THE SUSTAINABLE DEVELOPMENT OF THE BULGARIAN TRANSPORT SYSTEM

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Abstract: *The paper aims to provide a theoretical overview of the nature of the transport system within the context of sustainable development and to study the framework indicators of the development of freight and passenger transport so as to identify opportunities for improving the infrastructure and applying global practices to the Bulgarian transport sector.*
The paper therefore provides a theoretical overview of the nature of the transport system and the sustainable development of decision making to overcome spatial disparities between freight and passengers. The effects and indicators of sustainable development of the transport of passengers and freight have been systematized.
The research focuses on two major areas and has two main objectives: to ensure high mobility of freight and passengers and to reduce the adverse impact of transport on the environment, in line with the 'Energy consumption as a percentage of the GDP' indicator and measured through specific indicators. The study also focuses on two other framework indicators 'Security and safety' and 'Environmental indicators'. The analysis is based on official statistics from Eurostat and the Bulgarian National Statistical Institute.
Based on the theoretical overview and the analysis of the empirical data, we have identified local problems as well as opportunities for improving the quality of the transport infrastructure in Bulgaria and adjusting world practices to the situation in Bulgaria in order to contribute to the active implementation of sustainable development ideas to the transport sector in the country.

Keywords: *transport system; infrastructure; sustainable development*

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Introduction

The progress of modern society is the result of the creative development of science and technology which are applied to all spheres of life, support economic growth, facilitate social integration, improve the quality of life and life expectancy, etc. Thus

a set of factors has come to determine the situation in each sector and to produce multiple economic and environmental effects. Hence, the evolution of the contemporary world reflects a number of constructive results, and systematically changes the configuration of the atmospheric and earth layers, the water bodies and the flora and fauna.

Hence, the idea to identify the relation between the cumulative effects of the transport sector in its dynamic development as a system and the establishment of conditions for transporting passengers and freight, while at the same time taking into account the significant emissions of harmful substances which disrupt the ecological balance of the environment.

The purpose of this paper is to present a theoretical overview of the nature of the transport system in terms of the concept of sustainable development and to study framework indicators of the development of freight and passenger transport so as to identify opportunities for improving the infrastructure and applying global practices to the transport sector in Bulgaria.

To accomplish this objective, we need to:

1. Provide a theoretical overview of the nature of the transport system within the context of sustainable development.

2. Study the indicators of sustainable development of the Bulgarian transport sector.

3. Identify opportunities for the sustainable development of Bulgarian transport.

The methods we have employed in our research are comparison and synthesis; dynamic statistical analysis, and the graphical method.

This research covers the period from 2008 (the first year in which some results could be expected as a result from Bulgaria's accession to the EU) to 2015 as more up-to-date information was not available at the time of writing this paper. That was also the major constraint which accompanied our research in the aspects we specified earlier. This constraint mainly relates to the lack of complete and up-to-date official statistics published by Eurostat and the National Statistical Institute which are the main sources of empirical data. It was therefore impossible to specify a single period for researching all indicators, although we attempted to research a period which would be closer to the present. Due to the lack of a comprehensive information database about special-purpose transport, the emphasis in this paper is on general-purpose transport, without underestimating its importance or impact on the sustainable development of the transport system.

Despite the constraints which we specified earlier, the problems we deal with in our research are up-to-date and there were sufficient theoretical and practical prerequisites for doing the research, in compliance with the main objectives and priorities set in the Strategy for Development of the Transport System of the Republic of Bulgaria till 2020, the National Strategy for Regional Development of the Republic of Bulgaria for the period from 2012 to 2022, the Integrated Transport Strategy for the period till 2030, which are in line with the European Transport Policy, with a view to achieving 'sustainable, smart and inclusive growth' (Ministry of Transport, Information Technology and Communications, 2017, p. 20).

1. The Transport System within the Context of Sustainable Development

1.1. Characteristics of the transport system and its sustainable development

Each system should be approached as a set of components which function in complex relationships and interact with one another. From this point of view, the most important thing for the transport system is the coordination of activities and the interaction among the different transport subsystems, which implies that the transport system has to be viewed as a system that includes the production activity of different modes of transport in an organizational and operational unity, in order to create conditions for improving the quality of transport, reduce the overall share of operating costs per unit of transport output and the relative share of total transportation costs in the national economy (Tsankov, St., 1983, pp. 5-6).

