Economics and Organization of Logistics
6 (4), 2021, 21–33
DOI: 10.22630/EIOL.2021.6.4.26

Julia Giera ✉, ***Ewa Kulińska*** ✉, ***Małgorzata Mac*** ✉
Opole University of Technology

Tools used in intelligent transport systems of city logistics

Narzędzia wykorzystywane w inteligentnych systemach transportowych w logistyce miejskiej

Abstract. Cities are large areas with numerous buildings between which there is an extensive road infrastructure. A society lives in them, which in order to be able to function must move. The need to move, combined with a high population density in the city, causes a lot of traffic – especially road traffic. Improving road traffic flow and reducing road congestion enables the use of intelligent transport systems in city logistics. The aim of the article is to present the tools used in intelligent transport systems of urban logistics. The research methodology used is the development of a diagram in which individual ITS tools were assigned to the appropriate link of the transport environment. Due to the growing requirements of people traveling by public transport, telematics is an important element. The article presents the tools that the passengers of the research facility can use, and thus traveling becomes more effective and comfortable. The use of appropriate tools of intelligent transport systems means not only following the principles of proper and effective functioning of urban logistics areas, but also increased comfort of travelers and improvement of road traffic safety. Research on increasing capacity in cities is an important topic in urban logistics. The need to conduct research on urban agglomerations results from the systematic increase in the demand for effective movement of people in urban agglomerations. The scope of entities is a narrow research group, however, the indicated elements belonging to intelligent transport systems translate into the possibility of using them in most urban agglomerations.

Key words: intelligent systems, transport, smart cities

Synopsis: Miasta są wielkimi obszarami z licznymi zabudowaniami, pomiędzy którymi przebiega rozbudowana infrastruktura drogowa. Żyje w nich społeczeństwo, które by móc funkcjonować, musi się przemieszczać. Potrzeba przemieszczania się połączona z dużym zagęszczeniem ludności w mieście powoduje duże natężenie ruchu – zwłaszcza ruchu drogowego. Poprawa płynności ruchu drogowego oraz zmniejszenie kongestii drogowej umożliwia zastosowanie inteligentnych systemów transportowych w logistyce miejskiej. Celem artykułu jest przedstawienie narzędzi stosowanych w inteligentnych systemach transportowych logistyki miejskiej. Zastosowana metodologia badawcza to opracowanie schematu, w którym przypisano poszczególne narzędzia ITS dla odpowiedniego ogniwa otoczenia transportowego. W związku z rosnącymi wymaganiami osób podróżujących przy pomocy komunikacji miejskiej, ważnym elementem jest telematyka. W artykule przedstawiono narzędzia, jakie pasażerowie obiektu badawczego mogą użytkować i tym samym podróżowanie staje się efektywniejsze i wygodniejsze. Zastosowanie odpowiednich narzędzi inteligentnych systemów transportowych to nie tylko postępowanie zgodnie z zasadami prawidłowego i efektywnego funkcjonowania obszarów logistyki miejskiej, ale również zwiększony komfort podróżujących oraz poprawa bezpieczeństwa w ruchu drogowym. Badania nad zwiększeniem przepustowości w miastach to istotny temat w logistyce miejskiej.

✉ Julia Giera – Opole University of Technology; Faculty of Production Engineering and Logistics; e-mail: j.giera@po.edu.pl; https://orcid.org/0000-0002-7297-458X
✉ Ewa Kulińska – Opole University of Technology; Faculty of Production Engineering and Logistics; e-mail: e.kulinska@po.edu.pl; https://orcid.org/0000-0002-3227-057X
✉ Małgorzata Mac – Opole University of Technology; Faculty of Production Engineering and Logistics

Potrzeba prowadzenia badań nad aglomeracjami miejskimi wynika z systematycznego zwiększania się zapotrzebowania do efektywnego przemieszczania się osób w aglomeracjach miejskich. Zakres podmiotów to wąską grupa badawcza, jednakże wskazane elementy należące do inteligentnych systemów transportowych przekładają się na możliwość wykorzystania w większości aglomeracji miejskich.

Słowa kluczowe: inteligentne systemy transportowe, transport, *smart cities*

JEL codes: L90, L92, O18

Introduction

The systematic increase in the movement of people in urban agglomerations, using various means of transport, forces the authorities of urban agglomerations to improve the city's capacity. The necessity to move is related to the high population density in the city, which causes a lot of traffic – especially road traffic. The subject of Intelligent Transport Systems (ITS) is directly related to urban logistics. ITS is a broad collection of various tools based on information or telematics technology.

