

ZHANG MIN, D. GOROVYI

THE ECONOMICAL ADVANTAGES AND DISADVANTAGES OF URBAN PASSENGER TRANSPORT MODES ACCORDING TO THE PURPOSES OF URBAN PASSENGER LOGISTICS

Urbanization and the significant growth of cities, due to the large processes of migration of rural residents to cities, passenger logistics became a separate problem of the 20th, and now the 21st century, especially urgent for the People's Republic of China. This led to the fact that the issues of urban passenger logistics became relevant. A distinctive feature of the human resources (passenger) logistics, in contrast to traditional transport logistics, is the quality of delivery or transportation. Therefore, the choice of the cheapest mode of transport (if there are no talks about perishable or fragile resources), the fastest delivery method, the optimal route, etc. plays an important role in ordinary transport logistics. Other goals play an important role in the transportation of people: comfort, small overload, convenient schedule, availability of accumulation points (stations, platforms, platforms, etc.), and especially – a choice of a transport mode vehicle and its suitability for transporting people. The aim of the article is to find out the economic advantages and disadvantages of all possible modes of urban passenger transport according to the purposes of urban passenger logistics. Many scientists discovered the problem of urban public transport mode choice, but it is still not have an optimal decision, as the aim of their study were connected technical side of urban transport or the management of existing transport modes, fuel alternative decisions, the possibility of traffic congestion reduction, etc. It the article it was shown that according to comparison on ecological and construction and operating cost criteria the best modes of passenger urban transport for ordinary landscape city are trolleybus and electric bus, as the most balanced modes. The most popular existing modes as bus and subway have lacks: a bus has a lack of environmental friendliness, and a subway has high cost on construction and operation. After choosing the best urban mode of passenger transport for the city two other main issues of organizing urban logistics are left. The choice of the method of accounting and control of travel and the choice of a fare rating system will be investigated in the next articles.

Keywords: logistics; urban transport; passenger transport; urban passenger logistics; modes of transport; advantages and disadvantages.

ЧЖАН МИНЬ, Д.А. ГОРОВИЙ

ЕКОНОМІЧНІ СИЛЬНІ І СЛАБКІ СТОРОНИ ВИДІВ МІСЬКОГО ПАСАЖИРСЬКОГО ТРАНСПОРТУ ВІДПОВІДНО ДО ЦІЛЕЙ МІСЬКОЇ ПАСАЖИРСЬКОЇ ЛОГІСТИКИ

Урбанізація і значне зростання міст через великі процеси міграції сільських жителів у міста, призвели до того, що пасажирська логістика стала окремою проблемою ХХ, а тепер і ХХІ століття, що є особливо актуальним для Китайської Народної Республіки. Відмінною рисою пасажирської логістики, в відмінні від традиційної транспортної логістики, є якість доставки або перевезення. Оскільки в звичайній транспортній логістиці важливу роль відіграє вибір найбільш дешевого виду транспорту (якщо не йдеться про швидкопсувні або крихкі ресурси), максимально швидкого способу доставки, оптимального маршруту і т. і., то в транспортуванні людей важливу роль відіграють інші цілі: комфорт, невелике перевантаження, зручний графік, наявність точок накопичення (станцій, платформ тощо), і особливо – вибір виду транспорту і його придатність для перевезення людей. Метою статті є виявлення економічних переваг і недоліків всіх можливих видів міського пасажирського транспорту для цілей міської пасажирської логістики. Багато вчених вивчали проблему вибору виду міського громадського транспорту, але до сих пір не знайшли оптимального рішення, оскільки цілі їх дослідження були пов'язані з технічною стороною міського транспорту або управлінням існуючими видами транспорту, альтернативними рішеннями по паливу, можливістю зниження транспортних заторів тощо. У статті показано, що в порівнянні за критеріями еколого-будівельної та експлуатаційної вартості кращими видами пасажирського міського транспорту для міста зі звичайним ландшафтом є троллейбус і електробус, як найбільш збалансовані види транспорту. У найбільш популярних існуючих видів транспорту, таких як автобус і метро, є недоліки: автобус є не екологічний, а метро дорого обходиться в будівництві і експлуатації. Після вибору оптимального міського виду пасажирського транспорту залишаються два інших основних питання організації міської логістики: вибір методу обліку та контролю проїзду, а також вибір тарифної системи. Вони будуть розглянуті в наступних статтях.

