 2021). Developed cities of the world compete with each other in designing and implementing solutions favoring the functioning of agglomerations (Anthopoulos & Fitsilis, 2014). The key aspect is to strive to reduce road traffic in cities and increase capacity, while taking into account the principles of sustainable development.

The policies of the European Union, member states and other countries in the world has to deal with the problems of transport and traffic. The efficiency of transport systems, achievement of economic goals, energy independence, as well as efforts to tackle climate change, depend on the policies and goals adopted by individual countries, regions and decisions taken at the local level (European Commission, 2021). Many city managers decide to implement technological, technical or organizational solutions limiting traffic in the city in order to improve the mobility of its inhabitants, health and quality of life of citizens. Implementing intelligent solutions in the field of urban transport systems is associated with a large financial outlay, therefore local authorities often look for other remedial measures.

Methodology

This article uses the methods of source analysis, descriptive analysis and the method of deduction to examine the question of how European city authorities are trying to reduce vehicle traffic in city centers. This is significant due to the emissions of pollutants and noise, the number of road accidents, the impact on the safety of all road users, and the deterioration of health and quality of life of inhabitants by limiting their mobility and transport accessibility caused mainly by road transport, including individual transport. In order to answer the research question, four growing capitals in Europe were selected due to the availability of data sources: Berlin, London, Warsaw and Amsterdam.

The analysis is based on published local strategies from the websites of local governments and responsible authorities, in which actions related to urban transport systems are discussed. During the analysis of strategic documents and other publicly available sources regarding the planned development of urban transport systems, a large amount of information was discovered, making it necessary to make slogan phrases or a general interpretation of the policies under analysis. For each analyzed city, the transport system was described, along with the planned development activities and the implemented objectives limiting road traffic in the cities.

Research results – case study

Berlin

Berlin has a complex and highly efficient urban transport system. Without it, a metropolis with 3,769,962 inhabitants would not be able to function efficiently (Statistik Berlin Brandenburg, 2021). However, the requirements for transport in this city are constantly changing, therefore the demand for new solutions in the field of improving urban transport is remarkably high. This is due to the need to increase the efficiency of the transport services

provided and the need to improve safety and reduce the environmental nuisance of transport. Designing and implementing new solutions in the area of transport in Berlin is based on cooperation to a greater extent between the private sector, non-governmental organizations, and research and development units, both domestic and foreign. The improvement of regional transport in Berlin and its neighboring Brandenburg area depends on the ability of all involved entities to perform their tasks (VBB, 2021).

According to the policy of the European Union, public transport should be the basic element in the movement of the population of a given agglomeration. The measures for this approach are the gradual limitation of individual transport in the city center (Dresden.de, 2013). Consequently, in Berlin, we can witness (Berlin.de, 2020):

- systematic expansion of the paid parking zone from 40% to 75% of the space intended for parking inside the Berlin ring and successively increasing fees by 20% per year for using it;
- a draft of a new clean air plan that will ban diesel vehicles up to Euro 5 on eight streets. This applies to parts of Leipziger Strasse, Brückenstrasse, Friedrichstrasse, Reinhardtstrasse, Stromstrasse, Alt-Moabit, Hermannstrasse and Silbersteinstrasse. The total length of traffic bans for vehicles that do not meet the emission requirements is 2.9 km. This is equivalent to 0.05 percent of the entire road network in Berlin;
- reconstruction of streets in favor of pedestrian zones and bicycle paths. An example is the pilot allocation of Friedrichstraße in the Mitte district to exclusive pedestrian and cyclist traffic;
- the introduction of priorities for public transport (e.g. separate lanes for bus transport);
- the introduction of a speed limit zone on 70% of roads in Berlin, up to 30 km/h at certain times, and a speed zone of 30 km/h permanently in force on more than 30 streets. This applies to parts of Sonnenallee, Spandauer Damm, Torstraße, Invalidenstraße, Turmstraße, Mariendorfer Damm and Mehringdamm.

The solutions adopted and implemented in Berlin's urban transport are based on Berlin.de (2020):

- limiting the development of urban road systems to only the necessary supplementation of peripheral routes (elimination of transit traffic) and elimination of local "bottlenecks", i.e. the phenomena of greater traffic intensity of means of transport in relation to the capacity of the infrastructure;
- the principle of prioritizing public transport means urban traffic is a restrictive measure for car users, as the increase in the attractiveness of public transport will result in its more effective use;
- increasing the share of pedestrian and bicycle travel by improving the conditions of their movement;
- the creation of an environmental zone (Umweltzone) in the center of Berlin. It is located in the inner ring of the Berlin S-Bahn (Figure 1). Only cars with a specific environmental badge (Feinstaubplakette) may enter this zone. From January 2010, only vehicles with a green sticker, i.e. those meeting the Euro 4 emission standard, are allowed to stay in the environmental zone.

