"ANGEL KANCHEV" UNIVERSITY OF RUSE
UNION OF SCIENTISTS - RUSE

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MAIN PROBLEMS AND PROSPECTS FOR DEVELOPMENT OF URBAN PASSENGER TRANSPORT IN BULGARIA [1]

Prof. Velizara Pencheva, PhD
Department of Transport,
"Angel Kanchev" Univesity of Ruse
Phone: 082-888 240
E-mail: vpencheva@uni-ruse.bg

Assoc. Prof. Asen Asenov, PhD
Department of Transport,
"Angel Kanchev" Univesity of Ruse
Phone: 082-888 605
E-mail: asasenov@uni-ruse.bg

Eng. Ivan Georgiev,
Department Applied Mathematics and Statistics,
"Angel Kanchev" Univesity of Ruse
Phone: 82 888 424
E-mail: irgeorgiev@uni-ruse.bg

Prof. Aleksander Sladkowski,
Department of Logistics and Transport Technologies,
Silesian University of Technology, Poland
Phone: +48 32 603 42 91
E-mail: aleksander.sladkowski@polsl.pl

Abstract: *Based on statistical analysis and existing transport practices, the dynamics of the development of urban transport in Bulgaria and some fundamental problems are presented. In accordance with the review of key strategic documents related to the European transport policy, innovation in technological, social and organizational environment, and best practices in the field of mobility, prospects for the development of public transpot are laid.*

Keywords: road transport, city transport scheme, urban transport, European practices

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INTRODUCTION

Before many cities in Europe stand the unsolved issues related to air pollution, climate change and congestion, noise pollution associated with the use of personal transport, lack of optimization and insufficient quality of public transport, sporadic implementation of measures to promote alternative movements and others. For the large cities in Bulgaria, solving them requires an integrated approach by offering public transport with high quality and clean vehicles, creating conditions for the use of different options for mobility considering its correlations and application of modern digitization.

Research in Bulgaria on the workload of public transport in cities and disclosure of the potential for its inclusion as an essential element in the supply chains, providing mobility of the population, and the application of new forms of mobility, promoting car-pooling is limited. It is

[1] The paper was presented at the plenary session on 26th October, 2018 with an original title in Bulgarian: ОСНОВНИ ПРОБЛЕМИ И ПЕРСПЕКТИВИ ЗА РАЗВИТИЕ НА ГРАДСКИЯ ПЪТНИЧЕСКИ ТРАНСПОРТ В СТРАНАТА

concentrated mainly on assessing the quality of the transport service of urban passenger transport, rather than on assessing the overall system mobility with its correlations.

The study reviews a statistical analysis of workload in urban passenger transport in Bulgaria on the basis of existing data for electric transport, an overview of the objectives for the cities defined in the White Paper "Roadmap to a Single European Transport Area - Towards a competitive and efficient transport system resource", published in 2011, and the three packages published by the Mobility European Commission, (European Union, 2011). Based on this review, best practices worldwide and analysis of modern technological development, the use of the concept Mobility-as-a-Service (MaaS), already known in international practice, is introduced. It implies a shift from the use of personal vehicles to integrated mobility services, (Goodall W., 2017).

1. Dynamics of the workload in urban passenger transport in Bulgaria.

Some information on the work done by the city electric transport in Bulgaria will be analysed here (Tabl. 1), (Kliucininkas L., 2009, Wołek M., 2013, Ministry of Transport, Information Technology and Communications, 2012, Trolley Project, 2013). The data for this include the number of transported passengers and trolley transport analysis in Bulgaria, tram and metro transport in the city. Sofia (NSI, 2017, Website of the Electrotransport Sofia, 2018).

Table. 1. Work carried out by electric transport in Bulgaria

Year	1989	2001	2002	2003	2004	2005
Electrical transport, Q, thousand passenger units	548 509	312 162	329 444	299 850	299 850	288 410
Electrical transport, P, mil. pkm	1 052	1 328	1 176	1 206	1 109	1 085
Average distance travelled l_{avp}, km	1.92	4.25	3.57	4.02	3.70	3.76
Year	2006	2007	2008	2009	2010	2011
Electrical transport, Q, thousand passenger units	286 339	293 794	299 100	286 252	291 167	280 181
Electrical transport, P, mil. pkm	1 055	1 075	1 076	1 173	1 355	1 276
Average distance travelled, l_{avp}, km	3.68	3.66	3.60	4.10	4.65	4.55
Year	2012	2013	2014	2015	2016	2017
Electrical transport, Q, thousand passenger units	285 859	269 448	254 589	248 081	244 902	279 654
Electrical transport, P, mil. pkm	1 430	1 375	1 065	1 058	1 121	1 412
Average distance travelled, l_{avp}, km	5.00	5.10	4.18	4.26	4.58	5.05