The aim of the article is to present the tools used in intelligent transport systems of urban logistics. The research methodology used is the development of a diagram in which individual ITS tools were assigned to the appropriate link in the transport environment. Every day, tens or even hundreds of thousands of passenger cars travel along city roads. As a result of the high volume of road traffic in relation to the low capacity of city roads, we are dealing with congestion – usually cyclically, in the morning and afternoon rush hours. Currently, the main goal of urban agglomerations is to reduce or even exclude the phenomenon of congestion, which will contribute to a better quality of life. There are many tools of intelligent urban logistics transport systems that help to smooth the road traffic.

Materials and methods

The research is based on scientific literature, own observation and data from research objects. Research entities are the urban agglomerations of Opole and Gdynia. The period of analysis of research objects is the second and fourth quarter of 2021. The applied research method is a case study of selected urban agglomerations. The aim of the case study is to show the concept of intelligent transport systems that are applicable in most urban agglomerations. In the chapters, the characteristics of intelligent transport systems and tools used in intelligent transport systems, materials are presented based on a wide review of domestic and foreign scientific literature on the intelligent transport systems tools available on the market that can be used in urban logistics. Individual tools are presented along with an indication of the form of use of a given device or system. The chapter on telematics solutions supporting public transport in city logistics presents the possibilities of using the tools of intelligent transport systems. Data on the urban agglomeration come from the official application and website of the cities.

Characteristics of intelligent transport systems

The concept of transport is defined many times in the literature. According Tarski I., it is a technological system for the distance transport of people, energy or goods [Tarski 1993, Gentile and Noekel 2016]. This concept is related to the use of specific infrastructure and means of transport [Madeyski et al. 1971, Koźlak 2008, Neider 2008]. The concept of transport is formulated by activities such as transporting goods, operating technical devices, delivering goods to the destination, as well as additional services [Neider 2008]. Transport is an essential part of our lives, the needs of which grow together with systematic economic and social development. Transport is a concept that defines the movement in a given time and space of our needs by means of appropriately selected means of transport. The subject of ITS is one of the most analyzed areas related to the functioning and impact of transport on other logistics processes. Intelligent transport systems are built from a variety of tools based on information technology, mobile telecommunications and vehicle electronics. They enable effective management of transport infrastructure [Koźlak 2008, Marczak and Kozłowski 2014]. Facilities using ITS can use a wide range of tools. The use of intelligent transport systems gives benefits ranging from economic, through an increase in the level of safety in transport, and ending with ecological ones [Nikitas et al. 2020]. The genesis of intelligent transport systems from the evolution of telecommunications and information technology, through transport telematics to intelligent transport systems is presented below transport systems (Figure 1).

