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Research of urban passenger transport in countries with a high Human Development Index

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Abstract: The aim of this research is to investigate urban passenger transport in countries with a high human development index and establish a logical relationship between this index and the features of urban transport in developed countries worldwide. The study's methodology is based on economic and statistical approaches to the economy's main indicators. Mathematical modelling is used to obtain results on the influence of passenger traffic indicators on GDP. The study also assesses the role of regulators in this process. The study's results are interpreted based on the experience of the largest countries with the highest degree of interaction between these indicators. Conclusions are drawn regarding the need to develop preventive measures, taking into account the best international practices. The results and conclusions of this research are significant for public transport workers. They provide a practical opportunity to improve various aspects of their activities and the quality of service in the field of public urban transport.

1 Introduction

It is difficult to overestimate the importance of the transportation system for the economy of any state. In conditions of economic instability caused by internal economic and political contradictions, as well as from the standpoint of the impact of the global financial crisis, the public transport sector remains one of the most stable sectors of the economy, ensuring the stability of the functioning of the economy of any state [1]. Therewith, the potential of the transport industry is so high that there are a great number of opportunities for its development. The current global fleet of registered automobile rolling stock is about 600 million units, including 86% of passenger cars, 13% of trucks, and only 1% of buses. The largest number of rolling stocks is concentrated in Europe (40%), America (32%), and Asia (21%). In general, the short-term prospects for the development of road transport in the world are fully correlated with long-term forecasts, which practically guarantee a fairly moderate growth rate of the fleet and road network for the period up to 2030 [2]. The progress in the development of road transport in modern countries with a high Human Development Index (HDI) will be expressed in the qualitative improvement of vehicles and the development, improvement, and implementation of highly efficient technological processes that contribute to reducing the burden on the environment.

It should be considered that the gradual introduction of environmentally friendly fuels into the practice of modern urban transport is quite realistic. The improvement of surface types of roads will continue quite quickly, increasing their capacity while increasing road safety. As for the distribution of vehicles worldwide, it is expected that the relative share of large countries will decrease due to the faster growth in the number of vehicles in developing countries, primarily in China [3]. In the future, it is expected to increase the fleet of trucks, especially in Europe, by about 1.5-3% annually until 2030. Nearly the same amount is projected to increase the total length of highways in the developed countries of the world. Industrialised countries will continue to dominate in terms of the quality of vehicles and roads until 2030. In other countries, the rapid increase in the number of vehicles and the length of roads will be characterised by qualitative indicators. It is difficult to overestimate the importance of passenger transport for the economic development of the country; this is the reason for the relevance of the subject

of this research. Nowadays, the transport system is the "circulatory" system of the economy. The development of transport is an indispensable condition for the functioning of the economy and ensuring a high quality of life for the population [4]. The specific features of transport as an economic industry are that it does not manufacture products itself but only takes part in their creation. Transport provides production with raw materials and equipment and delivers finished products to the consumer. The gross domestic product (GDP), which is the main indicator of the country, depends on the development of transport.

The problems of the development of the transport system of any state become problems of its economic development and prevent the creation of full-fledged living conditions in society since the quality of transport system functioning is directly related to the standard of living of any society. The development of transport is directly related to the human development index since the problems of transport network development cause a decrease in the overall standard of living in the country, which, in turn, negatively affects the quality of life of individual citizens [5]. Thus, the existence of a clear relationship between the level of transport system development in the state and the standard of living in the country and in society in general largely determines the prospects for the development of both the state itself and its transport system, since the relationship between these two components determines the prospects for improving the standard of living in society and the opportunities for increasing the HDI in a particular state in general.

