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Roundabout Way Towards High Mobility. Dialectics of Mobility in the History of Mankind

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ABSTRACT

The objective of the study described in the article is a long-term analysis of the quantitative and qualitative parameters of spatial mobility of the population and forecasting its future prospects based on the use of the dialectical method, methods of historical and statistical analysis, which is necessary to understand the required directions and rates of development of transport systems appealed to provide opportunities to meet the needs in spatial movements in the present and creating conditions for increased mobility in the future.

Based on statistical data, the study underlines the already high but still tending to grow level of spatial mobility of the population in modern society. It is concluded that mobility has turned to be an urgent need in modern society, and the need to move has become one of the most important human needs. The revealed changes in spatial mobility in the historical retrospective highlights the non-linear nature of mobility, which can be considered within the framework of the dialectical triad «thesis – antithesis – synthesis».

The paper identifies the prospects for the growth of spatial mobility of the population in the context of digitalisation. Also, a new concept is introduced that of «spatial-digital mobility», defining must-to-have characteristics of transport systems to provide for the required level of spatial-digital mobility. In addition, the study argues for the significant role of construction of high-speed surface infrastructure for implementation of the growing potential of spatial mobility of the population and analyses the relevant parameters of the Transport Strategy of the Russian Federation until 2030 with a forecast for the period up to 2035. It is concluded that the deepening of socio-economic modernisation will be accompanied by a further increase in spatial mobility of the population, which requires the accelerated development of innovative transport.

Keywords: spatial mobility of the population, socio-economic development, transport, passenger turnover, modernisation, urbanisation, travel distance.

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INTRODUCTION

In modern conditions, spatial mobility of the population has reached a very high level both in the world and in our country and continues to increase, being both an important factor in socio-economic development, and a serious challenge for transport systems.

Transport developments should, on the one hand, satisfy the high demand for travelling, both quantitatively and qualitatively, and, on the other hand, stimulate the growth of spatial mobility. Hence, relevance of a long-term analysis of changes in the level and nature of spatial mobility of the population in the context of socio-economic development and revealing of its further prospects. Carrying out such an analysis is the *objective* of this article. The study engaged the dialectical method, methods of historical and statistical analysis.

RESULTS

High and Increasing Mobility is an Integral Feature of Modern Society

Modern society is a society of high spatial mobility. An increasing number of people are moving more frequently, over longer distances and at higher speeds.

The Table 1 shows the representative data on the growth of mobility of the population of the Russian Federation since the beginning of this century. Passenger turnover of public transport and the corresponding indicator of population mobility [1, p. 226] before the start of the coronavirus pandemic increased by more than 30 % (the impact of the pandemic on passenger traffic will be discussed below)[1, 2].

In 2019, each inhabitant of the country, on average, travelled more than 4300 kilometres with public transport alone, excluding personal cars (the number of which amounted to 46,3 million units[2]; an increase of almost by 2,5 times compared to 2000), trips by taxi, the number of which grew at a faster pace [2, p. 44], carsharing cars and various micromobility devices that are gaining popularity.

As evidenced by a number of studies [3–5], ultra-long-term comparisons covering secular periods are most indicative in the analysis of transport activity. Comparison of the level of spatial mobility achieved at the beginning of 21st century with the level that existed at the beginning of 20th century, in the pre-war year 1913 (about 200 passenger•km/person per year), shows a more than twenty-fold increase over this period. This is a very impressive increase in mobility, which ensured its entry to a qualitatively new level.

As stated above, mobility should be assessed not only by intensity of movements, but also by their speed and range.

The increase in speed is fixed for specific modes of transport. For example, the speed of passenger trains over the period under review increased by 13,1 % in long-distance traffic and by 14,4 % in suburban traffic. In road transport, the desire to increase speed is manifested in improvement of the speed characteristics of cars, but their implementation is hindered, especially in megacities and agglomerations, due to infrastructural constraints [6]. In general, incomplete use of speed capabilities of vehicles, i.e., low speed efficiency [7] is a systemic problem of transport.

The growth in the speed of travelling is most clearly reflected in the change in the structure of passenger turnover by modes of transport (Table 2). If on the eve of 20th century, the fastest transport, which is air transportation, provided only 11 % of passenger turnover, three times less than each of the then leaders (railway and road), then in 2019 it performed significantly better in terms of passenger turnover than railways and road transport together. This cardinal structural shift is a very clear characteristic of the desire of a modern man to accelerate movement. It is no coincidence that the use of high-speed and traffic-free air transport is considered as one of possible solutions to the problem of accelerating travel in megacities [8].

With an increase in speed of movement, accessibility of more distant territories during the trip increases proportionally (as studies by G. A. Golts [9, pp. 82–121; 10, pp. 263–296] showed), temporal availability of territories plays a key role for the territorial distribution of the population and its communication capabilities, and therefore should be considered in development of transport systems. The criterion of temporal availability was used in development of a promising topology of a high-speed ground innovative transport network in [11] and in

[1] Transport in Russia: Stat. collection. Moscow, Goskomstat Rossii publ., 2003, 182 p. [Electronic resource]: https://rosstat.gov.ru/storage/mediabank/TRANSP.ZIP. Last accessed 03.03.2022.

[2] Transport in Russia. 2020: Stat. collection. Moscow, Rosstat publ., 2020, 108 p. [Electronic resource]: https://rosstat.gov.ru/storage/mediabank/UbzIvBZj/Transport_2020.pdf. Last accessed 03.03.2022.