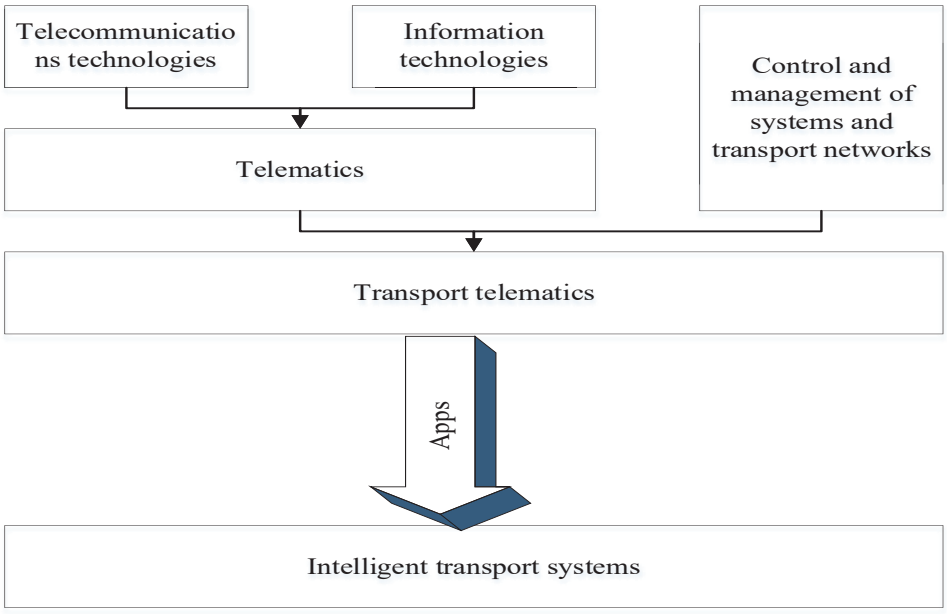

Figure 1. The genesis of intelligent transport systems
Rysunek 1. Geneza inteligentnych systemów transportowych
Source: own study based on: [Koźlak 2008].

ITS are a wide collection of various tools based on information technology, wireless communication and vehicle electronics. Due to the complexity of the above elements, they enable efficient and effective management of transport infrastructure, including city logistics. In such systems, the functioning of transport is largely supported by integrated measuring solutions (sensors, sensors), telecommunications, IT and information solutions, as well as automatic control [Koźlak 2008].

The scope of application of intelligent transport systems tools [Koźlak 2008, Maruszczak 2016]:

- road traffic management systems,
- public transport management systems,
- cargo transport and vehicle fleet management systems,
- road incident management systems and emergency services,
- traffic safety management systems and monitoring of violations of regulations,
- information services for travelers,
- electronic payment services and electronic toll collection systems for road use,
- advanced technologies in vehicles.

The implementation of transport policy is one of the priorities in the application of Intelligent Transport Systems (ITS) in individual areas of urban logistics. The most important effects of using ITS are [Koźlak 2008, Kamiński 2020]:

- general improvement in the efficiency of the transport system (in particular, shortening the travel time, reducing the number of stops and road incidents),
- increasing the level of road safety,
- reduction of harmful exhaust components, dust and noise emissions.

The field of application of intelligent transport systems that is important for improving the functioning of transport is freight and rolling stock management. Dissemination of ITS in this area helps to increase the efficiency of transport, but also contributes to the improvement of road safety.

Tools used in intelligent transport systems

The city as a living organism is a constantly changing structure, therefore it requires the use of already existing management concepts or the creation of new concepts in order to meet today's challenges. Various concepts that fall under the main element, i.e. city logistics, are also used to manage an urban agglomeration. All concepts belonging to urban logistics, to a different extent, have the potential to influence the development of an urban area [Festag 2014].

The purpose of using intelligent tools for urban logistics is to minimize or eliminate certain undesirable phenomena and to improve broadly understood flows in urban agglomerations. The table 1 identifies intelligent tools in city logistics.

Tabele 1. Tools used in intelligent transport systems of city logistics
Tabela 1. Narzędzia wykorzystywane w inteligentnych systemach transportowych logistyki miejskiej

Tools used in intelligent transport systems of city logistics	
Equipment	**Application form**
City logistic terminals (city-terminals)	One way to reduce the number of commercial vehicle trips around the city is to create city terminals. The location for this type of facility should be close to interchange junctions. The possibilities that arise from the introduction of this type of terminals are: – consolidation of shipments, – working out optimal delivery routes to avoid empty runs. Reloading of cargo incoming to the city to low-emission means of transport, which then deliver the goods directly to the addressees in the city.
City Card	It is an IT system that enables more convenient use of city services. The data carrier in this IT system is the City Card with a unique identification number assigned to each card. Thanks to the introduction of the City Card and its integration with many services, residents of the urban agglomeration can: pay for journeys by public transport, renting city bikes, parking, cinema, theater, museum, swimming pool. Money for payments with the city card is deducted from the personal account assigned to this card or from the funds to which the card is topped up.
System	**Application form**
Smart city	It is a concept of creating a smart city, which was established in 2007 as a result of the European Union's activities aimed at managing the energy sector and reducing greenhouse gas emissions. According to the definition, a Smart city is: an urban agglomeration that freely uses all technological and communication solutions. In order to improve the efficiency of city infrastructure, its interactivity and stimulating the increase of awareness of city dwellers. It can be considered that a smart city is a method of managing an urban agglomeration aimed at improving the quality of life of city residents. The concept of a smart city consists of several different elements, such as: creating long-term city management plans, using technological facilities, focusing on environmental protection, creative people, the possibility of implementing innovation and eliminating problems.
Expansion of the city's transport infrastructure	The transport infrastructure in the city consists of many elements that every inhabitant of the urban agglomeration encounters on a daily basis, such as: roads and traffic lights, pedestrian communication routes, bridges, viaducts, signs, tracks for various types of vehicles railways, energy networks, bus stops, bays, depots, transfer junctions, stations, parking lots, garages, reloading locations. As you can see, the whole urban infrastructure consists of many different elements, which, however, make up one functional whole. Due to changes in road traffic, transport habits and preferences of the population, the city's transport infrastructure must also be constantly developed and adapted to the modern expectations of urban infrastructure users. This task is not easy due to the relatively small space in the cities. Therefore, any reconstruction or transformation of the road infrastructure must be thought out and planned in detail with a view to the future. The current problem of cities is road congestion, therefore the road infrastructure is expanded with new roads (access roads to new housing estates and ring roads in order to relieve the city center from as many vehicles as possible) along with modern infrastructure in the field of road telematics.