In Table 1 are specified the number of passengers Q and transport operation P (pkm) for a period of 17 years (2001-2017) and completed about 1989, when the country went from a centralized to a market economy. Estimated average distance travelled l_{avp}

$$l_{avp} = \frac{P}{Q} \text{ (km)} \quad (1)$$

In Table 2 are taken out basic numerical characteristics of the number of transported passengers, transport operation and the average distance traveled for the period 2001-2017: average value, median, mode, standard deviation, dispersion coefficient of skewness, kurtosis

coefficient, scope, minimum value, maximum value, percentiles. Excluded from the study in 1989, not typical for the period.

Table 2. Main statistical numerical characteristics of number of passengers, mileage and average distance travelled for the period 2001-2017.

Statistics

		Q, Number of passengers, thousand.	P, Transport work, mil. pkm	l_{avp}, Average distance, km
Valid (Valid) data for 17 years		17	17	17
Mean (Average)		285 240	1 200.12	4.23
Median (Median)		286 339	1 173.00	4.18
Mode (Mode)		299 850	1085.00	3.57
Std. Deviation (Standard deviation)		21 898.01	133.98	0.529
Variance (Disprersiya)		$4.795*10^8$	17 951.11	0.280
Skewness (coefficients. Asymmetry)		-0.232	0.575	0.350
Kurtosis (coefficient of kurtosis)		0.295	-1.300	-1.18
Range (Swap)		84 542	375.00	1.53
Minimum (minimum)		244 902	1 055.00	3.57
Maximum (max)		329 444	1 430.00	5.10
Percentiles (percentage)	25	274 551	1 080.50	3.69
	50	286 339	1 173.00	4.18
	75	299 475	1 341.50	4.61

Table 2 shows that over the period, the average number of passengers per year is 285 240. at a median of 286 339 and mode 299 850, with a coefficient of variation of 7.68%, indicating that the sample is highly homogeneous. The average cost of the transport operation is 1200.12 mil. pkm in 1 173 median mil. pkm, mode - 1 085 mil. pkm and coefficient of variation 11.16% a homogeneous sample. Average distance travelled over the period 4.2 km, median - 4.2, mode - 3.57, with a coefficient of variation 12.52% a homogeneous sample.

Considering the time nature of the data, the absolute growth, the growth rate (%) and the rate of increase (%) are calculated on the main basis of 2001 and a chain basis and the average annual growth rate and growth for the whole period 2001-2017. (Tables 3 and 4) the number of passengers and transport work in pkm.

Table 3. Absolute growth, growth rates, growth rates at constant number of passengers stranded and base-period 2001-2017.

Year	Absolute growth		Growth,%		Growth rates, %	
	Constant base 2001	Chain base	Constant base 2001 = 100%	Chain base	Constant base 2001 = 0%	Chain base
2001	-	-	100	-	0	-
2002	17 282	17 282	105.5	105.6	5.5	5.6
2003	-12 312	-29 594	96.1	91.0	-3.9	-9.0

2004	-12 312	0	96.1	100.0	-3.9	0
2005	-23 752	-11 440	92.4	96.2	-7.6	-3.8
2006	-25 823	-2 071	91.7	99.3	-8.3	-0.7
2007	-18 368	7 455	94.1	102.6	-5.9	2.6
2008	-13 062	5 306	95.8	101.8	-4.2	1.8
2009	-25 910	-12 848	91.7	95.7	-8.3	-4.3
2010	-20 995	4 915	93.3	101.7	-6.7	1.7
2011	-31 981	-10 986	89.8	96.2	-10.2	-3.8
2012	-26 303	5 678	91.6	102.0	-8.4	2.0
2013	-42 714	-16 411	86.3	94.3	-13.7	-5.7
2014	-57 573	-14 859	81.6	94.5	-18.4	-5.5
2015	-64 081	-6 508	79.5	97.4	-20.5	-2.6
2016	-67 260	-3 179	78.5	98.7	-21.5	-1.3
2017	-32 508	34 752	89.6	114.2	-10.4	14.2

From Table. 3 follows that in the research period from 2001 to 2017 the growth almost every year-on-year basis 2001 base permanently decrease. For the whole period in 2017 compared to base 2001the growth was 99.3%, while growth rate was negative -0.7%.