2 Materials and methods

The methodology of this study is based on economic and statistical approaches to the interaction of the main indicators of the economy, based on which the results of mathematical modelling of the influence of the interaction of passenger traffic indicators on GDP are obtained and an assessment of the role of regulators in the process under study is formed. The methods of modern computational mathematics in combination with the mathematical support of computers include many applications software packages that allow solving various linear systems that arise in practice. The use of the MatLab package, which is a modern software tool for matrix calculations, ensures high accuracy of the results of calculations that were performed within the framework of this research. The theoretical basis of this research is the studies of scientists from all over the world who were engaged in the practical development of issues of improving the quality of public transport in countries with a high standard of living and human development. To improve the perception of the information provided and to obtain the most objective picture of the research, all the achievements of Russian authors taken in the order of citation and used as materials in this paper have been translated into English. Based on the collected theoretical data, a mathematical calculation of indicators that are of fundamental importance for obtaining qualitative results of this research was performed.

The whole complex of research works that form the basis of this study is divided into three main stages. At the first stage of this research, a theoretical analysis of studies in the field of prospects for the development of urban public transport was carried out in countries with a high level of social development and the human development index. The obtained theoretical material serves as a qualitative basis for subsequent practical research within the framework of the stated topic. At the second stage of research, a computer study of the main indicators of the economy was performed, based on which the results of mathematical modelling of the influence of the interaction of passenger traffic indicators on GDP were obtained and an assessment of the role of regulators in the process under study was formed. These indicators are of fundamental importance from the standpoint of obtaining high-quality results from research and forming final conclusions based on them, which reflect the entire complex of research works. In addition, at this stage of the research, an analytical comparison of the results obtained in the course of it with the results of other researchers on the issues put into the subject of this study was carried out to form the most balanced and objective results. At the final stage of the research, based on the results obtained, the final conclusions were formulated, which are a logical reflection of the study of passenger urban transport in countries with a high human development index. In general, the results of this research obtained using modern computer modelling methods, as well as the conclusions formulated on their basis, can serve as a qualitative scientific foundation for subsequent research aimed at studying a wide range of issues related to various aspects of the development of public transport in countries with a high human development index.

3 Results

The statistical reports obtained allowed obtaining the necessary statistical data on urban transport traffic (UTT), the dynamics of gross domestic product (GDP), and the mid-year population (MYP) from 2003 to 2018, distributed across nine countries in Europe, Asia, and America. Tables 1 and 2 were compiled based on these data, where Table 1 shows the ratio of UTT to MYP growth and Table 2 shows the ratio of GDP growth in the corresponding country. Table 1 shows the ratio of UTT to MYP growth, split by nine countries. The table shows that the ratio of urban transport passenger traffic to the mid-year population in eight countries, besides Japan, has increased over the past 16 years.

Table 1 The ratio of UTT growth to MYP, splitted by nine countries

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Russia	-0.01	-0.07	0.00	0.08	0.05	0.04	-0.02	0.01	-0.14	-0.08	0.01	0.03	-0.04	-0.08	-0.07	0.03
Belarus	-0.02	-0.14	0.20	-0.18	-0.25	-0.03	-0.05	-0.12	-0.10	0.03	0.04	0.14	0.00	-0.13	-0.09	-0.10
Hungary	0.01	0.05	-0.07	0.08	-0.06	-0.02	-0.09	-0.05	-0.02	-0.05	0.01	0.01	0.00	-0.01	0.00	0.01
Germany	-0.02	-0.06	0.07	-0.02	0.06	0.03	0.00	0.04	0.00	0.03	0.01	0.04	0.03	-0.01	0.02	0.04
Italy	-0.02	-0.02	0.00	-0.04	0.00	0.00	0.06	-0.01	-0.03	-0.02	-0.01	-0.05	0.10	0.02	0.04	0.00
Great Britain	0.00	0.02	-0.04	0.13	0.01	0.05	0.06	0.05	-0.01	0.04	0.04	0.03	0.01	0.04	0.02	0.02
Kazakhstan	0.29	-0.21	0.03	0.10	0.02	0.12	0.05	-0.01	-0.02	0.08	0.01	0.15	0.05	-0.09	-0.12	0.04
Japan	0.02	0.00	-0.01	-0.02	0.01	0.01	0.02	-0.01	-0.02	0.00	0.01	0.02	0.03	0.00	0.03	0.01
USA	-0.31	-0.03	0.04	-0.05	0.04	0.01	0.00	0.35	0.12	0.00	-0.01	0.01	0.06	0.00	-0.01	0.00