cont. Table 1

Transport telematics	It is a combination of modern information technologies with communication technologies and control methods. Transport telematics can support various types of areas, such as: road infrastructure, vehicles, organization of road and pedestrian flows, and all indirect activities related to the above-mentioned areas. Telematics systems are characterized by: – immediate readiness to change actions, – collecting a lot of data, – the option of linking various devices and their functionalities, – continuous operation, – an option to expand the system's capabilities. The road telematics systems include all: sensors, detectors, cameras, various types of electronic or telecommunications communication systems, traffic lights, variable message boards, websites, mobile applications, data transmission means. Thanks to all these components, working on the proper functioning of road telematics systems, we can distinguish such telematics solutions as: variable message signs, weather stations, intelligent light signals, traffic control systems, video sensors, warning system against road works and accidents, detection of too high vehicles, a traffic volume survey system, passenger flow counting systems, information systems for free parking spaces and many others. The use of telematics in cities results, above all, in smoothening vehicle traffic, making public transport more attractive, reducing environmental pollution resulting from the large amount of exhaust fumes in cities, and reducing passenger car mileage.

Source: own study based on: [Saniuk and Witkowski 2011, Kądziela et al. 2012, Neumann 2017, Rześny-Cieplińska and Wach-Kloskowska 2017, Zawieska and Pieriegud 2018, Ostaszewski and Białek 2020].

Today's concepts must be innovative and modern, and most often relate to the city's infrastructure, logistics, ecological and economic infrastructure. The main goal of developing various logistics concepts regarding the city area is to minimize the occurrence of the phenomenon of congestion, improve the smoothness of driving in the city, improve accessibility to the city, and if possible, remove delivery vehicles or trucks from city centers [Tundys 2012]. Thanks to continuous analyzes of all flows in the city, all negative phenomena are monitored on an ongoing basis. As a result, you can work on the methods of solving the most difficult points in everyday life. Creating solutions to problems and then introducing them is often a long process, with a long period of preparation and implementation.

Telematics solutions supporting public transport in city logistics

The issue of urban public transport in urban agglomerations is an extremely important issue for the inhabitants and for the very functioning of the city. The functioning of the city's communication network improves the mobility of residents, especially those who do not have their own means of road transport. In addition, buses running on urban roads have the potential to relieve urban roads of passenger cars, which at the same time reduces the negative impact on the natural environment (reducing passenger vehicles, i.e. reducing noise and the amount of exhaust gases). In order to meet modern needs and requirements, city logistics must use more and more modern solutions that will ensure the achievement of goals. In the case of public transport in the city, which is operated by buses, it is important to make the most recent and up-to-date information available to travelers. The most useful information for travelers is, of course, arrival/departure time, travel time, and up-to-date information on delays. Additionally, the payment options for city tickets are important, so that the payment

method and the availability of tickets do not cause any problems for travelers [Barceló et al. 2005].

Due to the growing requirements of people traveling by public transport, telematics has proved to be helpful. It allowed for visible development in the area of public transport infrastructure, making traveling more pleasant and comfortable. In addition, telematics increases the competitiveness of public transport in relation to individual modes of transport by providing passengers with the latest information and modern payment methods.