In related literature, there is a view (Bakalova, V. & Hr. Nikolova, 2010, p. 22) which summarises the nature of the transport system as a combination of the means of transport and transport routes that ensure the spatial movement of freight and passengers on the basis of interdependent and coordinated work performed by each mode of transport and in the presence of certain unity in the technological process of transport, with the aim (Gerami, V. D. & A. V. Kolik, 2014, p.11) to ensure the access to and the efficient exploitation of natural resources, to connect the regions of production and consumption, to expand the product markets, and to promote the achievement of higher standards of living.

Transport systems (Rodrigue, J. P., C. Comtois & B. Slack, 2006, p. 38) consist of a complex set of relationships between demand, service points and networks supporting traffic. They highly depend on the environmental conditions which affect transportation costs, capacity, efficiency, reliability, and speed. These conditions are closely related to the development of transport networks, both in terms of capacity and territorial scope. At the same time, transport systems evolve within a complex network of relationships between the supply of transport, which is determined by the scale of the network's operational capacity and the demand for transport, i.e. the mobility demands within a specific territory.

In terms of its structure, the transport system can be divided into two parts: general-purpose transport and special-purpose transport (see Fig. 1).

Therefore, the scope of transport system refers to all modes of transport for general and special purposes which are combined in the process of operation and organization so as to achieve specific economic, social and environmental effects. The alternative nature of a combined transport solution provided by the transport system creates the potential for developing the sector in line with sustainability pillars, thus aiming to preserve the environment by reducing the harmful impact which people have upon both living and non-living nature.

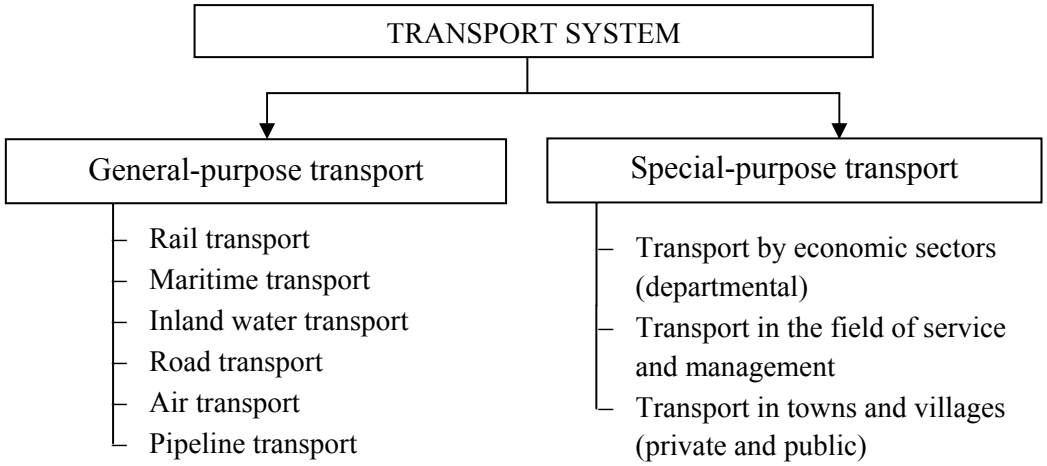

Figure 1. Structure of the transport system.
(Amirov, M. Sh. & S. M. Amirov, 2016, p.15)

Many concepts of sustainable development lay an emphasis on the importance of increasing the efficiency of technological progress, since technology must contribute to the development of a society where it is possible to maintain the current standard of living or even increase it by using fewer resources and less energy. The underlying idea of these concepts is that raising efficiency by 1% will reduce the use of resources by 1%. This is not generally the case, since technological improvements cause behavioural responses. Usually, raising the efficiency by 1% leads to reducing the use of resources by less than 1% and may even lead to increased consumption of resources. This phenomenon is also known as 'the boomerang effect' (Binswanger, 2001).

Therefore, the opportunities for sustainable development of the transport system should merely relate to the development of scientific and technical progress, but should also be approached bearing in mind the organizational, managerial, legal, behavioural, etc. prerequisites which affect the different modes of transport and the infrastructure providing them.

The choice of suitable transport has a direct impact on the operation of the transport system and its sustainable development. This choice affects the price of the product, the time and reliability of its delivery as well as the environmental situation within a specific region. In order to comply with the basic logistics principles of delivering goods at the right time, at the right place, in the right quantity, quality and assortment at an optimum level of costs, including ecological costs, it is necessary to approach all modes of transport independently or in combination with their operational and economic advantages. The choice of optimum transport is based on information about the specific characteristics of the different modes of transport – rail, road, pipeline, water (river and sea) and air.