In Japan, in 2015 and 2017, there was an increase in the coefficient by 0.01. UTT in Japan increased by 12.5%, and MYP tended to increase between 2003 and 2010, with a downward trend between 2011 and 2018. In Kazakhstan, the coefficient under consideration was 0.29 in 2003 and 0.04 in 2018 [6]. In Russia, the coefficient increased due to a sharp increase in passenger traffic on urban transport by 75.5%, while the average population increased by only 20.81%.

Table 2 The GDP growth rate in the nine countries under consideration

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Russia	-0.05	0.00	0.02	0.00	-0.01	0.01	0.01	-0.03	-0.14	0.12	0.00	-0.01	-0.02	-0.01	-0.03	0.02
Belarus	-0.01	0.00	0.02	0.04	-0.02	0.01	-0.01	0.01	-0.10	0.07	-0.02	-0.04	-0.01	0.01	-0.06	0.01
Hungary	-0.04	0.01	0.00	0.02	-0.01	0.00	-0.04	0.01	-0.08	0.07	0.01	-0.03	0.04	0.02	-0.01	-0.01
Germany	0.01	-0.04	0.00	0.01	0.00	0.02	0.01	-0.03	-0.06	0.09	0.00	-0.03	0.00	0.01	0.00	0.00
Italy	0.00	-0.03	0.00	0.01	-0.01	0.01	0.00	-0.03	-0.05	0.07	-0.01	-0.03	0.01	0.02	0.01	0.00
Great Britain	-0.01	-0.01	0.01	0.01	-0.01	0.01	0.01	-0.05	-0.03	0.06	0.00	0.00	0.01	0.01	-0.01	0.00
Kazakhstan	0.00	-0.05	0.07	0.00	-0.07	0.03	0.05	0.00	-0.05	-0.03	0.06	-0.06	0.10	-0.07	0.00	0.01
Japan	-0.02	0.00	0.01	0.01	-0.01	0.00	0.00	-0.03	-0.05	0.10	-0.05	0.02	0.00	-0.01	0.00	0.00
USA	-0.03	0.01	0.01	0.01	-0.01	0.00	-0.01	-0.02	-0.03	0.05	-0.01	0.01	-0.01	0.01	0.00	-0.01

Table 2 shows the ratio of UTT to MYP growth, split by nine countries. In all the countries under consideration, there is no stability in the relationship between average GDP growth and average population growth. For example, in Kazakhstan, the ratio of GDP growth to MPG was 0.00 in 2003 and 0.01 in 2018, which indicates an increase in the value of GDP. In eight countries, the peak or highest coefficient (except Kazakhstan) occurred in 2012, which is explained by stable GDP growth. The value xn (n = 1,..., 16) entered in Table 1 determines the ratio of UTT to MYP in the 9 countries taken for the study, based on which Table 3 follows, representing the values of xn in ascending order, considering the minimum values and increments of units, splitted by 9 countries.