Ключові слова: логістика; міський транспорт; пасажирський транспорт; міська пасажирська логістика; види транспорту; сильні та слабкі сторони.

ЧЖАН МИНЬ, Д.А. ГОРОВОЙ

ЭКОНОМИЧЕСКИЕ СИЛЬНЫЕ И СЛАБЫЕ СТОРОНЫ ВИДОВ ГОРОДСКОГО ПАССАЖИРСКОГО ТРАНСПОРТА В СООТВЕТСТВИИ С ЦЕЛЯМИ ГОРОДСКОЙ ПАССАЖИРСКОЙ ЛОГИСТИКИ

Урбанизация и значительный рост городов, из-за больших процессов миграции сельских жителей в города, привели к тому, что пассажирская логистика стала отдельной проблемой ХХ, а теперь и ХХІ века, что является особенно актуальным для Китайской Народной Республики. Отличительной чертой пассажирской логистики, в отличие от традиционной транспортной логистики, является качество доставки или перевозки. Поскольку в обычной транспортной логистике важную роль играет выбор наиболее дешевого вида транспорта (если не идет речь о скоропортящихся или хрупких ресурсах), максимально быстрого способа доставки, оптимального маршрута и т. д., то в транспортировке людей важную роль играют другие цели: комфорт, небольшая перегрузка, удобный график, наличие точек накопления (станций, платформ и т.д.), и особенно – выбор вида транспорта и его пригодность для перевозки людей. Целью статьи является выявление экономических преимуществ и недостатков всех возможных видов городского пассажирского транспорта для целей городской пассажирской логистики. Многие ученые изучали проблему выбора вида городского общественного транспорта, но до сих пор не нашли оптимального решения, поскольку цели их исследования были связаны с технической стороной городского транспорта или управлением существующими видами транспорта, альтернативными решениями по топливу, возможностью снижения транспортных заторов и т.д. В статье показано, что в сравнении по критериям эколого-строительной и эксплуатационной стоимости лучшими видами пассажирского городского транспорта для города с обычным ландшафтом являются троллейбус и электробус, как наиболее сбалансированные виды транспорта. У наиболее популярных существующих видов транспорта, таких как автобус и метро, есть недостатки: автобус не экологичен, а метро дорого обходится в строительстве и эксплуатации. После выбора оптимального городского вида пассажирского транспорта остаются два других основных вопроса организации городской логистики: выбор метода учета и контроля проезда, а также выбор тарифной системы. Они будут рассмотрены в следующих статьях.

Ключевые слова: логистика; городской транспорт; пассажирский транспорт; городская пассажирская логистика; виды транспорта; сильные и слабые стороны.

Introduction. Transport is one of the most important sectors of the national economy, which realizes the needs of the

economy and the population in all modes of traffic. It plays an important role in the economic, socio-political, defense and

cultural life of each country, region, city and even town. The special economic science called logistics studies the economic sphere of transportation. Traditionally, logistics is considered as the doctrine of planning, management and control the movement of material, information and financial resources in various systems. However, this approach, as a rule, is limited only by issues of goods transportation, i.e. material resources. Nevertheless, in the era of globalization and economic integration, the role and need for rapid and rational movement not only material, but also human resources are increasing. After all, urbanization and the significant growth of cities, due to the large processes of migration of rural residents to cities, passenger logistics became a separate problem of the 20th, and now the 21st century, especially urgent for the People's Republic of China. This led to the fact that the issues of urban passenger logistics became relevant.

Analysis of the issue state. A distinctive feature of the human resources (passenger) logistics, in contrast to traditional transport logistics, is the quality of delivery or transportation. Therefore, the choice of the cheapest mode of transport (if there are no talks about perishable or fragile resources), the fastest delivery method, the optimal route, etc. plays an important role in ordinary transport logistics. Other goals play an important role in the transportation of people: comfort, small overload, convenient schedule, availability of accumulation points (stations, platforms, platforms, etc.), and especially – a choice of a transport mode vehicle and its suitability for transporting people.