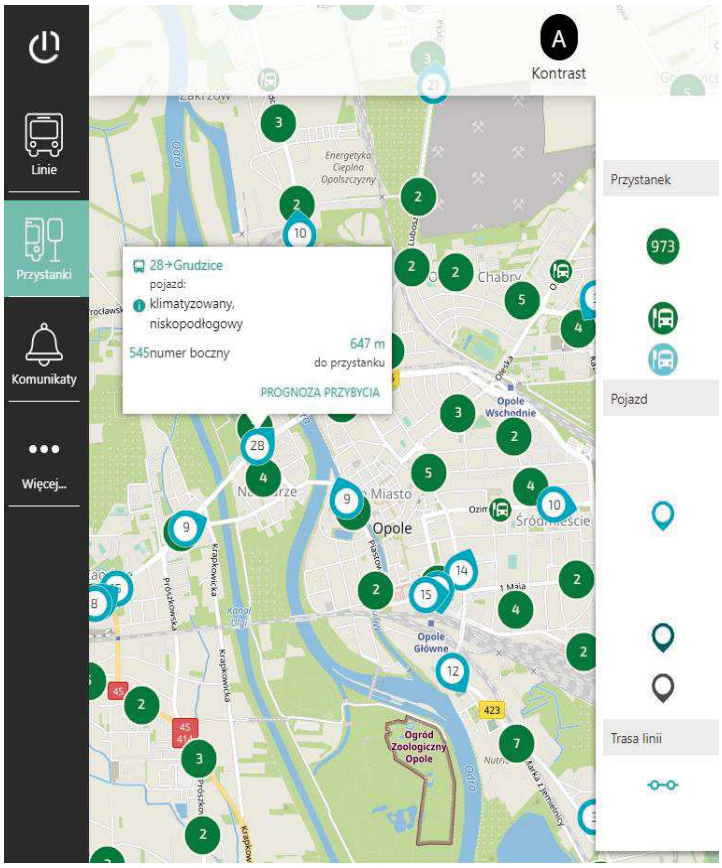

Figure 2. Passenger portal – dynamic passenger information MZK Opole
Rysunek 2. Portal pasażerski – dynamiczna informacja pasażerska MZK Opole
Source: [Dynamiczna informacja…].

As telematics solutions supporting public transport in cities, the following can be distinguished:

1. Dynamic passenger information system – it is a system whose task is the ongoing management of information flow and making it available. Thanks to this, people using the transport offered by the organizer of the public transport network have constant and free

access to up-to-date data on: commuting, bus position. Due to the wide use of GPS transmitters in public transport vehicles, it is possible to read the current position of the vehicles, which are then transferred to the management center. The management center is then able to process the information received and provide passengers with the actual arrival time of the buses and any delays caused by traffic congestion [Brożyna 2017]. All information regarding the time of departures, arrivals, delays and bus features (such as: low floor, air conditioning) is transferred to passenger portals (Figure 2), mobile applications and electronic variable message boards (Figure 3).

Figure 3. A variable message board at the bus stop in Opole
Rysunek. 3. Zmienna tablica ogłoszeń na przystanku autobusowym w Opolu
Source: [maj and usz 2020].

The passenger portal is able to provide the passenger with all the relevant information about the time and position of the bus, and even the remaining distance to the nearest stop. In addition, the designers of the portal took care of the clear and legible appearance of the website so that everyone could read the necessary information without any problems.

Locating variable message boards at bus stops in the realities of the frequent road congestion in cities, which causes delays in the arrival of city buses, has a huge impact on: reducing the uncertainty of travelers as to the arrival of the bus, improving the comfort of waiting for the bus due to the possibility of making sure that the bus did not depart anymore [Kaszubowski and Oskarbski 2011].

2. Priority system for public transport vehicles – the growing number of passenger cars and other private means of transport has resulted in the phenomenon of congestion, which has extended the travel time through the city streets. For this reason, more and more

extensive implementation of the priority system at intersections for public transport vehicles has started. In order to obtain the greatest possible continuity of city bus traffic, modern telematics elements are used, which can identify public transport vehicles even several meters before the intersection – in order to adjust traffic lights in time for all road users, taking into account the priority for the oncoming bus, of course. Identification of public transport vehicles can be performed using: induction loops and video detection. For the priority system to function properly, special signals for buses are used at intersections, and the whole is managed by a controller usually located in the vicinity of the intersection [Perzński and Lewiński 2016].