Table 1

Growth of mobility of the population of the Russian Federation in 2000-2019 using public transport [1, 2]

No.	Indicators	2000	2019	Growth rate, %
Passenger turnover of public transport, bln passenger•km, including:		485,9	635,2	130,7
1.	Railway	167,1	133,6	80,0
2.	Bus	164,4	122,5	74,5
3.	Tram	25,1	3,8	15,1
4.	Trolleybus	28,1	4,2	14,9
5.	Metro	46,9	47,4	101,1
6.	Sea	0,04	0,05	125,0
7.	Inland water	0,9	0,6	66,7
8.	Air	53,4	323,0	604,9
Mobility of population, passenger•km/person, including by modes of transport:		3314,5	4328,2	130,6
1.	Railway	1139,8	910,3	79,9
2.	Bus	1121,4	834,7	74,4
3.	Tram	171,2	25,9	15,1
4.	Trolleybus	191,7	28,6	14,9
5.	Metro	319,9	323,0	101,0
6.	Sea	0,28	0,35	125,0
7.	Inland water	6,1	4,1	67,0
8.	Air	364,3	2200,9	604,1

determining the long-term tasks for development of a Single backbone transport network in accordance with the new Transport strategy of the Russian Federation[3].

Accordingly, an increase in transportation speeds contributes to the growth of another important indicator of spatial mobility which is travel distance.

The average travel distance during the period under review has increased for most modes of transport, and most significantly for buses and inland water transport (Table 3). But the overall increase in average travel distance is much higher than for any mode of transport. This phenomenon, which can be attributed to the category of statistical paradoxes, is associated with the above-mentioned structural shift: an increase in the share of trips made using air transport, which, while providing the highest speed, allows to cover the longest travel distance.

Thus, in the long-term period preceding the pandemic, key indicators that can be used to characterise spatial mobility increased significantly in the country.

From this point of view, Russia was in line with global trends towards the growth of mobility. Data for a group of 15 foreign countries, shown by Rosstat [Federal Statistic Service] in the context of the main modes of passenger transport (excluding water transport and urban electric transport), indicate a dynamic growth in passenger turnover in the pre-pandemic period (Table 4). The important difference of those indicators for selected countries from Russian indicators is the high dynamics of passenger turnover in railway transport, which significantly exceeds the growth in passenger turnover on air lines. This is primarily due to the more than 2,3 times increase in passenger turnover on the railways of China, which is the world leader both in the total volume of passenger railway traffic and in the scale of development of high-speed railway lines. In other words, the dynamics of railway passenger turnover is significantly accelerating due to development of high-speed railroads, which allows them to successfully compete with aviation in providing acceptable travel time over long distances [12, pp. 52–53]. This indicates the importance of building high-speed railway lines (HSR) in Russia to ensure additional growth in mobility of the country's inhabitants. The socio-economic efficiency of high-speed rail construction has been substantiated by Russian scientists for many years [13; 14], and it is important that development

[3] Transport strategy of the Russian Federation until 2030 with the forecast for the period until 2035 // Appr. by the order of the Government of the Russian Federation dated November 27, 2021 № 3363-r, 285 p., pp. 88–89. [Electronic resource]: https://docs.cntd.ru/document/727294161?marker=65C0IR. Last accessed 03.03.2022.

Table 2

Changes in the structure of passenger turnover by modes of public transport in the Russian Federation

No.	Transport modes	Share in passenger turnover, %		Change, percentage points
		2000	2019	
1.	Railway	34,4	21,0	-13,4
2.	Bus	33,8	19,3	-14,5
3.	Tram	5,2	0,6	-4,6
4.	Trolleybus	5,8	0,7	-5,1
5.	Metro	9,7	7,5	-2,2
6.	Sea	0,0	0,0	0
7.	Inland water	0,2	0,1	-0,1
8.	Air	11,0	50,9	+39,9
Total		100,0	100,0	–

Source: [Author's calculations].

of high-speed rail communication is provided for in the Transport strategy of the Russian Federation[3].

An important indicator of the growth of global mobility in the modern era is the steadily high growth rate of world passenger turnover at the end of 20th–beginning of 21th century. During the period 1996–2015, their growth amounted to over 4 % on average per year [15, p. 160], while the world population increased by about 1 % on average per year [16, p. 300]. That is, the average annual increase in transport mobility was about 3 %.

Sustainability of the Need to Move

The coronavirus pandemic has had an extremely negative impact on spatial mobility around the world. In our country, in the second quarter of 2020, which witnessed the peak of anti-epidemic mobility restrictions, the passenger turnover of the transport system as a whole decreased by almost five times compared to the corresponding period of the previous year, and by the previous quarter, instead of an ordinary seasonal increase [17, p. 6] there was a more than threefold decline (Table 5).

During this period, it was believed that the decline in mobility that occurred will be long-term, as people, due to fear of becoming infected, even after restrictions are cancelled, will prefer to refuse long-distance travel, and many short-range trips, including those related to work, will be replaced by digital communications. However, this position did not have time to take root in scientific discourse, since it was refuted by life. In the third quarter of 2020, when mobility restrictions were significantly eased, passenger turnover more than tripled compared to the second quarter, instead of the usual seasonal growth by only about 25 %. Apparently, the main reason that mobility remained significantly below the pre-pandemic level was the persistence of a significant part of the restrictions, primarily on cross-border movements. There is every reason to expect (and this is recorded in the Transport strategy[3]) that after the final cancellation of

Table 3

Change in the average travel distance of passengers using public transport in the Russian Federation

No.	Modes of transport	Average travel distance, km		Growth rate, %
		2000	2019	
1.	Railway	117,8	111,2	94,4
2.	Bus	7,5	11,5	153,3
3.	Tram	3,4	3,1	91,2
4.	Trolleybus	3,2	3,7	115,6
5.	Metro	11,2	13,7	122,3
6.	Sea	40,0	8,3	20,8
7.	Inland water	34,6	54,5	157,5
8.	Air	2321,7	2465,6	106,2
Total		11,1	35,6	320,7

Source: [Author's calculations].