Figure 1. The area of the valid environmental zone (Umweltzone) in the center of Berlin. It is within the inner ring of the Berlin S-Bahn (Senatsverwaltung für Gesundheit, Umwelt und Verbraucherschutz, Berlin, 2007)

London

Current social trends are causing transport problems in London. One of the main reasons is the dependence of residents on means of individual transport, which affects congestion, pollution and human safety. In many zones, car use is more advantageous in terms of time due to the lack of alternatives. Clinging to personal transport contributes to the premature death of London citizens, as well as contributing to heart disease and cancer development (https://www.london.gov.uk/).

The current population of London in 2021 is over 9,400,000 (World Population Review, 2021). Due to the continued population growth in the city, a strategy has been developed to change the transport structure to provide real alternatives in return for the abandonment of passenger cars. Passenger cars are regarded as spatially inefficient means of transport

due to the space they occupy in relation to the number of people who can drive them. The number of individual vehicles limits the mobility of residents, delaying travel by public transport and reducing the efficiency of freight and commercial travel (Mayor of London, 2018).

The main strategic goals were set in the transport policy adopted by London, such as (Mayor of London, 2018):

- zero emission vehicles: new taxis from 2018, new Private Hire Vehicles from 2023, new buses from 2025, all new passenger cars and vans from 2030, and all other vehicles from 2040;
- reducing road traffic: freight traffic, in particular in the morning rush hours in central London, by 10% compared to current traffic by 2026, and reducing total traffic in London from 10% to 15% by 2041;
- reducing the number of fatalities and serious injuries as a result of road collisions, in particular involving buses, by 2030, and from all road vehicles by 2040;
- opening of Crossrail 2: a new railway line that will provide capacity for an additional 270,000 people, thus serving stations near many new homes and new jobs in London without having to travel through central London;
- accessibility to public transport: improvement by 2041 with a view to the non-staircase network and shortening such trips by an average of half of the current time.

London has implemented a number of initiatives to reduce the use of passenger cars. These solutions include (Transport for London, 2021):

- Congestion charge: introduced since 2003. At the beginning it effectively reduced traffic congestion by 30% and car traffic by 15% in the center entrance fee zone;
- Ultra Low Emission Zone (ULEZ) – from October 2021, the ULEZ extends beyond the center of London, as shown in Figure 2, the orange area covers the former ULEZ zone, yellow is the extended zone. ULEZ applies to most vehicles, including passenger cars and vans, which must meet the prescribed emission standards;
- Low Emission Zone (LEZ): works independently of the ULEZ, introduced to discourage the use of heavy-duty diesel vehicles with the most polluting engines.

Warsaw

For many years, the transport system of Warsaw was based mainly on car traffic. Today, the direction set out in the Transport Policy for Warsaw, with 1,777,972 inhabitants, assumes balancing car traffic, public transport, and pedestrian and bicycle traffic (Statistical Office, 2021). The greatest threat to achieving this specific goal is the still low cost of purchasing a used vehicle and its operation (ISO, 2021). This results in a steady increase in the number of vehicles on Warsaw streets. Over the

Figure 2. Change of the ULEZ zone from 2021 (ULEZ, 2021)

years, attempts have been made to keep up with the increase in vehicles by expanding roads and parking lots. However, the dense and compact buildings of the city condemned this plan to failure from the very beginning. In the capital of Poland, solutions are needed aimed at reducing the demand for individual transport instead of trying to meet its needs. The development of contemporary urban agglomerations requires a constant search for new solutions in public transport that would improve the quality of life and air quality in the city (SISKOM, 2021).

The transport policy adopted by Warsaw includes goals and measures in line with the adopted strategy of sustainable development. The tasks presented by the local authority relate primarily to (Zielone Mazowsze, 1995):

- improving the cargo transport system;
- improving the quality of public transport;
- ensuring the efficient functioning of transport with the growing level of motorization;
- limiting the negative impacts of transport on the environment and living conditions of the inhabitants;
- improving the safety of road users.