3. Electronic toll collection system – toll collection systems for journeys by means of public transport may also be modern. In order to facilitate the purchase of tickets for individual city zones or the number of journeys, automatic toll collection systems have been implemented. They record the time a passenger gets on and off, so that fares can be charged in direct proportion to the number of stops traveled - instead of a predetermined ticket price, regardless of the number of stops traveled.
4. In addition to the fair distribution of costs for bus journeys, the carrier obtains data, inter alia, on the number of passengers and stops used by the most people. On the basis of what you can decide about a greater number of stops on the so-called task [Biniasz 2016].
5. Dynamic bus lanes – most often in Polish cities you can meet fixed bus lanes by placing appropriate road signs and painting horizontal signs. However, access to telematics solutions allows the introduction of flexible bus lanes, which are introduced only when they are needed. This is an interesting idea, because in some places bus lanes cannot be marked constantly in both directions of travel. Therefore, we can distinguish dynamic bus lanes located on the outer lanes of the road and dynamic variable-direction bus lanes, which are marked at the axis of the road. The variable-direction bus lane will find its application especially on three-lane roads, which are characterized by heavy traffic and the occurrence of congestion during rush hours. Therefore, the middle lane designated as a floating lane in the morning rush hours may function as a bus lane towards the center, while in the afternoon rush hours the bus lane would function in the opposite direction. According to the current regulations, there are no regulations that would determine the specific marking of dynamic bus lanes. Certainly, in terms of organization, changing a given lane in a bus lane must be preceded by displaying the new traffic organization in advance. This is due to the fact that all vehicles driving in a dynamically changing lane have time to leave it freely. On the other hand, drivers of vehicles who see the new marking must comply with it and not enter the dynamic lane. In this way, after some time, the dynamic bus lane will be free from means of individual transport, and buses will be able to use it, reducing travel time as a result of, for example, a missed traffic jam [Molecki 2016]. It should be taken into account that the main condition for creating dynamic bus lanes is a road consisting of at least three lanes (Figure 4).

Figure 4. Markings for a dynamic bus lane
Ryc. 4. Oznaczenia dynamicznego pasa dla autobusów
Source: [Ruciński n.d.].

All the above-mentioned telematic systems for payments, organization, traffic management and information flow are designed to support the currently functioning public transport networks. The solutions presented in this chapter were created mainly for passengers, their comfort and convenience, as well as improving the bus travel time during rush hours. However, these activities do not only affect the benefit of people using public transport, but also create a competitive advantage of public transport companies over individual transport – thus they can reduce road traffic, reduce the incidence of road congestion and help to reduce the amount of exhaust fumes in cities.

System environment diagram for Intelligent Transport Systems

Intelligent transport systems have numerous tools that can be used in city logistics. The ITS architecture is the basis for planning, defining, connecting and coordinating individual transport subsystems in the areas of city logistics. It was defined on the basis of the transport system, the main link of which is the system environment, i.e. city logistics. On Figure 5 is a diagram of the elements of intelligent transport systems in city logistics.