The purpose of the work. The aim of the article is to find out the economic advantages and disadvantages of all possible modes of urban passenger transport according to the purposes of urban passenger logistics.

Analysis of the main achievements and literature. Many scientists discovered the problem of urban public transport mode choice, but it is still not have an optimal decision. The great input to highlight this problem was done by Vukan R. Vuchic, however his decisions were connected mostly with technical side of its implementation [1] or the management of existing transport modes [2]. The environmental problems of urban city exploitation were discovered by Paul Mees [3]. Nicholas Low studies the problem of fossil-fuel usage by mass transport. His ideas are connected with transport fuel alternative decisions [4]. Richard Iles's researches are connected with rational decisions for public transport in developing countries [5]. Other side the transportation planning in USA with urban problems of growth and development are studied by Michael Southworth and Eran Ben-Joseph [6]. David Levinson and Kevin Krizek research the possibility of traffic congestion reduction [7]. Jens Schade, Bernhard Schlag [8], Erik Verhoef, Michiel C.J. Bliemer [9], Dmytro Gorovyj and Kseniia Gorova [10] investigate the fear system of the transport. However, the problems of economical advantages and disadvantages of all possible modes of urban passenger transport are not still enough investigated.

Presentation of the main research material. The purposes of urban passenger logistics are: meeting the needs of city residents in transport; ability to move a significant number of passengers over long distances; rational organization of the transport system in space and time; efficiency and environmental friendliness of transport; possibility of using in the conditions of existing buildings and terrain [1].

The main mode of modern mass transport in cities is usually a bus. A bus is a rail-less mechanical motor vehicle, technically designed to carry nine or more passengers and capable of maneuvering on the road, driven by an energy source stored or produced from fuel stored on board [11]. The world's first city bus with an internal combustion engine entered the route on April 12, 1903 in London [11]. Due to the ease of operation and the absence of additional costs in organizing the route (there is no need for rails, contact network, only the organization of transport stops), a bus is the cheapest and most massive mode of urban transport in the world, it is used both in large cities and small towns. The city bus makes frequent stops at which a large number of passengers take off and take on board. Such a bus should have wide doors and passages, storage areas, handrails for standing passengers. In metropolitan areas with difficulties in roads traffic, buses have a separate lane, where other road users do not have access. These buses are called metrobuses [11]. However, in addition to advantages, buses also have disadvantages – low environmental friendliness during use, high wear, noise, the use of long buses on city roads leads to their low maneuverability, and therefore to traffic jams and a greater likelihood of road accidents.

It is necessary also to mention a taxi. It is not mass transport, but serve for a single transportation of passengers without specified routes to any point with payment for carfare by the counter-taximeter, or by agreement, on a pre-calculated route [12]. The most common mode of passenger cars used as taxi are station wagons or sedans, less often minivans (even pick-up trucks in Thailand). The strengths of using a taxi as a mode of transport are delivery to any part of the city at any time, in the shortest possible time and around the clock. But along with this, there are a number of weaknesses: high cost of services; low passenger capacity; the possibility of denial of service due to the lack of free cars; a large number of "illegal" cars and delivery services (Uber, Bolt, Bla-Bla Car) create competition.

In the poor countries, there is a specific mode of transport – route taxis. In fact, there are two types of them – tuk-tuk, where they use a scooter or a pickup truck (Jakarta, Bangkok, New Delhi), and minibus (Johannesburg, Kharkiv, Odesa, Tirana, etc.). In the case of using a scooter, they are inherently closer to a taxi, but differ in a lower fare. In the case of using a pickup or minibus, route taxis carry out transportation along certain lines – routes. Route taxis differ from the bus primarily by the small number of passengers. In some countries (South Africa, Thailand, Bolivia, Albania, etc.) they differs by the fact that they can stop and take off passengers not only at public transport stops, but also on demand in all places along the route.