Table 4. Absolute growth, growth rates, growth rates of the transport work in pkm at constant chain and base-period 2001-2017.

year	Absolute growth		Growth%		Growth rates%	
	Constant base 2001	Chain base	Constant base 2001 = 100%	Chain base	Constant base 2001 = 0%	Chain base
2001	-	-	100	-	0	-
2002	-152	-152	88.6	88.6	-11.4	-11.4
2003	-122	30	90.8	102.6	-9.2	2.6
2004	-219	-97	83.5	92.0	-16.5	-8.0
2005	-243	-24	81.7	97.8	-18.3	-2.2
2006	-273	-30	79.4	97.2	-20.6	-2.8
2007	-253	20	81.0	101.9	-19.0	1.9
2008	-252	1	81.0	100.1	-19.0	0.1
2009	-155	97	88.3	109.0	-11.7	9.0
2010	27	182	102.0	115.5	2.0	15.5
2011	-52	-79	96.1	94.2	-3.9	-5.8
2012	102	154	107.7	112.1	7.7	12.1
2013	47	-55	103.5	96.2	3.5	-3.8
2014	-263	-310	80.2	77.5	-19.8	-22.5
2015	-243	20	81.7	101.9	-18.3	1.9
2016	-207	-3 179	84.4	98.7	-15.6	-1.3
2017	84	34 752	106.3	126.0	6.3	26.0

From Table 4 follows that in the research period the growth rate almost every next year, on 2001 basis, is decreasing. For the whole period in 2017 compared to base 2001 the growth was 100.38%, and the growth rate is growing 0.38%.

2. Review of strategic documents related to the European transport policy in modern cities

In March 2011 it was published in the White Paper "Roadmap to a Single European Transport Area - Towards a competitive and efficient transport system resource" which is a strategic document for the development of the European transport system by 2050, (European Union, 2011). This is a strategic document of EU transport. The White Paper sets out 10 objectives of achieving a competitive and efficient transport system as benchmarks for achieving the reduction of greenhouse gas emissions by 60%. The specific objectives of the cities are:

- achieving city logistics in major cities virtually free of carbon dioxide by 2030;

-reducing by half the vehicles using conventional fuels in urban transport by 2030; phasing them out in cities by 2050.

In 2009 the European Commission adopted an Action Plan on Urban Mobility, (Action Plan on Urban Mobility. 2009), proposing twenty measures to encourage and help local, regional and national authorities in achieving their goals for sustainable urban mobility. In the action plan, the Commission presented for the first time a comprehensive support package in the field of urban mobility. In subsequent years, three packages of mobility have been successively adopted.

In July 2016, the Commission adopted a strategy for mobility with low emissions, by listing various initiatives on mobility with low emissions.

3. Public Transport and mobility in modern cities

The main components of the transport system including urban transport systems are: transport infrastructure; vehicles; means of traffic management and communications.

The transport system for urban passenger transport is part of the transport system of cities. Its effectiveness for cities is undeniable and improves the quality of service, it is essential. Meanwhile the issues should be considered more complex by contacting the system of mobility and its correlations (Fig. 1). Integrated solutions that take full account of the entire transport system, energy, land use, socio-economic conditions and the environment are being developed.

Social, economic and technological changes are placing increasingly complex demands on the transport system. New technologies and innovations can help develop a sustainable mobility system and are important prerequisites for tackling major societal challenges, including climate change, resource scarcity and demographic change.

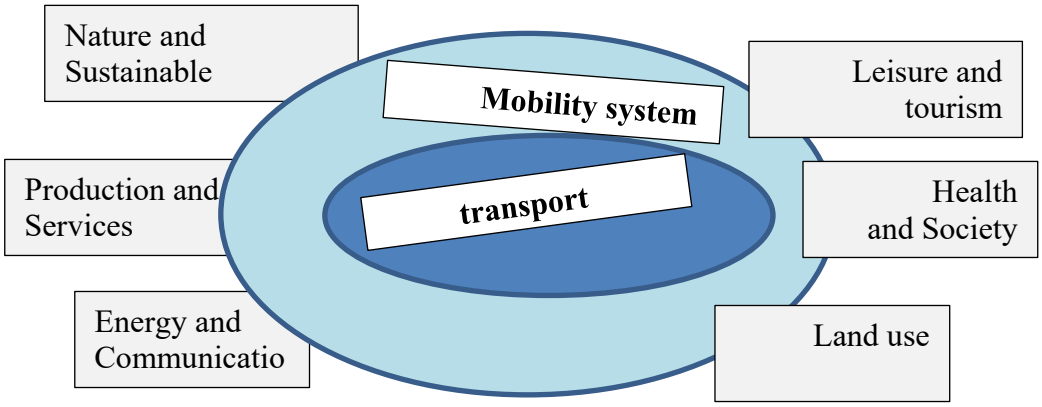

Fig. 1. The system of mobility and its correlations

It is necessary to seek effective solutions to today's challenges, on the one hand, to overcome high emissions of CO_2, air pollution, congestion and noise levels, while on the other, to create awareness that mobility is a key feature of modern society and human right for everyone.