Table 4

Long-term growth in passenger turnover in a group of foreign countries*

No.	Modes of transport	Passenger turnover, bln passenger•km		Growth rate, %
		2005	2018	
1.	Railway	938, 7	1796, 9	191, 4
2.	Road	11140, 3	12573, 1	112, 9
3.	Air	1922, 9	3352, 2[1]	174, 3
Total		14001, 9	17722, 2	126, 6

* Indicators of the following countries were compared: Azerbaijan, Armenia, Belarus, Great Britain, Germany, Kazakhstan, Kyrgyzstan, China, Poland, Moldova, USA, Tajikistan, Uzbekistan, Ukraine, France.

restrictions, there will be a rapid recovery of passenger turnover to the level preceding the pandemic, and then their growth will continue[3].

The rapid recovery of passenger traffic wherever restrictions have been cancelled indicates that mobility has become an urgent need in modern society, and the need to move has become one of the most important human needs. And this is no coincidence. Spatial mobility is an integral element of modernisation of any society and is closely related to social mobility [16, pp. 243–244]. It significantly affects the spread of innovations and economic growth, increasing the value of human capital and the welfare of society [18]. That is why freedom of movement, which is a necessary condition for high and geographically differentiated spatial mobility [2, pp. 45–46] is so important for people.

Spatial mobility has played an important role in formation and development of human society [19, pp. 41–44] and economics [18]. However, its growth was by no means linear. It seems necessary to focus attention on the non-linear nature of the change in mobility in the history of mankind for a deeper understanding of its its relationship with socio-economic development.

Mobility during the Early Stages of Social Development

The period of formation of human society was a period of almost continuous movement of small groups of gatherers and hunters [16, p. 39]. But the speed of their movement was low – up to 25–30 km per day [20, p. 27], and the trips were mainly carried out cyclically over a certain territory. And very slowly, as a rule, under the influence of external factors, there was a migration to other territories, which can be called «diffusion». Its average speed, depending on the historical period and direction of movement, was estimated from 300–400 meters to two kilometres per year [21, p. 356; 26].

The subsequent transition to the settled lifestyle and then to a productive economy, apparently, was associated with development by mankind of all territories available for life [18, p. 54] and was a mechanism for adaptation to climate change under specific natural conditions [23; 24].

Table 5

Dynamics of passenger turnover of public transport* in the Russian Federation in the pre-pandemic period and after the start of the pandemic (2019–2020)

Year	Period	Passenger turnover, bln passenger•km	in % to	
			the corresponding period of the last year	the previous period
2019	I quarter	116, 7	107, 8	93, 6
1.	II quarter	143, 0	108, 4	122, 5
2.	III quarter	178, 2	106, 7	124, 7
3.	IV quarter	132, 6	106, 4	74, 4
4.	Year as a whole	570, 5	107, 3	–
2020	I quarter	111, 2	95, 3	83, 9
5.	II quarter	30, 3	21, 2	27, 3
6.	III quarter	99, 1	55, 6	327, 1
7.	IV quarter	71, 8	54, 2	72, 5
8.	Year as a whole	312, 5	54, 8	–

Source: Socio-economic situation in Russia in January-December 2020.Moscow, Rosstat publ., 2020, 376 p. [Electronic resource]: https://nangs.org/analytics/download/6536_eebada54288ef7abbe5d55eafa67d0f7. Last accessed 03.03.2022.
* Without taking into account urban transport.

Grain specialisation and narrowing of resources among settled farmers required an expansion of exchange to obtain other resources from other, often remote, regions [24; 25, pp. 231–232] (in modern conditions, delivery of goods has also become an alternative to personal trips for them, which was especially evident when mobility was limited during the pandemic).

Long-distance transportation of material goods along water and caravan routes turned into a specialised activity. People engaged in this activity moved many hundreds of kilometres [25, pp. 232–233]. Thus, with a general decrease in daily mass mobility of people as a result of the transition to settled life and then to a productive economy, mobility of material goods and those who were engaged in their movement increased, which is an example of the dialectic of mobility. Moreover, as the economy developed, both the volume of material goods moved and the range of their movement increased.

In essence, the transition to settled life did not mean a renounce to mobility, nor a decrease in mobility, but a change in its nature: a transition from mass mobility to specialised mobility, accompanied by an increase in the range of travelling. This is an important conclusion, indicating that already in antiquity, development required a *qualitative* increase in mobility.

Spatially highly mobile societies of pastoral nomads became a «pair» of settled agricultural societies. A symbiosis arose between settled and nomadic societies, based on the complementarity of those types of economic activity in which these societies specialised, and the development of exchange between them [24; 25].

After the transition «from an appropriating to a producing economy», the «role and scale of migration» increased sharply [16, p. 227], the nature of which has changed qualitatively compared to the primitive period. It was no longer a slow diffusion of small groups of people; «whole peoples representing a socially and culturally integrated whole» migrated [16, p. 228], which led to significant demographic, socio-economic and cultural changes.

Thus, at the earliest stages of the history of human society, spatial mobility played a key role as an integral element of economic activity and the very existence of human societies. Then, as the economy and society changed qualitatively, the nature of mobility also changed qualitatively (moreover, the mobility of material goods played an increasingly important role [18]), while mobility continued to play a key role in socioeconomic development.