The second most popular urban mode of transport is a tram. A tram is a surface electric railway type of street and partly street public transport for transporting passengers on predetermined routes, used mainly in cities (although there are examples of intercity tram routes) [13]. A tram is one of the oldest modes of urban passenger public transport among the existing at the beginning of the 21st century and it originated in the first half of the 19th century as a horse-drawn vehicle. Nowadays, a tram is often a type of historical transport. For example, it has been preserved by separate lines in Lisbon and Porto (Portugal), Barcelona (Spain), Leeds (Great Britain), etc. Although in many cities its role as the main vehicle remains significant, including for environmental reasons and due to technological improvements, for example Prague (Czech

Republic), Budapest (Hungary), Warsaw (Poland), Vienna (Austria), Brussels (Belgium), etc. Most trams use electric traction with the supply of electricity through an overhead contact network, however, there are also trams powered by a contact third rail or batteries. In the past, there were horse trams (horse trams), pneumatic, steam and gas-powered trams. Currently, in addition to electric, there are cable cars and diesel trams, however, the last ones are deprived of the main advantage of the tram – environmental friendliness, and therefore they are practically not used. The main disadvantage of a tram is a noise (although in some cities their wheels use rubber tires to reduce it), the cost of organizing and maintaining the rail infrastructure and contact networks, high maintenance costs in the autumn-winter period (the need to clear the rails from snow). In some cities of the world, in particular in Ukraine, Russia, Poland, Belgium, Portugal, Turkey, Sweden, Switzerland, Germany and Israel, a high-speed trams are used (Kryvyi Rig, Kyiv, Porto, Volgograd, Istanbul, Stockholm, Cologne, Jerusalem, Krakow, Antwerp, Zurich, etc.). They move along dedicated high-speed sections or underground, and therefore does not interfere with traffic on city streets, creates little noise in the external environment and less operating costs in winter (for underground use). In German, such a high-speed underground tram (as well as the subway) is called U-Bahn.

Trolleybuses are also widespread as mass passenger transport in European cities (Kharkiv, Kyiv, Minsk, Bratislava, Budapest, Athens, Chisinau, Ostrava, Vilnius, Moscow, St. Petersburg, Salzburg, etc.). A trolleybus is a trackless motor vehicle of contact type with an electric drive, which receives electric current from an external power source (from central power stations) through a two-wire contact network using a pantograph and combines the advantages of a tram and a bus [14]. A trolleybus is similar in design to a bus, so many manufacturers build trolleybuses on the platform of serial buses. Trolleybuses are used mainly in cities, but there are also intercity trolleybuses (for example, the Yalta – Simferopol route in Ukraine). The main advantages of the trolleybus are its environmental friendliness (no emissions) and the absence of rails, i.e. the possibility of using on city roads. In addition, the capacity of a low-floor trolleybus is usually more than that a low-floor bus, since no space is required for placing fuel tanks, the engine, and transmission units of the trolleybus are much more compact, some of the electrical equipment can be placed on the roof. Besides, the specific energy consumption of a trolleybus per transported passenger is 30-35% lower than that of a bus [14]. The disadvantages of a trolleybus usage are the lack of autonomous running (without power supply), binding to the existing (or construction of a new one) contact network, a trolleybus consumes more electricity in comparison with a tram.

Many cities of the world use another specific mode of transport – a subway (metro, or rapid transit). A subway is an off-street urban passenger transport system with rout trains running there [15]. Different variants of the name are used in modern English: mostly in American – subway, rail, in British – the underground, metro. For example, London Underground, New York Subway, Montreal Metro, Delhi Metro, Lahore Metro, but in Liverpool – Merseyrail, in Washington – Washington Metrorail (or Washington Metro), in San Francisco – BART (Bay Area Rapid Transit), in Singapore – MRT (Mass Rapid Transit), U-Bahn in Germany, etc. The term U-Bahn is short for *Untergrundbahn* (underground railway). However, in