Table 3 A series for the variable x as a statistical series in non-decreasing order

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}	x_{16}
Europe																
Russia	1.00	1.03	1.06	1.14	1.15	1.15	1.19	1.23	1.23	1.23	1.30	1.31	1.31	1.38	1.39	1.41
Belarus	1.00	1.07	1.11	1.13	1.15	1.16	1.19	1.27	1.27	1.31	1.36	1.39	1.74	1.77	2.00	2.04
Hungary	1.00	1.01	1.01	1.01	1.02	1.02	1.02	1.04	1.06	1.10	1.19	1.19	1.20	1.21	1.21	1.26
Germany	1.00	1.04	1.06	1.06	1.08	1.09	1.12	1.12	1.15	1.16	1.19	1.20	1.24	1.26	1.27	1.28
Italy	1.00	1.04	1.05	1.05	1.05	1.06	1.07	1.08	1.09	1.09	1.09	1.10	1.11	1.11	1.13	1.13
Great Britain	1.00	1.01	1.01	1.03	1.09	1.10	1.13	1.18	1.21	1.22	1.25	1.28	1.32	1.33	1.36	1.38
Asia																
Kazakhstan	1.00	1.01	1.03	1.10	1.12	1.20	1.21	1.23	1.25	1.26	1.29	1.30	1.32	1.32	1.41	1.46
Japan	1.00	1.01	1.04	1.05	1.05	1.06	1.07	1.08	1.08	1.09	1.13	1.15	1.16	1.23	1.24	1.34
America																
USA	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.03	1.04	1.04	1.04	1.04	1.04	1.05	1.05	1.05

It can be seen here that Belarus has the highest coefficient due to population growth, while the United States has the lowest. Let us assume that there is a one-to-one correspondence between the values of xn and yn, i.e., each value of the independent variable x corresponds to a given degree of accuracy to one value of the dependent variable y. In this case, the task arises to identify the form of the connection and determine the functional dependence that defines y as a function of f (x). Let f (x, a, b) be a function of one variable x with two parameters a and b, which approximates the dependence of the value of y on x. To determine the type of the function f (x, a, b), the results of arithmetic means are used in equation (1):

$$M_x(1) = \frac{1}{16}\sum_{i=1}^{16} x_i,\ M_y(1) = \frac{1}{16}\sum_{i=1}^{16} y_i, \quad (1)$$

geometric mean (equation (2)):

$$M_x(0) = \frac{1}{16}\sqrt[16]{\prod_{i=1}^{16} x_i},\ M_y(0) = \frac{1}{16}\sqrt[16]{\prod_{i=1}^{16} y_i}, \quad (2)$$

harmonic mean (equation (3)):

$$M_x(-1) = \frac{16}{\sum_{i=1}^{16}\frac{1}{x_i}},\ M_y(-1) = \frac{16}{\sum_{i=1}^{16}\frac{1}{y_i}}, \quad (3)$$

the quadratic mean (equation (4)):

$$M_x(2) = \sqrt{\frac{\sum_{i=1}^{16} x_i^2}{16}},\ M_y(2) = \sqrt{\frac{\sum_{i=1}^{16} y_i^2}{16}}, \quad (4)$$

cubic mean (equation (5)):

$$M_x(3) = \sqrt[3]{\frac{\sum_{i=1}^{16} x_i^3}{16}},\ M_y(3) = \sqrt[3]{\frac{\sum_{i=1}^{16} y_i^3}{16}}, \quad (5)$$

harmonic and quadratic mean (equation (6)):

$$M_x(-2) = \sqrt{\frac{16}{\sum_{i=1}^{16}\frac{1}{x_i^2}}},\ M_y(-2) = \sqrt{\frac{16}{\sum_{i=1}^{16}\frac{1}{y_i^2}}}. \quad (6)$$

The results of the mathematical calculations are presented in Tables 4 and Table 5.