Increased Mobility and Socio-Economic Modernisation

The great geographical discoveries of 15th–17th centuries gave a powerful impetus to the growth of spatial mobility and became an important factor in formation of the prerequisites for the industrial revolution and modernisation of the economy and society [27; 28, pp. 166–168]. The key element of this modernisation was the creation of innovative, mechanical, transport, driven not by the muscular strength of animals or people, but by the power of steam, and then by internal combustion engines and electricity [29].

Already steam transport created the conditions for the growth of spatial mobility, facilitating, accelerating, and reducing the cost of movement of people and goods over long distances [29; 30; 31, pp. 49–88]. Thus, the growth in passenger turnover of railways and the corresponding indicator of population mobility in the Russian Empire during the period of «modernisation of Witte–Stolypin» [32] before the First World War (Table 6) is more than indicative. In 13 years, passenger turnover had increased by 2,3 times, i.e., the average annual growth rate had attained 6,6 %. The dynamics of passenger turnover significantly outstripped the increase in the population, and the mobility of the population when travelling by rail increased almost by 1,8 times, and its average annual growth rate attained 4,6 %. It is noteworthy that a serious decline in the mobility of the population, which occurred in 1905 under war conditions and during socio-political upheavals, was fully «recouped» the very next year, after which the dynamic population growth continued. The study [18] revealed a significant positive impact of the growth of railway mobility of the population on macroeconomic indicators in the period under review. The correlation coefficient between the net national product and the level of population mobility was 0,896.

Greater spatial mobility provided by development of the railway network and the increased availability of rail travelling, including for people of low income, expanded the possibilities of individual choice, the search for better living conditions, including in other promising regions. Only «in the period from 1906 to 1914, the population of the eastern half of the

empire grew due to migration by about 2 million people (about 220 000 people annually)» [33, p. 331], most of whom obtained the opportunity for a more prosperous life than in their native places. And this was the result of the synergy of infrastructure development, construction of the Trans-Siberian Railway, and institutional changes in the course of ongoing modernisation reforms [32; 34].

It is important to note that the powerful migration flow that rushed to the Trans-Ural lands, in contrast to the collective migrations of antiquity, was a totality of individual families and individuals who made the decision to move based on personal aspirations and assessments. Thus, a global trend was revealed in the country, which was the «migration transition», which consisted in formation of a new, individual, model of migration [16, pp. 243–246]. The growth of spatial mobility in the context of institutional transformations contributed to the change in the people themselves, the growth of the predominant personality reasons, the implementation of a more active life position.

Railway mobility contributed not only to development of the eastern regions, but also to urbanisation, which increased sharply after a significant increase in the length of Russian railway network (by more than 12 thousand km), while the connectivity of the territories of the European part of the country was achieved in the 1870s, so, the level infrastructure provision of the population exceeded the critical milestone of 2 km/10 thousand people [34, p. 162]. If in 1869 the urban population (with suburbs) in the European part of Russia (excluding Poland and Finland) was 6,2 million people, and its share was 9,5 %, then by 1914 this number had more than tripled, up to 19,5 million people, and amounted to 15,3 % of the total population [35, p. 839]. This was in line with global trends: in the whole world, the share of the urban population at the beginning of 20th century was about 15 %, while a century earlier it was only slightly more than 5 % [16; 29].

Urbanisation is a key element of modernisation of society, characteristic of its different stages [36, p. 4]. It is important not only for social progress, but also for economic growth: the share of the three hundred largest cities in the world in the world population is about 20 %, while their contribution to the world GDP is about 50 % [37], which is ensured due to agglomeration effects formed thanks particularly to the rational organisation of transport systems of megacities and urban agglomerations [38; 5, pp. 229–236].

It is the development of urban and suburban transport that ensures high spatial mobility of the population of megacities and agglomerations, which becomes an everyday character and is an important factor in obtaining a high return on human capital concentrated there, which is the «main element of the wealth of modern societies», exceeding GDP in developed countries by 10–11 times, and the value of physical capital by 3,6 to 7 times [39, p. 537].

Due to development of urban transport, its growing availability and a gradual increase in traffic speeds, the distance of daily trips in megacities and agglomerations increased within the time that individuals consider it possible to spend on such trips [9, pp. 125–129; 44].

Thus, in a modern urbanised society, there has been a return to everyday mass mobility (moreover, daily distances covered are on average comparable to those covered by primitive gatherers and hunters), but at a qualitatively new level provided by modern transport systems. This is a vivid example of the dialectic of spatial mobility. Everyday mass mobility is no longer an instrument of a weakly specialised appropriating economy, but an instrument of highly specialised and highly productive activity. Individuals in a modern urbanised society are moving not so much to where there are currently the most resources, but, first, to where their work skills and competencies are valued more, and thus there is an opportunity to increase the return on their human capital. And just as the growth in the value of transported goods is the basis for the formation of the value of the infrastructure and other means of transport used to move them [41, pp. 133–141; 42, pp. 74–75], the growth in the value of human capital, achieved through travel, determines the value of fixed assets of passenger transport.

Prospects for Spatial Mobility

The prospects for spatial mobility of the population should be considered in the context of accelerating digital transformation of society, the economy and transport [43; 44].