Warsaw has started to implement solutions related to the reduction of road traffic, concerning trucks. These include (Zielone Mazowsze, 1995):

- restriction of the entry of vehicles over 16 tons to the center of Warsaw from 7 am to 10 am and from 4 pm to 8 pm;
- limiting the transit traffic of heavy goods vehicles over 16 tons round the clock;
- C-16 identifier: this can be obtained by vehicles that, as part of their activities, must enter the zone that is prohibited for heavy goods vehicles (Figure 3);
- C-5/C-10 identifier: entitles 5 t/10 t vehicles to enter a limited zone of the city. Additionally there may be other restrictions allowing the entry of vehicles inside these zones, e.g. up to 2.5 tons.

Amsterdam

Amsterdam is one of the most visited capitals in Europe by tourists and is a dynamically developing service and business center. To ensure that the city remains a safe and friendly place, city authorities will be forced to take more restrictive measures. The need to reduce air pollution and noise has become a priority issue for the Amsterdam authorities. This is due to, inter alia, studies which have shown that a significant proportion (40–60%) of traffic in the city center and surrounding neighborhoods is "through traffic" or traffic with a destination outside the city's historical area. This traffic also poses a risk to pedestrians and cyclists, therefore road safety is at the heart of all the solutions mentioned above. The methods of improving safety mainly include providing more space for pedestrians and cyclists and limiting speed and traffic for cars (https://www.amsterdam.nl/en/).

The capital of the Netherlands has a population of 872,922. The city's main goal is to limit individual transport in the historic city center (AllCharts.

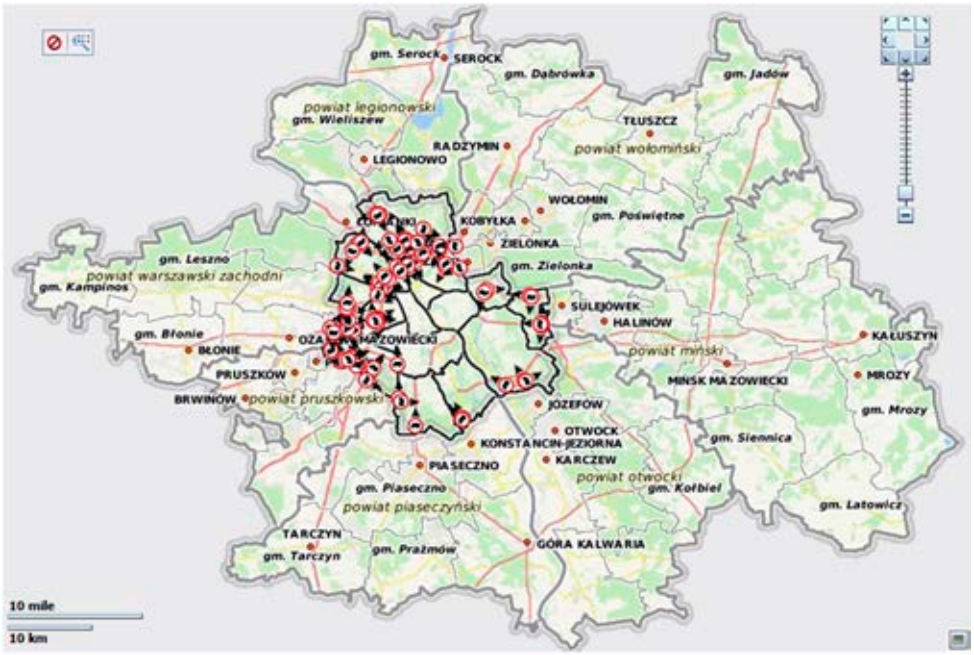

Figure 3. Zone C-16 prohibiting the movement of vehicles over 16 tons in Warsaw (ZDM, 2021)

info, 2021). The transport targets set by the local authorities include (Amsterdam.nl, 2021):

- designing and creating more vehicle-free space and parking lots in the city center, thus limiting car traffic and introducing 30 km/h zones;
- expanding infrastructure for bicycles by building new bicycle bridges and ferry services on the waterway, as well as more parking spaces for bicycles (with a strong emphasis on the development of underground, multi-storey bicycle garages);
- improving traffic flow on important routes, but in particular increasing the attractiveness of public transport;
- providing fast and efficient routes to and from the city for cars and places for loading and unloading goods in the city center;
- expanding park and ride facilities on the outskirts of the city and designation of priority routes for each type of transport;
- improving rail traffic for the entire region, thereby improving the frequency of journeys.