Table 4 Mean values x_n

Country	$M_x(1)$	$M_x(0)$	$M_x(-1)$	$M_x(2)$	$M_x(3)$	$M_x(-2)$
Russia	13.64	11.50	7.29	14.83	15.67	3.79
Belarus	21.15	16.89	8.83	23.88	26.18	3.90
Hungary	9.06	7.66	5.53	10.04	10.82	3.52
Germany	9.03	8.00	5.92	9.59	9.99	3.63
Italy	6.10	4.94	3.82	7.26	8.35	2.9
Great Britain	8.29	7.26	5.51	9.06	9.82	3.56
Kazakhstan	25.26	20.56	9.73	27.61	29.49	3.94
Japan	3.90	3.50	3.02	4.21	4.46	2.54
USA	33.05	27.50	11.07	35.24	27.17	3.97

Table 5 Mean values y_n

Country	$M_y(1)$	$M_y(0)$	$M_y(-1)$	$M_y(2)$	$M_y(3)$	$M_y(-2)$
Russia	12.87	11.25	7.39	13.77	14.61	3.82
Belarus	9.63	8.47	6.12	10.30	10.82	3.66
Hungary	8.46	7.44	5.60	9.13	9.69	3.57
Germany	6.82	5.98	4.73	7.52	8.25	3.34
Italy	5.22	4.49	3.65	5.87	6.51	2.86
Great Britain	5.35	4.83	4.06	5.75	6.14	3.12
Kazakhstan	5.66	4.99	4.11	6.23	6.75	3.13
Japan	5.91	4.94	3.82	6.83	7.83	2.83
USA	3.68	3.23	2.77	4.12	4.59	2.34

Based on the calculated values of the independent variable x from the statistical data in Tables 4 and 5, find the corresponding values are found (equations (7), (8)):

$$M_x(1) \to y_1^*,\ M_x(0) \to y_0^*,\ M_x(-1) \to y_{-1}^*, \quad (7)$$

$$M_x(2) \to y_2^*,\ M_x(3) \to y_3^*,\ M_x(-2) \to y_{-2}^*, \quad (8)$$

As the research shows, passenger traffic strongly depends on the country's economy [7]. This can be seen from the graphical analysis as well as from the values of the correlation coefficients for certain time periods and the comparison of the two values: GDP and passenger traffic. Moreover, it is the country's economy (and its main indicator of GDP) that is the main factor affecting the total passenger traffic on transport. The extremely small value

of the correlation coefficient for the entire period under consideration is insignificant in this case.

4 Discussion

In the current economic situation around the world, the impact of public transport on the development of the economy is difficult to overestimate. The outstanding role played by transport in the issues of ordering and transforming the surrounding space to meet the needs of the population, as well as contributing to the transformation of the person into an individual on a planetary scale, allows defining public transport as an important component of social development, the qualitative and systematic functioning of which is a necessary condition for the development of society in general [8]. The evolution of the transport system of a single state in modern economic realities is determined by cyclical, avalanche-like, sharp changes in the parameters of the speed and scale of operations performed, which inevitably affect the systemic change in human views and ideas about the real possibilities of the existing transport system. It is necessary to consider the fact that a sufficient number of transport innovations have appeared in recent years, the existence of which confirms the development of prerequisites for revolutionary changes in the transport industry. The consistent transformation of the state's transport industry contributes to the creation of high-quality conditions for the implementation of large-scale economic changes that can improve the operation of the state's transport system as well as change the conditions of cargo and passenger transportation for the better [9].

In recent years, a considerable number of prerequisites have been created for improving the functioning of transport in many countries, and this trend is characteristic not only for states with a high human development index but also for developing countries. In assessing the real prospects for the development of the transport industry in general, it is necessary to consider the existing economic trends and problems of the development of the transport industry that need to be solved [10]. Timely solutions to urgent problems and tasks in the transport industry contribute to its full-fledged development, which has a positive impact on the economic development of a particular state in general. For the sustainable development of the transport system of any state, it is necessary to carefully identify the main innovative solutions that are important in the context of prospects for improving the efficiency of using conventional technical means designed to optimise the operation of the transport system [11]. Effective innovations intended for practical use in the development of transport systems in modern states can qualitatively change the economic situation in states for the better since they carry the prospects of improving the functioning of entire industries and individual systems [12]. Therewith, an important aspect is the ease of practical use of these innovative technological solutions and their availability for a wide range of users.