Although development of digital interaction opportunities creates an alternative to physical movement, the opinion of researchers indicating that digitalisation contributes to the growth of spatial mobility of the population, including through the emergence of new forms of mobility

Table 6

The growth of mobility of the population of the Russian Empire with the account of railway transportation in the years of pre-war modernisation, 1900–1913

Indicators	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913
Passenger turnover of railways: bln passenger•km	9,7	10,2	10,7	11,5	11,3	10,3	11,7	13,9	14,6	15,6	17,2	18,5	20,1	22,3
% to the year 1900	100,0	105,2	110,3	118,6	116,5	106,2	120,6	143,3	150,5	160,8	177,3	190,7	207,2	229,9
Mobility of the population when traveling by rail: passenger•km/ person	72,9	75,6	78,1	82,7	80,1	71,5	80,1	93,3	95,4	99,4	106,8	112,8	119,6	130,4
% to the year 1900	100,0	103,7	107,1	113,4	109,9	98,1	109,9	128,0	130,9	136,4	146,5	154,7	164,1	178,9

Source: [18].

based on the relationship of spatial movements and digital interactions, seems reasonable [45; 46].

Firstly, digital communications make it possible to keep in touch with relatives and friends during spatial movements, removing thus one of the significant barriers to such movements.

Secondly, digitalisation increases the amount of information about the possibilities of increasing the efficiency of using the human capital of an individual, adding its value through spatial movements, which can stimulate geographic mobility.

Thirdly, due to digitalisation, «while traveling by public transport, a person can make purchases in an online store or solve work tasks» [46, p. 260], which makes it more acceptable for him to increase frequency, duration (and hence the distance) of trips, that is, it stimulates spatial mobility.

Digitalisation does not replace spatial mobility, but offers it new goals and routes, fills it with new content. *Spatial-digital mobility* is being formed, which can be interpreted as the ability to quickly move (including multimodally) from any point in space to any other point and, at the same time, implement global digital communications both at the end points of the route and throughout its entire length. Provided that such mobility is ensured, the implementation of J. Attali's forecast about an increase in the time spent on travelling and its saturation with a variety of types of labour and leisure activities is quite possible [47]. In practice, this is already happening.

It should be noted that the opportunity, thanks to digital technologies, to spend time in transport usefully does not reduce people's desire to speed up travel. This is evidenced by the above statistics and introspective understanding. In the context of digitalisation, people are ready to travel more often and further (if it brings them adequate benefits), but for each specific trip they prefer a faster option (of course, taking into account cost and comfort).

Based on the foregoing, to ensure spatial and digital mobility of the population, transport systems should:

• Allow high speed travel.

• Be flexible and multimodal, allowing comfortable, fast, and reliable movement «from door to door».

• Be fully integrated with digital systems so that a person does not «fall out» of the digital space during the trip.

From the point of view of the latter criterion, high-speed land transport has significant advantages over aviation.

It should be noted that among the goals of development of the transport system of our country until 2030 and for the forecast period until 2035, both the increase in the mobility of the population and the digital transformation of the industry are provided[3] [14, p. 80]. At the same time, even according to the conservative scenario, a high dynamic of the transport mobility of the population is predicted (Table 7), and according to a more ambitious scenario, which is considered as a baseline, the conservative level

Table 7

Target indicators for increasing the transport mobility of the population (including trips by private car) to the level of the base year, 2019 (%)[3]

	2030	2035
Conservative scenario	153,5	165,1
Base scenario	165,1	181,4

instead of 2035 should be reached as early as in 2030, after which the mobility will continue to grow quite dynamically.

According to the conservative scenario, the average annual growth in the transport mobility of the population is to be 3,2 %, and according to the baseline – 3,8 %, which is comparable to the dynamics of railway mobility at the beginning of the last century. This indicates that the level of spatial mobility of the population achieved in the course of a long-term modernisation of society, of the economy and of transport is by no means the limit, and its dynamic increase will continue.

Thus, the growth of spatial mobility of the population is of a long-term nature, which is a serious challenge for transport, the answer to which should be based on innovative solutions and the creation of a wide range of alternative options to meet the demand for travel, which have high socio-economic prospects [48; 49].

CONCLUSION

The rise and development of human society is inextricably linked with spatial mobility and its growth. At the same time, the growth of mobility has not been a linear process. Rather, it can be interpreted within the framework of the well-known dialectical triad: «thesis – antithesis – synthesis».

The early stages of social development, under the conditions of an appropriating pre-agrarian economy, were characterised by mass everyday mobility at low speeds and short travel distances.

The formation of a productive economy was preceded by a transition to settled life, but implementation of productive economy required a partial replacement of the spatial mobility of people by spatial mobility of material goods with a simultaneous increase in the range of movements and their transformation into a specialised activity.

And, finally, the modern modernised and urbanised society, which is the result of many thousands of years of development of the productive economy and transport, which allowed humanity to enter the era of modern economic growth [18; 28], based on a qualitatively new level of both technical, technological and socio-economic developments, has achieved a synthesis of everyday mass mobility over relatively short distances with long-distance movements of both people and material goods, and the intensity, range and speed of the mobility has reached historically unprecedented levels.

Thus, humanity moved non-linearly towards modern high spatial mobility. It was a roundabout way or a detour, at different stages of which mobility changed not only quantitatively, but also qualitatively, but its role for economic activity and social life has always been high. At the same time, the achieved level of spatial mobility is by no means the limit. Deepening the modernisation of the society requires further growth in mobility, which, in turn, needs to accelerate the innovative development of transport.

REFERENCES

1. Macheret, D. A., Kudryavtseva, A. V., Ledney, A. Yu., Chernigina, I. A. General technical and economic course of railways [*Obschiy tekhniko-ekonomicheskiy kurs zheleznykh dorog*]. Moscow, MIIT publ., 2017, 364 p. [Electronic resource]: https://www.elibrary.ru/item.asp?id=32652216. Last accessed 03.03.2022.