some German cities (Cologne, Dusseldorf, Bochum, Dortmund, Stuttgart, etc.) the word U-Bahn is used for high-speed underground tramlines. Subway lines, unlike trams, are always laid separately from street transport: most often in tunnels (London, New York, Paris, Madrid, Beijing, Bangkok, Rome, Warsaw, Prague, St. Petersburg, Kharkiv, etc.). Sometimes they are laid on overpasses or on the surface of the earth (partially, Kyiv, Moscow, Bangalore, Rennes, Toronto, Kuala Lumpur, Chongqing, etc.), but they do not intersect with other road users, and this is different from the high-speed tram (which is also sometimes called a metro). The construction of the subway (especially the underground) requires heavy investments; therefore, it is economically justified only in the cities with a large passenger traffic. The first 6 km of underground line was built in London and it was launched on January 10, 1863 [15]. Initially, it was operated on steam traction, which was replaced by electric power since 1890. Power electric supply of subway trains is performed from the third (contact) rail (in Beijing, Kyiv, Kharkiv, Paris, Sao Paulo, etc.), from the overhead contact network (in Vienna, Lisbon, Shanghai, etc.) or from the cable car (in Perugia). The largest subway in the world in the number of stations and routes is operated in New York (472 stations, 36 routes); with the length of the lines – in Beijing (690.5 km) and Shanghai (676 km); by annual passenger traffic – in Beijing and Tokyo; in terms of daily passenger traffic – in Beijing, Shanghai, Shenzhen and Seoul [15]. The smallest subways are located in Tabriz, Maracaibo, Catania, Genoa, and Dnipro (7.8 km). Lausanne, Brescia and Rennes are the smallest cities in the world with a subway.

The economic advantages of the subway are its separate location, high route speed (up to 80 km / h) and carrying capacity (up to 60 thousand passengers per hour in one direction), low noise for the environment (for underground), environmental friendliness, lack of intersection with other modes of transport. The disadvantages of subway are high construction costs, high operating costs, possible safety problems (for underground), and the possibility of rapid spread of respiratory diseases (as Coronavirus).

In Asian or American cities (Wuhu, Guang'an, Liuzhou, Bengbu, Guilin, Kuala Lumpur, Tokyo, Bangkok, Jakarta, Las Vegas, Seattle, Sao Paulo, etc.), another mode of transport similar to the subway is popular, it is monorail road. Formally, the monorail refers to a railroad that uses one bearing rail, as opposed to a conventional railroad, where there are two of them [16]. The main advantage of the monorail road is that it, like a subway, does not directly intersect with other road users on the streets of the city. It means that the likelihood of collisions with other traffic objects is negligible. In addition, a monorail is much cheaper in construction in comparison with a subway. A visibility in a monorail train is better than in a ground transport due to the elevation of transport lines to a certain height. As a result, monorail trains are also often used as sightseeing transport in parks or other recreational areas (for example, in Disney Park (USA), at Ueno Zoo (Japan), etc). In addition, a monorail road is characterized by a low noise level (compared to a tram or subway) due to the use of quiet electric motors and rubberized wheels. The disadvantages of the monorail are more energy consumption, high costs for the construction and operation of switch tracks compared to a system with two rails, high construction and operating costs compared to a tram or railway, more accidents due to falling vehicles from a height.

Another type of monorail is the tramway, common in Germany (Wuppertal, Dresden). It is called in German H-bahn, from *Hochbahn* (Elevated railway). It is a monorail two-track suspension system on overpasses [17]. Unlike a monorail, a carriage does not stand on a rail, but it is suspended from it. It has the same advantages and disadvantages as the monorail.

Also, first in Germany (Berlin, Dresden, Hanover, Cologne, etc.), and then in other countries (France, Australia, USA, Ukraine, etc.), the city railway became widespread. In Germany, it is called S-Bahn (from *Stadtbahn* – city railway). The S-Bahn is essentially closer to suburban railway trains, since it serves not only urban, but also suburban areas, for example, Berlin and Potsdam in Germany [18]. In France, this transport system is called RER (*Réseau Express Régional* – The system of local express trains) [19]. However, unlike Berlin, where the main sections of the S-Bahn are located on overpasses within the city, RER in Paris is located underground in tunnels, like a subway. Unlike these cities, Metro Trains Melbourne has only ground sections. Since 2009 in Ukraine Kyiv city electric train has been operating. The main advantage of such transport is the use of railways coaches and their existing rail system. This type of transport is especially beneficial for suburban residents working within the city, since it allows them not only to get to the city, but also to get to their destination without a change at the station. The disadvantages are high costs in construction of underground and elevated sections, traffic road jams and accidents with ground sections.