Nowadays, urban railway transport is in urgent need of increasing competitiveness compared to automobile transport, and the forecast of transport development prospects indicates the possibility of the appearance of vacuum transport systems and technological solutions based on the principles of magnetic levitation in cities in the future. Thus, these principles are the foundation for the functioning of the MagLev (Magnetic Levitation) magnetic suspension bearing system, which allows modern urban transport to move at higher speeds while maintaining proper safety standards, and the movement at the same time occurs at higher levels of transport highways above ground [13]. This considerably reduces travel time by eliminating the need for such vehicles to stay in traffic jams as well as by avoiding emergency collisions. When using transport of this kind, friction is practically reduced to a minimum value, which allows significantly increasing the speed of movement and reducing the likelihood of accidents, as well as energy costs for transportation. In addition, the use of such technology is completely harmless from an environmental standpoint. In addition to all the above, this technology allows for minimising air resistance so that the speed of vehicles operating through the use of these technologically innovative solutions can reach 3000 km/h [14].

In recent decades, projects of vehicles designed for use in the conditions of a modern city and combining the characteristics of an aeroplane and a car have been widely developed. Such transport innovations include the projects Terrafugia Transition (a flying car with folding wings), AeroMobil, Carplane, etc. The practical use of such technological solutions allows for qualitatively solving several important problems at once, such as eliminating traffic jams on highways, as well as considerably saving time for moving passengers and cargo. In general, the introduction of this innovation can bring the modern automotive industry to a qualitatively new level [15]. Modern creators of vehicles used in urban conditions in the field of public transport consider the needs of urban residents and the needs of people of various ages and belonging to various social groups. The purposeful implementation of the described trend implies the development of transport sociology as an independent discipline that describes the processes occurring in the public urban transport system from the standpoint of the norms and laws of modern science [16]. Therewith, it should be considered that improving environmental safety in combination with minimising energy costs during transportation using public transport are priority areas for the development of the modern transport industry in medium and large cities. To date, work has been completed in the United States to create a modern tractor powered by lithium-ion batteries and designed for the transportation of heavy loads. The maximum range for using such a vehicle without additional charging is 2000 km [17]. The use of a detailed device allows considerably expanding the possibilities of practical use of environmentally friendly

vehicles, provided that the energy necessary for the successful implementation of all current transport tasks is saved.

Public road transport has an extensive infrastructure and, in recent years, has often been put at the service of the ecological paradigm. For example, in France, a few years ago, as an experiment, traffic was opened along a kilometre-long stretch of road, on which solar cell parts were used as road surface elements. The mean value of the electric energy generated for this section of the road, according to approximate calculations, was 775 kWh per day. Therewith, the final peak output was at the level of 1500 kWh per day, which means almost doubled value. The generated electricity was used to meet the needs of a small village located in the vicinity of this road [18]. The problem of cargo transportation due to the use of technological resources in public transport is largely explained by the variety of environmental requirements that are currently imposed on transported goods, as well as the physical characteristics that are required to be maintained by vehicles intended for transportation of this kind. The heaviest and largest loads can be transported in batches of various volumes; urgent delivery of goods by public transport can be carried out by using small-sized vehicles. In any case, the challenges it faces and the opportunities for the development of public urban transport in each city and state determine the prospects for the development of modern public transport [19].

The prospects for the development of urban public transport are largely determined by modern socio-economic trends as well as technological innovations put forward. Considering the realities of the current economic situation in society, it is important not only to understand the trends of a macroeconomic and macrosocial nature but also to consider the individual requests of private entities and organisations for the functioning of modern transport systems. The urbanisation of modern society is the most important factor determining the requirements for the quality of public transport and the efficiency of its functioning. Economically developed states with a high standard of living and a high human development index have been concentrated around megacities for several decades now, which are also developing intensively in countries with a lower level of economic development [20]. The quality of public transport functioning in these and other states is determined by the requirements put forward by urban residents and individual organisations for the level of satisfaction of their needs with this transport. Modern public transport used in an urbanised society must meet the requirements of speed and reliability of transportation, be environmentally friendly and comfortable, and also produce as little noise as possible. Modern designers of vehicles intended for use in urban environments face a difficult task since it is not easy to create a device that can combine all of the above characteristics. The problems of urban transport require the development of comprehensive solutions that can meet the needs of a wide range of subjects and organisations, while preferences should be based on the specific features of the individual choice of public transport users [21].