We can define four main objectives in providing mobility:

-fairness - to ensure that everyone has access to jobs, markets and entertainment through quality transport regardless of economic or social status;

- efficacy - to ensure that people move from one place to another quickly and smoothly;
-safety - a vision of zero deaths in road accidents;
-ecology - to reduce the environmental footprint of the sector, to combat climate change and pollution.

The high complexity of mobility-related challenges is due to the complexity inherent in the system of transport itself (users, vehicles and infrastructure) and to the close interaction between transport systems and other systems (energy, society, spatial development, ecosystem and so on).

Along with the transport of goods, transport infrastructure, vehicles transport systems of modern cities need innovative potential in the field of personal mobility.

Modern technological development allows the development of a completely new mobility concept, namely Mobility-as-a-Service (MaaS), which implies a shift from the use of personal vehicles to mobile solutions, consumed as a service by creating combined and / or integrated mobility services. This is achieved by combining transport services by providers of public and private transport services and administration, which plans and manages journeys, so that users can pay a single account for each trip or monthly fee for a limited distance, (Goodall W., 2017).

The key concept of MaaS is to provide solutions for mobility of persons based on their travel needs.

A key component of each model MaaS is traveling without ticket. Using a smart card or smart phone, the user can enter and exit all transportation vehicles required for any given trip.

Creating an integrated system for mobility in cities throughout the country, which is more flexible than the existing transport network becomes possible when the service is in line with the actual demand. There are more choices for passengers to get from point A to point B in ways that are easier, faster, cheaper, cleaner and safer than those currently available. Looking further into the future, MaaS will likely include autonomous vehicles, although autonomous vehicle technologies are still in the pilot stage, because the technology is not yet ready for use on a mass scale. Besides, there are a number of complex issues that need to be resolved by regulations about safety, responsibility, use of data and privacy.

It is imperative that the priorities in the development of modern transport systems in cities should be linked to the creation of conditions for mobility by walking or bike, using public transport and, to a lesser extent, by car, using MaaS concept (Fig. 2).

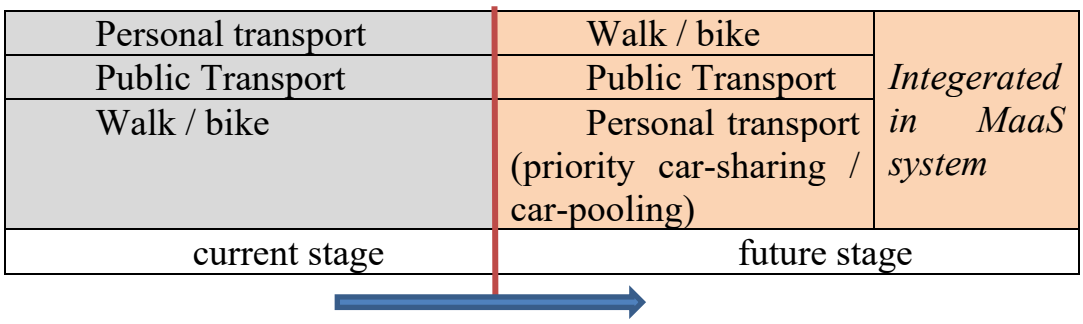

Fig. 2. Prioritization of mobility at the time and in the future

Walking and / or cycling stimulate the future, followed by the use of public transport. Private transport provides priority use of new forms of ownership and use of vehicles means, car-sharing and / or car-pooling included in the integrated MaaS system and gradual rejection of the use of private vehicles for urban travel.

Observations of the system for urban passenger transport in Bulgaria show capacity, improved efficiency and quality of transport services and abilities to adapt the transport system to transport use as a service on behalf of restricting the use of private cars, something that is reported (Website of the Ruse Municipality, 2018, Website of the Google maps, 2018, Website of Ruse public transport, 2017).