2. Macheret, D. A. Freedom of Movement and Features of Transport Systems. *World of Transport and Transportation*,

2019, Vol. 17, Iss. 3, pp. 40–54. [Electronic resource]: https://mirtr.elpub.ru/jour/article/view/1665. Last accessed 03.03.2022.

3. Macheret, D. A. What is evidenced by the centenary dynamics of the indicators of the largest railway systems [*O chem svidetelstvuet stoletnyaya dinamika pokazatelei krupneishikh zheleznodorozhnykh sistem*]. *Ekonomicheskaya Politika*, 2016, Vol. 11, Iss. 6, pp. 138–169. [Electronic resource]: https://www.elibrary.ru/item.asp?id=27810881. Last accessed 03.03.2022.

4. Izmaikova, A. V. Waves of Railway Innovative Development. *World of Transport and Transportation*, 2015, Vol. 13, Iss. 5, pp. 26–38. [Electronic resource]: https://mirtr.elpub.ru/jour/article/download/512/801. Last accessed 03.03.2022.

5. Razuvaev, A. D. Economic assessment of creation, evolution and strategic development of transport infrastructure (on the example of railway transport): Monograph [*Ekonomicheskaya otsenka sozdaniya, evolyutsii i strategicheskogo razvitiya transportnoi infrastruktury (na primere zheleznodorozhnogo transporta): Monografiya*]. Moscow, Prometei publ., 2021, 286 p. ISBN 978-5-00172-251-9.

6. Macheret, D. A. Economy of Bottle Necks. *World of Transport and Transportation*, 2014, Vol. 12, Iss. 3, pp. 64–75. [Electronic resource]: https://mirtr.elpub.ru/jour/article/view/86. Last accessed 03.03.2022.

7. Lapidus, B. M., Macheret, D. A. Improving the speed efficiency of transport communication based on continuous movement of goods and passengers [*Povyshenie skorostnoieffektivnosti transportnogo soobshcheniya na osnove nepreryvnogo peremeshcheniya tovarov i passazhirov*]. Fundamental research for long-term development of railway transport. Moscow, Intekst publ., 2013, pp. 85–94. [Electronic resource]: https://www.elibrary.ru/item.asp?id=20401876. Last accessed 03.03.2022.

8. Tsypin, P. E., Razuvaev, A. D., Ledney, A. Yu. Air transportation in a metropolis as a factor in development of its transport infrastructure [*Vozdushnie perevozki v megapolise kak factor razvitiya ego transportnoi infrastruktury*]. *Science and education: the future and goals of sustainable development. Proceedings of 16th International Scientific Conference*. Moscow, 2020, pp. 622–629. [Electronic resource]: https://www.elibrary.ru/item.asp?id=44538517. Last accessed 03.03.2022.

9. Golts, G. A. Transport and resettlement [*Transport i rasselenie*]. Moscow, Nauka publ., 1981, 248 p. [Electronic resource]: https://www.elibrary.ru/item.asp?id=28132974. Last accessed 03.03.2022.

10. Golts, G. A. Culture and economy of Russia for three centuries, 18th–20th centuries. Vol. 1. Mentality, transport, information (past, present, future) [*Kultura i ekonoimka Rossii za tri veka, XVIII–XX vv. T. 1. Mentalitet, transport, informatsiya (proshloe, nastoyashchee, budushchee)*]. Novosibirsk, Siberian Chronograph publ., 2002, 536 p. [Electronic resource]: https://www.elibrary.ru/item.asp?id=28134510. Last accessed 03.03.2022.

11. Lapidus, B. M., Macheret, D. A. A projected topology of a high-speed transport system deploying vacuum levitation systems. *Transport Rossiiskoi Federatsii*, 2018, Iss. 1, pp. 15–21. [Electronic resource]: https://www.elibrary.ru/item.asp?id=32637976. Last accessed 03.03.2022.

12. Lapidus, B. M. The future of transport. World Trends with a Projection on Russia: Monograph [*Budushchee transporta. Mirovie trendy s proektsiei na Rossiyu:Monografiya*]. Moscow, Prometei publ., 2020, 226 p. ISBN 978-5-907224-52-8.

13. Miroshnichenko, O. F. Methodological support of calculations of the economic efficiency of construction of high-speed lines [*Metodicheskoe obespechenie raschetov ekonomicheskoi effektivnosti sooruzheniya vysokoskorostnykh linii*]. *Vestnik VNIIZhT*, 1993, Iss. 2, pp. 31–35. [Electronic resource]: https://www.elibrary.ru/contents.asp?id=33846613. Last accessed 03.03.2022.

14. Lapidus, B. M. Social and economic preconditions of developing high-speed railway traffic in Russia. *Bulletin of the Joint Scientific Council of JSC RZD*, 2013, Iss. 2, pp. 9–12. [Electronic resource]: https://www.elibrary.ru/item.asp?id=19068940. Last accessed 03.03.2022.

15. Varnavsky, V. G. Global transport and logistics infrastructure [*Globalnaya transportno-logisticheskaya infrastruktura*]. *Bulletin of the Russian Academy of Sciences*, 2021, Vol. 91, Iss. 2, pp. 157–166. DOI: 10.31857/S0869587321020110.

16. Vishnevsky, A. G. Demographic history and demographic theory [*Demograficheskaya istoriya i demograficheskaya teoriya*]. Moscow, Publishing House of the Higher School of Economics, 2019, 368 p. ISBN 978-5-7598-1706-2 (print); ISBN 978-5-7598-1836-6 (e-book).