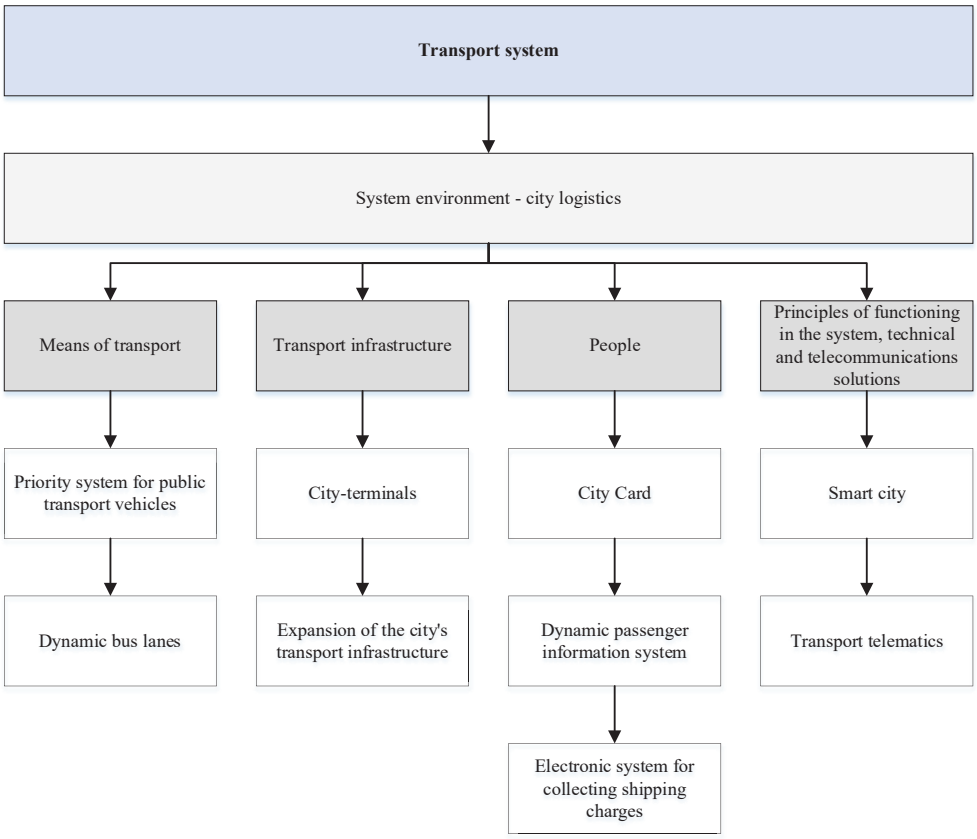

Figure 5. System environment diagram for Intelligent Transport Systems
Rysunek 5. Diagram środowiska systemowego dla inteligentnych systemów transportowych
Source: own study.

The functioning and development of a transport company and urban logistics areas should rely on the ability to adapt the transport system to the environment. Therefore, the four main links in the system environment have been characterized:

- means of transport,
- transport infrastructure,
- people,
- principles of functioning in the system, technical and telecommunications solutions.

Appropriate tools belonging to the group of intelligent transport systems in city logistics have been assigned to a particular group of the environment. By presenting the tools in a pictorial way, it was possible to adjust the appropriate element to the needs of a given area of city logistics. The ITS is the basis for the effective development of city logistics. Indication of elements where appropriate tools can be introduced makes it easier for individual units that will want to implement appropriate ITS tools to familiarize themselves with the elements.

Cities are large areas with numerous buildings between which there is an extensive road infrastructure. The need to move is connected with a high population density in the city,

which causes a large volume of traffic – especially road traffic. Improving road traffic flow and reducing road congestion is possible thanks to the use of intelligent transport systems tools.

Conclusion

The public transport network in each city plays a very important role, as it allows residents to maintain a high level of mobility throughout the entire urban agglomeration. Along with the increasing popularity of a passenger car, the scale of congestion in cities is increasing, which has a negative impact primarily on the natural environment and the quality of life of city residents. City authorities are taking various measures to reduce vehicle traffic and make driving smoother. One of the elements of increasing the capacity of urban agglomerations is the implementation of intelligent transport systems tools. The functioning and development of a transport company and urban logistics areas should rely on the ability to adapt the transport system to the environment. Therefore, the four main links in the transport system environment have been characterized, namely: means of transport, transport infrastructure, people, principles of functioning in the system, as well as technical and telecommunications solutions. Improving road traffic flow and reducing road congestion is possible thanks to the use of various tools of intelligent transport systems of urban logistics. Research facilities are two urban agglomerations. Despite the fact that the scope of entities is a narrow research group, they translate into most urban agglomerations.

References

Barceló J., Codina J.E., Casas J., Ferrer J.L., García D., 2005: Microscopic traffic simulation: A tool for the design, analysis and evaluation of intelligent transport systems, Journal of Intelligent and Robotic Systems 41, 173–203.

Biniasz D., 2016: Rozwiązania telematyczne w transporcie miejskim – studium przypadku, Efektywność transportu, Autobusy 6, 516–524.

Brożyna E., 2017: System dynamicznej informacji pasażerskiej w komunikacji miejskiej – analiza użyteczności i zadowolenia pasażerów na przykładzie KZK GOP, Inteligentne systemy transportowe, Autobusy 6, 16–21.

Dynamiczna informacja pasażerska, MZK Opole, [electronic source] https://dip.mzkopole.pl/# [access: 22.11.2021].

Festag A., 2014: Cooperative intelligent transport systems standards in Europe, IEEE Communications Magazine 52, 12, 166–172.