Funiculars are used as urban transport in the cities with a significant difference in height relief (Kyiv, Tbilisi, Baku, Prague, Budapest, Lisbon, Porto, Kaunas, Vladivostok, Genoa, Naples, Barcelona, San Francisco, etc.). Funicular (from Latin *Funiculus* – rope, cable) is a rail vehicle with cable traction for transporting people or goods in two connected carriages over a short distance along a steep rail track [20]. Funicular lines, being part of the city's transport system, are also often used as sightseeing and excursion transport for tourists. The funicular drive (i.e. its engine) is located at the top station, and the funicular carriages do not have their own engines. The funicular is most often laid on a separate track. Its variety, which is laid along the streets of the city and can intersect with other road users, is called a cable car [21]. Such vehicles operate in Lisbon, San Francisco, Seattle, etc. There are underground funiculars in Istanbul (Turkey) and Haifa (Israel), which makes them similar to a subway. The main advantages of funiculars are its separate location (not to cable cars), low noise for the environment, a unique way to get to the hill. The disadvantages are high costs for construction and operating of steep rail compared to a tram, high cable wear due to its constant friction, traffic road jams and accidents with cable cars, the shortage of route; it operates only on steep routes.

Also, elevator lifts (Porto, Lisbon, Mlada Boleslav, Brussels, Salvador, Stockholm, Izmir) they can use as urban transport for vertical movement of passengers. They are designed to assist pedestrians to overcome a steep slope [22]. As a rule, the transport service on such lifts is provided non-24 hours a day and in some cities (Brussels, Mlada Boleslav) it is free. A separate type of such lifts, which, however, is often confused with a funicular, is the inclined lift. Unlike a lift-elevator, it lifts passengers not vertically, but at an angle, like a funicular. However, unlike a funicular, where the cable is attached simultaneously to a pair of vehicles, with the ascending and descending vehicles balancing each other, in an inclined

elevator, one car is either lifted by a winch to a station at the top of the slope [23]. Such cities as Odesa, Cuneo, Paris, etc. use this mode of transport. The main advantages of lifts are its separate location, possibility to move passengers on vertical slope, possibility to serve as architectural attracters. The disadvantages are low passenger capacity, low speed, accidents with cables due to wear, the shortage of route; it operates only on steep routes.

To overcome natural barriers (for example, ravines, gorges, rivers), aerial cableway are used in Koblenz, Bratislava, Haifa, Barcelona, Ashgabat, Kharkiv, Odesa, Nizhny Novgorod, New York, Singapore, Portland, Caracas, Hong Kong, Funchal, Tbilisi, London, etc. An aerial cableway is a type of transport for moving passengers and goods, which use a cable (rope) to move carriages (cabins or chairs) in horizontal way without touching the ground, stretched between the supports. Moreover, if initially aerial cableways acted as a full-fledged form of urban transport, then recently they are more often objects of tourist and entertainment complexes. Cabins can be open or closed and vary in the number of passengers who can be in them at the same time [24]. The main advantages of aerial cableways are a lack of intersection with other modes of transport, possibility to move passengers through natural barriers, possibility to serve as architectural attracters. The disadvantages are low passenger capacity, low speed, accidents with cables, the shortage of route, and high dependence on weather.

The cities with a significant water surface use water taxis or waterbuses. Water taxi or a waterbus are small displacement passenger ships or ferries, operating in excursion mode or in mode public transport in cities or on short-distance commuter routes on rivers, in gulfs, canals or channels. These water taxis run on established routes and carry a large number of passengers. Scheduled water taxis operate in New York, Boston, Toronto, Auckland, London, Istanbul, Hong Kong, New York, Rotterdam, Amsterdam, Bangkok, Copenhagen and other cities. In Venice, they call as water taxis the small boats, which operate in the same mode as ordinary "car" taxis. Ships carrying more passengers on certain routes they call "water buses" in this city (in Italian – *vaporetto*). [25]. The main advantages of water vehicles are a lack of intersection with other modes of transport, water surface usage. In the same time, the last is the main disadvantage as the passengers get out of ferry have to change their mode of transport to continue their trip. The disadvantages are also low speed, accidents on water, and high dependence on weather.