17. Macheret, D. A., Lednei, A. Iu. Impact of seasonal irregularity of transportation on efficiency of transport infrastructure. *Transport Rossiiskoi Federatsii*, 2019, Iss. 6, pp. 4–9. [Electronic resource]: https://www.elibrary.ru/item.asp?id=42194730. Last accessed 03.03.2022.

18. Macheret, D. A. The role of density, population mobility and movement of material goods in different concepts of economic growth [*Rol plotnsti, mobilnosti naseleniya i peremeshcheniya materialnykh blag v raznykh kontseptsiyakh ekonomicheskogo rosta*]. *Voprosy teoreticheskoi ekonomiki*, 2021, Iss. 4, pp. 50–78. [Electronic resource]: https://cyberleninka.ru/article/n/rol-plotnosti-mobilnosti-naseleniya-i-peremescheniya-materialnyh-blag-v-raznyh-kontseptsiyah-ekonomicheskogo-rosta. Last accessed 03.03.2022.

19. Macheret, D. A. Social Significance of Transportation Speed. *World of Transport and Transportation*, 2017, Vol. 15, Iss. 3, pp. 40–52. [Electronic resource]: https://mirtr.elpub.ru/jour/article/view/1209. Last accessed 03.03.2022.

20. Maksakovskiy, V. P. Historical geography of the world [*Istoricheskaya geografiya mira*]. Moscow, Lenand publ., 2016, 624 p. ISBN 978-5-9710-1597-0.

21. Markov, A. V. Human evolution. In 2 books. Book 1: Monkeys, bones and genes [*Evolyutsiya cheloveka. V 2 kn. Kn. 1: Obezyany, kosti i geny*]. Moscow, Astrel: CORPUS publ., 2012, 464 p. [Electronic resource]: https://batrachos.com/sites/default/files/pictures/Books/Markov_2011_E%60volyutsiya%20cheloveka_1_Obez'yany%60,kosti%20i%20geny%60.pdf. Last accessed 03.03.2022.

22. Morris, I. Why the West Rules – for Now. The pattern of history and what the reveal about future. New York: Farrar, Straus and Giroux, 2010, 944 p. ISBN 9780374290023.

23. Kaube, J. Die Anfänge von allem. Berlin, Rowohlt, 2017, 400 p. ISBN-10 9783871348006; ISBN-13 978-3871348006.

24. Scott, J. C. Against the Grain. A Deep History of the Earliest States. New Haven and London: Yale University Press, 2017, 312 p. DOI: 10.1111/padr.12152.

25. Ponting, C. World History. A New Perspective. London: Chatto & Windus, 2000, 944 p. ISBN-13 9780701168346.

26. Macheret, D. A. Transport Factor in the Era of Ancient Civilizations. *World of Transport and Transportation*, 2014, Vol. 12, Iss. 2, pp. 230–239. [Electronic resource]: https://mirtr.elpub.ru/jour/article/view/72. Last accessed 03.03.2022.

27. McNeil, W. H. The Rise of the West: A History of the Human Community. Chicago: The University of Chicago Press, 1992, 860 p. ISBN-13 978-0226561417.

28. Macheret, D. A. The transport factor of formation of the era of modern economic growth [*Transportniy factor*

formirovaniya epokhi sovremennogo ekonomicheskogo rosta]. *Ekonomicheskaya Politika*, 2019, Vol. 14, Iss. 1, pp. 154–179. [Electronic resource]: https://cyberleninka.ru/article/n/transportnyy-faktor-formirovaniya-epohi-sovremennogo-ekonomicheskogo-rosta. Last accessed 03.03.2022.

29. Smil, V. Energy and Civilization: A History. Cambridge, MA: The MIT Press, 2017, 564 p. DOI: 10.7551/mitpress/10752.001.0001.

30. Mortimer, I. Centuries of Change: Which Century Saw the Most Change? London: Bodley Head, 2014, 416 p. ISBN-13 9781847923035.

31. Zagorsky, K. Ya. Economics of transport [*Ekonomika transporta*]. Moscow-Leningrad, Gosizdat publ., 1930, 268 p. [Electronic resource]: https://www.studmed.ru/zagorskiy-k-ya-ekonomika-transporta_77670b556c4.html. Last accessed 03.03.2022.

32. Davydov, M. A. Modernization of Witte–Stolypin and its specifics [*Modernizatsiya Vitte–Stolypina i ee spetsifika*]. *Voprosy teoreticheskoi ekonomiki*, 2017, Iss. 1, pp. 109–131. [Electronic resource]: https://www.elibrary.ru/item.asp?id=32817318. Last accessed 03.03.2022.

33. Schenk, F. B. Russlands Fahrt in die Moderne. Mobilitat and sozialer Raum im Eisenbahnzeitalter [*Poezd v sovremennost. Mobilnost i sotsialnoe prostranstvo Rossii v vek zheleznykh dorog: Transl. from German*]. Moscow, Novoe literaturnoe obozrenie publ., 2016, 584 p. [Electronic resource]: https://na5ballov.pro/lib/novaya/8683-shenk-fb-poezd-v-sovremennost-mobilnost-i-socialnoe-prostranstvo-rossii-v-vek-zheleznyh-dorog.html. Last accessed 03.03.2022.

34. Macheret, D. A. Economic notes on the Russian railroads. *Otechestvennie zapiski*, 2013, Iss. 3 (54), pp. 162–176. [Electronic resource]: https://www.elibrary.ru/item.asp?id=21218771. Last accessed 03.03.2022.