Gentile G., Noekel K., 2016: Modelling Public Transport Passenger Flows in the Era of Intelligent Transport Systems, Springer Cham, Switzerland.

Kądziela A., Zakrzewski S., Pawelski Z., 2012: Propozycja cyklu zapewniających prawidłowe działanie system karty miejskiej, Logistyka 3, 1001–1004 [CD].

Kamiński T. 2020: Kooperacyjne Inteligentne Systemy Transportowe (C-ITS) jako rozwiązania podnoszące bezpieczeństwo i efektywność transportu drogowego, Gospodarka Materiałowa i Logistyka 6, 10–18.

Kaszubowski D., Oskarbski J., 2011: Sposoby wykorzystania rozwiązań telematycznych w tworzeniu zrównoważonych systemów transport miejskiego, Autobusy 12, 185–193.

Koźlak A., 2008a: Ekonomika transportu. Teoria i praktyka gospodarcza, WUG, Gdańsk.

Koźlak A., 2008b: Inteligentne systemy transportowe jako instrument poprawy efektywności transportu, Logistyka 2.

Madeyski M., Lissowska E., Marzec J., 1971: Wstęp do nauki o transporcie, Szkoła Główna Planowania i Statystyki, Warszawa.

maj, usz, 2020: Sprawdziliśmy, czy mieszkańcy Opola noszą maseczki. Prawie 80 proc. z nich robi to dobrze, Wyborcza.pl Opole, [electronic source] https://opole.wyborcza.pl/opole/51,35086,26404274.html?i=0 [access: 22.11.2021].
Marczak M., Kozłowski R., 2014: Budowa inteligentnych systemów transportowych jako szansa dla zrównoważonego rozwoju regionów, Ekonomia i Zarządzanie 6, 2, 34–42.
Maruszczak M., 2017: Inteligentne systemy transportowe a zarządzanie ruchem w miastach, Komunikacja Publiczna 2, 45–56.
Molecki A., 2016: Dynamiczne pasy autobusowe, Inteligentne systemy transportowe, Autobusy 11, 10–15.
Neider J., 2008: Transport międzynarodowy, PWE, Warszawa.
Neumann T., 2017: Wykorzystanie systemów telematyki na przykładzie wybranych przedsiębiorstw transport drogowego, Efektywność transport, Autobusy 12, 605–610.
Nikitas A., Michalakopoulou K., Njoya E.T., Karampatzakis D., 2020: Artificial Intelligence, Transport and the Smart City: Definitions and Dimensions of a New Mobility Era, Sustainability 12(7), 2789.
Ostaszewski P., Białek B., 2020: Dzika logistyka miejska. Co zrobić, aby e-commerce nie zrujnował nam życie i nie zniszczył naszych miast, Stowarzyszenie Miasto Jest Nasze, Warszawa.
Perzński T., Lewiński A., 2016: Telematyka transport w komunikacji miejskiej, Prace naukowe Politechniki Warszawskiej 113, 401–409.
Ruciński A., n.d.: Autobus jeździ pod prąd. W Gdyni otwarto pierwszy kontrapas, WP autokult, [electronic source] https://autokult.pl/36018,autobus-jezdzi-pod-prad-w-gdyni-otwarto-pierwszy-kontrapas [access: 02.05.2021].
Rześny-Cieplińska J., Wach-Kloskowska M., 2017: Logistyczne aspekty koncepcji Smart City, Studium przypadku na podstawie miast Europejskich, Studia Miejskie 27, 129–141.
Saniuk S., Witkowski K., 2011: Zadania infrastruktury transport miejskiego w logistyce miejskiej, Logistyka 2, 495–506.
Tarski I., 1993: Ekonomika i organizacja transportu międzynarodowego, PWE, Warszawa.
Tomaszewska E.J., 2015: Inteligentny system transportowy w mieście na przykładzie Białegostoku, Zeszyty Naukowe Uniwersytetu Szczecińskiego 875, Problemy Zarządzania, Finansów i Marketingu 41, 2, 317–329.
Tundys B., 2012: Wpływ rozwiązań z zakresu logistyki miejskiej na kształtowanie rozwoju regionu, Zeszyty Naukowe Politechniki Śląskiej. Seria Transport 75, 93–102.
Zawieska J., Pieriegud J., 2018: Smart city as a tool for sustainable mobility and transport decarbonisation, Elsevier 63, 39–50.