In cities where environmental friendliness of transport plays an important role, but it is not possible to use a tram or trolleybus due to narrow streets and the need to preserve architectural monuments, a new mode of transport is now used – it is an electric bus (Beijing, Shanghai, Lhasa, Shenzhen, Tianjin, Vienna, Krakow, Moscow and etc.). An electric bus is a road motor vehicle of general use with an electric drive, designed to transport people along the roads by a specified route. An electricity required for an electric bus can be generated on board (for example, by fuel cells), or stored on board in a storage device [23]. An electric bus of medium or large capacity, according to the design principle and the electrical equipment used, is in many ways similar to a trolleybus. However, in the general concept it is an electric car with the exception of the size, capacity and power of the electric drive. The first electric bus appeared in Great Britain in 1906.

[23]. However, for a long time this mode of transport was not used due to the high cost of its production, low efficiency and the availability of cheaper alternatives with low environmental requirements. Thus, the main advantages of an electric bus are its environmental friendliness, the possibility of using it on public roads without their modification (no contact network, rails, etc.), greater maneuverability compared to a trolleybus, the possibility of creating on bus body. But at the same time and still there are a number of drawbacks that restrain the development of this promising transport – a low cruising range without recharging fuel cells, high cost of fuel cells, the need to organize recharging stations at the headland, low efficiency (especially in hot or cold weather conditions).

In 2013, Elon Musk proposed a new version of passenger transport and called it as hyperloop, which will work on the principle of pneumatic mail or electromagnetic catapult. Hyperloop was conceived as an overhead pipeline located on supports, inside of which single transport capsules 25-30 m long move in one direction at a speed of 480 to 1102 km / h (depending on the landscape) at intervals of 30 seconds in one direction [24]. Elon Musk himself considers his idea as the fifth mode of transport after a train, plane, car and ship. Therefore, this mode of transport can both be considered as intercity and inner city one, as agreements on the construction of 10 km long operational routes in the cities of Dubai (UAE) and Tongren (PRC) have already been concluded. However, since there is still no full-fledged operation of this type of transport, it is too early to talk about the economic advantages and disadvantages of this type of transport, although the main ones are pointed below.

Conclusions. It was shown that according to comparison on ecological and construction and operating cost criteria the best modes of passenger urban transport for ordinary landscape city are trolleybus and electric bus, as the most balanced modes. Bus has a lack of environmental friendliness, and a subway has high cost on construction and operation. Other modes have less capacity or are still not operated (as hyperloop). But never the less bus and subway are still two the most popular modes of urban passenger transportation all over the world due to their main advantages – usage of existing road system for buses and big capacity, speed and expectance of road intersections for subway. All other modes of urban transport are on occasional location all over the world depending on their historic development (tram or trolleybus), slopes (cable car, funicular, lift), nature intersections (aerial cableway), or water coverage (waterbus).

After choosing the best urban mode of passenger transport for the city two other main issues of organizing urban logistics are left. The choice of the method of accounting and control of travel and the choice of a fare rating system will be investigated in the next articles.