35. Mironov, B. N. Russian Empire: from tradition to modernity: In 3 vol. Vol. 1. [*Rossiiskaya imperiya: ot traditsii k modernu: v 3 t. T:1*]. St. Petersburg, Dmitry Bulavin publ., 2018, 896 p. [Electronic resource]: http://www.bmironov.spb.ru/wp-content/uploads/2019/10/Mironov_Ros_imp_2_e_izd_t_1.pdf. Last accessed 03.03.2022.

36. Macheret, D. A. Transport and modernization: theoretical aspects of mutual influence. *Transport Rossiiskoi Federatsii*, 2021, Iss. 3 (94), pp. 3–8. [Electronic resource]: https://www.elibrary.ru/item.asp?id=46683400. Last accessed 03.03.2022.

37. Martianov, V. S. The cities and states: in search of a new strategy of interaction. *Obshchestvennie nauki i sovremennost*, 2019, Iss. 3, pp. 170–184. [Electronic resource]: https://www.elibrary.ru/item.asp?id=37711160. Last accessed 03.03.2022.

38. Razuvaev, A. D. A methodology for economic evaluation of erecting transport infrastructure in megapolises. *Transport Rossiiskoi Federatsii*, 2019, Iss. 4 (83), pp. 18–21. [Electronic resource]: https://www.elibrary.ru/item.asp?id=39543740. Last accessed 03.03.2022.

39. Kapelyushnikov, R. I. Economic essays: Methodology, institutions, human capital [*Ekonomicheskie ocherki: Metodologiya, instituty, chelovecheskiy capital*]. Moscow, Publishing House of the Higher School of Economics, 2016, 574 p. [Electronic resource]: https://institutiones.com/download/books/3972-ekonomicheskie-ocherki-kapelyushnikov.html. Last accessed 03.03.2022.

40. Marchetti, C. Anthropological Invariants in Travel Behavior. Technological Forecasting and Social Change, 1994, Vol. 47, No. 1, p. 75–88. DOI: 10.1016/0040-1625(94)90041-8.

41. Ledney, A. Yu. Development of methodological approaches to assessing the economic efficiency of development of transport infrastructure, taking into account the volume and unevenness of transportation. Ph.D. (Economics) thesis [*Razrabotka metodicheskikh podkhodov k otsenke ekonomicheskoieffektivnosti razvitiya transportnoi infrastruktury s uchetom obemov i neravnomernosti perevozok. Dis… kand. ekon. nauk*]. Moscow, RUT (MIIT) publ., 2020, 176 p. [Electronic resource]: https://rut-miit.ru/content/%D0%94%D0%B8%D1%81%D1%81%D0%B5%D1%80%D1%82%D0%B0%D1%86%D0%B8%D1%8F_%D0%9B%D0%B5%D0%B4%D0%BD%D0%B5%D0%B9_%D0%90%D0%AE.pdf?id_wm=864660. Last accessed 03.03.2022.

42. Razuvaev, A. D., Ledney, A. Yu. The economic significance of transport speeds for the value of transport infrastructure. *Finansovie aspekty strukturnykh preobrazovanii ekonomiki*, 2021, Iss. 7, pp. 73–83. [Electronic resource]: https://www.elibrary.ru/item.asp?id=47178604. Last accessed 03.03.2022.

43. Schwab, K. The Fourth Industrial Revolution. Geneva: World Economic Forum, 2016, 172 p. [Electronic resource]: https://law.unimelb.edu.au/__data/assets/pdf_file/0005/3385454/Schwab-The_Fourth_Industrial_Revolution_Klaus_S.pdf. Last accessed 03.03.2022.

44. Lapidus, B. M. The impact of digitalization and Industry 4.0 on development of the railway transport ecosystem [*Vliyanie tsifrovizatsii i Industrii 4.0 na razvitie ekosistemy zheleznodorozhnogo transporta*]. *Zheleznodorozhniy transport*, 2018, Iss. 3, pp. 28–33. [Electronic resource]: https://www.elibrary.ru/item.asp?id=32678032. Last accessed 03.03.2022.

45. Sharko, E. R. Distant work: a new challenge of population mobility (experience of megacities and small cities). *Vestnik Akademii*, 2021, Iss. 2, pp. 74–83. [Electronic resource]: https://www.elibrary.ru/item.asp?id=47265792. Last accessed 03.03.2022.

46. Starikova, A. V., Demidova, E. E. Spatial mobility and digitalization: the role of new values in public life and the impact on population migration [*Prostranstvennaya mobilnost i tsifrovizatsiya: rol novykh tsennostei v obshchestvennoi zhizni i vliyanie na migratsii naseleniya*]. *Annual Theological Conference of the Orthodox St. Tikhon Humanitarian University*, 2019, Iss. 29, pp. 259–262. [Electronic resource]: https://www.elibrary.ru/item.asp?id=41848748. Last accessed 03.03.2022.

47. Attali, J. Une brève histoire de l`avenir. Paris: Fayard, 2006, 427 p. ISBN-13 9782213631301.

48. Kudryavtseva, A. V. Social and economic perspectives for transport innovations. *Transport Rossiiskoi Federattsii*, 2017, Iss. 2 (69), pp. 34–39. [Electronic resource]: https://cyberleninka.ru/article/n/sotsialno-ekonomicheskie-perspektivy-transportnyh-innovatsiy. Last accessed 03.03.2022.

49. Kudryavtseva, A. V. Methodology for assessing the socio-economic prospects of transport innovations [*Metodologiya otsenki sotsiano-ekonomicheskoi perspektivnostitransportnykh innovatsii*]. *Ekonomika zheleznykh dorog*, 2017, Iss. 4, pp. 62–68. [Electronic resource]: https://www.elibrary.ru/item.asp?id=29217965. Last accessed 03.03.2022. ●

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