Actions have been taken to reduce transport problems in the city and their harmfulness to people and the environment. As a result (Amsterdam.nl, 2021), the following measures were introduced:

- low emission zone: vehicles with diesel engines with the emission class 0 to 3 (Figure 4) cannot enter the designated zone, and from 2022 this zone will be extended and the regulations will be tightened to allow entry only to vehicles meeting the emission standard 6, vehicle entry ban with a traditional drive. This will apply from 2030;
- in public transport: since 2020, a number of changes and investments have been made to improve the transport accessibility of residents (such as the development of a public transportation network), with the implementation of all tasks by 2030.

Figure 4. LEZ in Amsterdam (CLARS, 2021)

Conclusions

More and more often local authorities are deciding to implement traffic restrictions in cities, aiming to reducing the negative effects of transport. In Berlin and London, efforts are being made to eliminate road traffic from the city centers. In Amsterdam and London, the activities in the near future are based on the aspiration to achieve effects of 'vision zero', i.e. drawing attention to vulnerable road users and eliminating fatal road accidents involving this group of participants. Over the years, Warsaw has attempted to keep up with the increase in vehicles by expanding roads and parking lots. Today, following the example of other large European cities, Warsaw is now introducing restrictions on the movement of trucks in its area. However, it is only a matter of time before further limitations of passenger cars, and thus individual transport, are brought in.

Each of the analyzed capitals requires a constant search and implementation of new solutions for urban transport systems, which is the main challenge for the authorities of European agglomerations, which have to face the dynamic processes of urbanization in cities and areas directly adjacent to cities. As indicated in this article, these changes should take place at the infrastructure level, which is often associated with high costs of implementing new solutions, especially in areas that have been poorly urbanized so far. Changes in urban transport systems, however, are not only infrastructural, which constitute a solid basis for, above all, social changes. The restrictions related to individual transport introduced in European cities are forcing society to change existing habits, which is the driving force to implement solutions that minimize transport problems occurring in urban transport networks. The implemented transport policies and the pace of implementing changes seem to be key aspects in discouraging society from using individual road vehicles in cities.

References

1. AllCharts.info (2021) *Information about the municipality of Amsterdam.* [Online] Available from: https://allcharts.info/the-netherlands/municipality-amsterdam/ [Accessed: July 1, 2021].
2. Amsterdam.nl (2021) *City of Amsterdam*. [Online] Available from: https://www.amsterdam.nl/en [Accessed: July 2, 2021].
3. Anthopoulos, L.G. & Fitsilis, P. (2014) Smart Cities and their Roles in City Competition: A Classification. *International Journal of Electronic Government Research* 10(1), pp. 63–77, doi: 10.4018/ijegr.2014010105.