Notably, there have been cases of companies offering such solutions, ranging from general concepts of public transport to specific samples of equipment intended for use in a modern city. Electric-powered vehicles that can compete with existing automobiles and rail-related vehicles have a special place among them. Electric vehicles are widely used in many countries for the transportation of passengers and cargo and have gained considerable popularity due to their quietness and environmental friendliness of use [22]. In addition, in a number of countries with a high human development index, unmanned electric-powered taxis and vehicles created using various innovative technologies have been successfully used for a long time. At the same time, public transport of the conventional type remains relevant and in demand since buses, trams, and trolleybuses are still widely popular among urban residents of different countries. Therewith, in a number of states and cities, conventional rail transport has already undergone considerable external transformations due to the introduction of innovative solutions that have largely changed both its appearance and the content of practical activities [23]. Modern urban rail transport still takes on large volumes of passenger and cargo transportation, while it is predicted that the trend towards a steady advance in the volume of rail transport compared to road transport will continue.

Since the population of countries with a high level of the human development index has a steady tendency to concentrate in and around large cities, in these states there is an increasing trend towards mobility of an unprecedented kind – both intercity, interstate, and intercontinental. The intensive pace of modern life in a large city, combined with the high value of the time of its residents, does not contribute to the development of trends for making long trips over long distances [24]. Citizens of modern cities tend to overcome any distance in small periods of time, so the consistent transition from long trips to short-distance travel is one of the main features of changes in the mobility of residents of modern cities, which has become possible with the development of the transport system over the past few centuries [25]. This is the reason for the focus of modern researchers' attention exclusively on certain types of transport, which implies the possibility of their consistent improvement. The quality of transportation plays a crucial role in this context; therefore, maintaining appropriate standards for the quality of public transport is currently the main task of the functioning of the entire public transport system in cities and countries with a high human development index.

5 Conclusions

The study of urban passenger transport features in countries with a high human development index led to the following conclusions: Passenger traffic is significantly

dependent on the state's economic development, as measured by GDP and the correlation coefficient within a specific time period. During the analysis of public transport development in relation to the economy of a particular state, it is important to compare the level of passenger traffic with the GDP indicator within a specific time period. It is worth noting that passenger transportation has some inertia. A sharp decline in GDP may result in a sudden drop in passenger traffic at a slower pace, while an increase in GDP may lead to a slower growth of passenger traffic. In other words, there may be a time delay between economic changes and changes in passenger traffic resulting from these changes. The correlation between passenger traffic and GDP has become particularly evident during certain 16-year periods. When communicating over longer time intervals, quantitative indicators lose their significance. Political and structural changes in society have a significant impact on the ratio of GDP and passenger traffic indicators. While the share of transport costs in GDP and household income may change, the strong dependence remains unchanged.

Passenger traffic depends on various political and economic factors, some of which cannot be quantified. In 2005, there was a significant drop in passenger traffic of 7.1%, despite a 6.4% growth in GDP. It is possible that the introduction of the law on monetization of benefits granted to the population played a role. It is worth noting that the most significant decrease in passenger traffic occurred on types of public transport such as buses, trolleybuses, trams, and metros. Additionally, it is important to note that the state continues to subsidize the majority of passenger transportation, including suburban transportation. Thus, this study can provide a qualitative basis for recommendations on prioritising the development of UTT based on the regression models obtained. This highlights the importance of the results for future research.

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