CONCLUSION

In data processing, the average annual passenger transport in Bulgaria with trolley buses, trams and metro for the period 2001-2017 is 285 240 thousand passengers with a minimum number of 244 902 and a maximum of 329 444 thousand passengers. The results show that the sample is homogeneous with a growth rate of 99.3% and a negative growth of -0.7% on a 2001 basis, which means a decrease in the number of passengers in the next annual period.

Data processing for average annual work in pkm in Bulgaria with trolley buses, trams and metro for the period 2001-2017 is 1200 mil. pkm, with a minimum value of 1055 and a maximum of 1430 mil. pkm. The results show that the data are homogeneous with a growth rate of 100.38% and an increase of 0.38% on a 2001 basis, which means an increase in the work done in the next annual period. This may be due to the greater average distance traveled by passengers, whose average of 4.2 km for the period varies from 3.57 km to 5.10 km.

A review of European documents and best practices in the field of mobility shows stimulation of walking and / or cycling, followed by the use of public transport. Private transport provides priority use of new forms of ownership and use of vehicles, car-sharing and / or car-pooling, integrated MaaS system and gradual rejection of the use of private vehicles for urban travel.

The transition to the digital economy led to a paradigm shift for mobility. The concept MaaS ("Mobility-as-a-Service") is the next stage in the development of mobility, together with the development of multimodal transport and innovative types of organization of transport (carsharing and / or carpooling, autonomous vehicles).

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REFERENCES

Commission of the European Communities. (2009). *Action Plan on Urban Mobility. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions*, Brussels, COM (2009) 490. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52009DC0490&from=EN (Accessed on 16.10.2018).

Kliucininkas L., Matulevicius. (2009). *Comparative Analysis of Bus and Trolleybus Related GHGs Emissions and Costs in Lithuani*a. 5th international Vilnius Conference, EURO Mini Conference, "Knowledge-Based Technologies and OR Methodologies for Strategic Decisions of Sustainable Development" (KORSD-2009). Institute of Mathematics and Informatics, Vilnius Gediminas Technical University. Vilnius, Lithuania. ISBN 978-9955-28-482-6, pp. 187-191. (Accessed on 16.10.2018).

Wołek M., Wyszomirski O. and others. (2013). *The Trolleybus as an Urban Means of Transport in the Light of the Trolley*. Wydawnictwo Uniwersytetu Gdańskiego. Gdańsk., p.167, ISBN 978-83-7865-174-1

http://www.zkmgdynia.pl/admin/__pliki__/TROLLEY_ebook_2013_.pdf (Accessed on 16.10.2018).

Goodall W., Fishman T., Bornstein J., Bonthron B. (2017). *The rise of mobility as a service. Reshaping how urbanites get around. Deloitte Development LLC*. Deloitte Review Issue 20,

https://www2.deloitte.com/content/dam/Deloitte/nl/Documents/consumer-business/deloitte-nl-cb-ths-rise-of-mobility-as-a-service.pdf (Accessed on 16.10.2018).

European Union. (2011). *White Paper "Roadmap to a Single European Transport Area - Towards a competitive and efficient transport system resource*". Luxembourg: Publications Office of the European Union, ISBN 978-92-79-18270-9, doi:10.2832/30955

Ministry of Transport, Information Technology and Communications. (2012). *Report analyzes the possibilities for economic and effectively increase the participation of trolley transport in inner-city passenger transport in Bulgaria*. Sofia, Bulgaria. (***Оригинално заглавие***: *Министерство на транспорта, информационните технологии и съобщенията, 2012. Доклад анализ относно възможностите за икономическото и ефективно увеличение на участието на тролейбусния транспорт във вътрешноградските пътнически превози в България. София, България*).

NSI. (2017). *National statistical yearbook 2016*. Sofia.

Trolley Project. (2013). *Transport Mode Efficiency Analysis: Comparison of financial and economic efficiency between bus and trolleybus systems*. http://www.trolley-project.eu/fileadmin/user_upload/download/TROLLEY_WP4_Transport_Mode_Efficiency_Analysis_Bus_vs_Trolleybus.pdf (Accessed on 16.10.2018).

Website of the Ruse Municipality. (2018). https://www.ruse-bg.eu/setlang/en/ (Accessed on 16.10.2018).

Website of the Google maps. (2018). https://www.google.bg/maps. (Accessed on 16.10.-2018).

Website of the Ruse public transport. (2017). http://www.ruse-bg.eu/bg/pages/468/-index.html (Accessed on 16.10.2018).

Website of the Electrotransport Sofia. (2018), http://www.elektrotransportsf.com/index.-php?option=com_content&view=article&id=78&Itemid=59&lang=bg (Accessed on 16.10.2018).