References

1. Vuchic V.R. Transportation for Livable Cities. New Brunswick, CUPR/Transaction, 1999. 376 p.
2. Vuchic V.R. Urban Transit Systems and Technology. Hoboken, NJ, John Wiley & Sons, 2007. 624 p.
3. Mees P. Transport for Suburbia: Beyond the Automobile Age. New York, Routledge, 2009. 240 p.
4. Low N. Transforming Urban Transport: The Ethics, Politics and Practices of Sustainable Mobility. New York, Routledge, 2013. 268 p.
5. Iles R. Public Transport in Developing Countries. Bingley, Emerald Group Publishing Limited, 2005. 478 p.
6. Southworth M. & Ben-Joseph E. Streets and the Shaping of Towns and Cities. Washington, D.C., Island Press, 2003. 197 p.
7. Levinson D. & Krizek K. Access to Destinations. Bingley, Emerald Group Publishing Limited, 2005. 414 p.
8. Schade J. & Schlag B. Acceptability of Transport Pricing Strategies. Bingley, Emerald Group Publishing Limited, 2003. 329 p.
9. Verhoef E., Bliemer M. C.J., Steg L. & van Wee B. Pricing in Road Transport: A Multi-disciplinary Perspective. Cheltenham, Edward Elgar Publishing, 2008. 324 p.
10. Gorovyi D., & Gorova K. Urban Public Transport Fare System in Different Cities. *Visnyk Natsional'noho universytetu "Lvivska politekhnika". Seriya: Menedzhment ta pidpryyemnytstvo v Ukraini: etapy stanovlennya i problemy rozvytku: zbirnyk naukovykh prats* [Bulletin of the National University "Lviv Polytechnic". Series: Management and Entrepreneurship in Ukraine: Stages of Formation and Problems of Development: A Collection of Scientific Papers]. 2016, no. 851, pp. 164-167.
11. Bus. (2020). Wikipedia. Retrieved from <https://en.wikipedia.org/wiki/Bus>
12. Taxicab. (2020). Wikipedia. Retrieved from <https://en.wikipedia.org/wiki/Taxicab>
13. Tram. (2020). Wikipedia. Retrieved from <https://en.wikipedia.org/wiki/Tram>
14. Trolleybus. (2020). Wikipedia. Retrieved from <https://en.wikipedia.org/wiki/Trolleybus>
15. Rapid transit. (2020). Wikipedia. Retrieved from https://en.wikipedia.org/wiki/Rapid_transit
16. Monorail. (2020). Wikipedia. Retrieved from <https://en.wikipedia.org/wiki/Monorail>
17. Elevated railway. (2020). Wikipedia. Retrieved from https://en.wikipedia.org/wiki/Elevated_railway
18. S-train. (2020). Wikipedia. Retrieved from <https://en.wikipedia.org/wiki/S-train>
19. Réseau Express Régional. (2020). Wikipedia. Retrieved from https://en.wikipedia.org/wiki/Réseau_Express_Régional
20. Funicular. (2020). Wikipedia. Retrieved from <https://en.wikipedia.org/wiki/Funicular>
21. Cable car. (2020). Wikipedia. Retrieved from [https://en.wikipedia.org/wiki/Cable_car_\(railway\)](https://en.wikipedia.org/wiki/Cable_car_(railway))
22. Santa Justa Lift. (2020). Wikipedia. Retrieved from https://en.wikipedia.org/wiki/Santa_Justa_Lift
23. Inclined elevator. (2020). Wikipedia. Retrieved from https://en.wikipedia.org/wiki/Inclined_elevator
24. Aerial lift. (2020). Wikipedia. Retrieved from https://en.wikipedia.org/wiki/Aerial_lift
25. Water taxi. (2020). Wikipedia. Retrieved from https://en.wikipedia.org/wiki/Water_taxi
26. Electric bus. (2020). Wikipedia. Retrieved from https://en.wikipedia.org/wiki/Electric_bus
27. Hyperloop. (2020). Wikipedia. Retrieved from <https://en.wikipedia.org/wiki/Hyperloop>

Надійшла (received) 29.08.2020

Відомості про авторів / Сведения об авторах / About the Authors

Чжан Мін (Чжан Минь, Zhang Min) – аспірант, Національний технічний університет «Харківський політехнічний інститут»; викладач, Звичайний університет Нейцзян, Коледж комп'ютерних наук та штучного інтелекту, м. Нейцзян, Китайська Народна Республіка; WeChat ID: min859389

Горовий Дмитро Анатолійович (Горовой Дмитрий Анатольевич, Gorovyi Dmytro Anatoliiovych) – доктор економічних наук, професор, професор кафедри економіки і маркетингу, Національний технічний університет «Харківський політехнічний інститут»; м. Харків, Україна; ORCID: <https://orcid.org/0000-0002-0416-3857>; e-mail: Dmytro.Gorovyi@kpi.edu.ua