4. Berlin.de (2020) Fahrverbote: Was Dieselfahrer wissen müssen. [Online] February 3. Available from: https://www.berlin.de/special/auto-und-motor/nachrichten/4947848-2301467-drohende-fahrverbote-was-dieselfahrer-wi.html [Accessed: July 2, 2021].
5. CATI (2012) *Innowacyjność w transporcie do 2020 roku – podstawowe pojęcia i tezy*. Warszawa: Centrum Analiz Transportowych i Infrastrukturalnych.
6. CLARS (2021) *Urban Access Regulations in Europe.* [Online] Available from: https://urbanaccessregulations.eu/countries-mainmenu-147/netherlands-mainmenu-88/amsterdam [Accessed: July 5, 2021].
7. Dresden.de (2013) *Verkehrsentwicklungsplan 2025plus*. [Online] Available from: https://www.dresden.de [Accessed: July 3, 2021].
8. European Commission (2021) *Mobility and transport*. [Online]. Available from: https://ec.europa.eu/transport/themes/urban/urban_mobility_en [Accessed: July 3, 2021].
9. Giannopoulos, G., Panou, M. & Tyrinopoulos, Y. (2010) *Urban Mobility the door-to-door strategy*. [Online] Available from: https://ec.europa.eu/invest-in-research/pdf/workshop/giannopoulos_b2.pdf [Accessed: July 4, 2021].
10. Gonzalez, J.N., Perez-Doval, J., Gomez, J. & Vassallo, J.M. (2021) What impact do private vehicle restrictions in urban areas have on car ownership? Empirical evidence from the city of Madrid. *Cities* 116, 103301, doi: 10.1016/j.cities.2021.103301.
11. Hammami, F. (2020) The impact of optimizing delivery areas on urban traffic congestion. *Research in Transportation Business & Management* 37, 100569, doi: 10.1016/j.rtbm.2020.100569.
12. ISO (2021) *Instytut Spraw Obywatelskich. Miasto w ruchu.* [Online] Available from: https://miastowruchu.pl/ [Accessed: July 1, 2021].
13. Iwan, S., Kijewska, K. & Lemke, J. (2016) Analysis of parcel lockers' efficiency as the last mile delivery solution – The results of the research in Poland. *Transportation Research Procedia* 12, pp. 644–655.
14. Janczewski, J. & Strzelczak, M. (2009) Innowacje w transporcie miejskim. *Płock's Notes, Notatki Płockie* 3/220, pp. 47–53.
15. JRC (2021) *Mobility.* [Online] Available from: https://urban.jrc.ec.europa.eu/thefutureofcities/mobility#the-chapter [Accessed: July 4, 2021].
16. Mayor of London (2018) *Mayor's Transport Strategy*. [Online] March. Available from: https://www.london.gov.uk/sites/default/files/mayors-transport-strategy-2018.pdf [Accessed: July 4, 2021].
17. Mohanty, S.P., Choppali, U. & Kougianos, E. (2016) Everything you wanted to know about smart cities: The Internet of things is the backbone. *IEEE Consumer Electronics Magazine* 5, 3, pp. 60–70, doi: 10.1109/MCE.2016.2556879.
18. Noussan, M., Hafner, M. & Tagliapietra, S. (2020) The Evolution of Transport Across World Regions. In: *The Future of Transport Between Digitalization and Decarbonization*. SpringerBriefs in Energy, Springer.
19. Pradhan, R.P., Arvin, M.B. & Nair, M. (2021) Urbanization, transportation infrastructure, ICT, and economic growth: A temporal causal analysis. *Cities* 115, 103213, doi: 10.1016/j.cities.2021.103213.
20. Senatsverwaltung für Gesundheit, Umwelt und Verbraucherschutz Berlin (2007) *Bessere Luft für Berlin. Umweltzone Berlin ab 2008.* [Online] Available from: http://www.station-berlin.de/tl_files/downloads/de/Umweltzone_Broschuere.pdf [Accessed: July 1, 2021].
21. SISKOM (2021) *Stowarzyszenie Integracji Stołecznej Komunikacji.* [Online] Available from: http://www.siskom.waw.pl/ [Accessed: July 1, 2021].
22. Statistical Office (2021) *Central Statistical Office*. [Online] Available from: https://warszawa.stat.gov.pl/ [Accessed: July 1, 2021].
23. Statistik Berlin Brandenburg (2021) [Online] Available from: https://download.statistik-berlin-brandenburg.de/ [Accessed: July 1, 2021].
24. Szołtysek, J. (2005) *Logistyczne aspekty zarządzania przepływami osób i ładunków w miastach*. Katowice, Poland: Wydawnictwo Akademii Ekonomicznej.
25. Szymańska, D. (2007) *Urbanizacja na świecie*. Warszawa: Wydawnictwo Naukowe PWN.
26. Transport for London (2021) *Ultra low emission zone*. [Online] Available from: https://tfl.gov.uk/modes/driving/ultra-low-emission-zone [Accessed: July 2, 2021].
27. ULEZ (2021) *Ultra Low Emission Zone 2021 Map*. [Online] Available from: https://ulez.co.uk/ultra-low-emission-zone-2021-map/ [Accessed: July 4, 2021]
28. United Nations (2018) 68% of the world population projected to live in urban areas by 2050, says UN. [Online] 16 May. Available from: https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html [Accessed: July 3, 2021].
29. VBB (2021) *Verbundberichte*. [Online] Available from: https://www.vbb.de/der-vbb/publikationen/verbundberichte/ [Accessed: July 3, 2021].
30. World Population Review (2021) *London population*. [Online] Available from: https://worldpopulationreview.com/world-cities/london-population [Accessed: July 3, 2021].
31. Wyszomirski, O. (2008) Transport miejski. Ekonomika i organizacja. Gdańsk: *Wydawnictwo Uniwersytetu Gdańskiego*.
32. ZDM (2021) *Zarząd Dróg Miejskich, Pojazdy ciężarowe*. [Online] Available from: https://zdm.waw.pl/sprawy/zezwolenia-i-identyfikatory/pojazdy-ciezarowe/ [Accessed: July 4, 2021].
33. Zielone Mazowsze (1995) *Polityka transportowa dla m.st. Warszawy*. [Online] Available from: http://zm.org.pl/?a=polityka_transportowa_95 [Accessed: July 4, 2021].

Cite as: Pędziwiatr, K., Sosik-Filipiak, K. (2021) Reduction of the movement of individual vehicles in cities – a case study. *Scientific Journals of the Maritime University of Szczecin, Zeszyty Naukowe Akademii Morskiej w Szczecinie* 68 (140), 47–54.