When compared to each other, all modes of transport have their advantages in contributing to the transportation of people and freight in compliance with environmental requirements. Road transport contributes the least to the cause of environmental protection. We should note that in the automotive industry certain innovations have

recently been made, their focus being on overcoming the negative emissions from combustion engines. The mass introduction of hybrid and electric vehicles will make road transport quick, flexible and environmentally friendly. The parameters related to the capacity, cost, regularity, length and volume of transport will be preserved. Their quantitative characteristics are subject to positive changes on the basis of combined and modal transport. Combinations of road, rail and water transport are both practically feasible and cost-efficient.

The performance of the two latter alternatives is high in terms of transport capacity, which automatically reduces their environmental footprint per unit of freight transported. A rational approach requires that rail and water transport should be employed more actively, since those, too, are optimum economic solutions. Performance ratios in terms of incurred costs and resources invested in transport activities are significantly higher when compared, for example, to road or air transport.

From an environmental point of view, pipeline transport is also to be preferred, although its main disadvantage relates to the absorption of investments in the construction of the necessary infrastructure. If we ignore this fact, it should be noted that the transportation of freight by pipes is more reliable for its regularity and the large volume of freight which can be transported without requiring the active participation of human resources or the direct contact of freight with the environment.

Presumably, the least suitable freight transport, in terms of its environmental impact, is airline transport. It is a suitable solution for the transportation of freight in special circumstances such as products with shorter lifecycle or urgent deliveries. Therefore, this option cannot be defined as a free choice of freight owners. Rather, the decision to use air transport largely depends on external factors. In fact, air transport not only deteriorates the environmental situation, but also, from the point of view of economic profitability, it is not the right choice, given the high transportation costs accumulated per unit of freight.

To overcome the disadvantages of the international environment, concepts such as the ‘sky bridge’ and the ‘ground bridge’ are often used (Rakovska, 2011, p. 245). ‘Sky bridge’ is a concept used to refer to the transportation of freight by combining air cargo and ocean freight solutions. The concept of ‘ground bridge’ is used to refer to the option of loading freight from vessels onto trains and transport by rail and then reloading that freight to another ship (David, P. A. & R. D. Stewart, 2008, p. 301). This reduces the transit time and eases routes, thus resulting in economies of scale and reduced environmental footprint.

Similarly, passenger transport also implies the use of all five transportation options, namely, road, rail, air, sea and river transport (see Table 1).

Each mode of transport has some advantages which render it preferable to the other modes of transportation when passengers make decisions how to cover some distance, although they relate to a number of major disadvantages that often require considering various combinations between different modes of transport so as to achieve optimum efficiency and rationality in organizing the transportation of people.

Table 1
Comparative characteristics by modes of general-purpose passenger transport

Mode of general-purpose passenger transport	Advantages	Disadvantages
Road transport	Generally accessible. Relatively high speed of movement and low transportation capacity. Provides rational transport in short and medium distances. Flexibility in providing the necessary frequency of movement.	A relatively expensive mode of transport in relation to the high average cost of transportation. Small transport length and volume of freight. High levels of environmental pollution and noise levels.
Rail transport	Highest efficiency for medium-distance passenger transportation. High transport capacity and operation in close intercity relations. Low cost of transportation, stable regularity. Comparatively low environmental pollution.	Inaccessibility in some areas. Low speed of transport. Special roads and terminals are needed. High noise levels.
Air transport	Possibility to be used in difficult and remote areas. Highest speed of passenger movement. No special roads needed.	Highest cost of transportation. Dependence on meteorological conditions. Special terminals are needed. High levels of environmental pollution and noise levels.
Maritime transport	Unlimited traffic capacity of the seaways and unlimited transport length. No special roads needed. Low level of environmental pollution.	Dependence on seasonal conditions. Special terminals are needed.
River transport	Low cost of transport. Attractiveness of river cruises. No special roads needed. Low level of environmental pollution.	Dependence of transport on seasons. Special terminals are needed.

Source: (Adapted and supplemented after Persianov, 2014, p. 27).

In terms of the advantages of road transport, we should note that it is considered to be generally accessible, which automatically renders it a transport option which is intensively used by passengers. Road transport is most frequently used for covering short and medium distances, its choice largely depending on the high performance ratios and relatively high speeds. Flexibility and speed, which change pre-traced routes,

have a great impact on the overall rating of road transport. Hence, passengers report maximum satisfaction with the provided transport service, considering the opportunity to reach their desired destination.

The increased rates of customer service add value and form relatively high transportation costs and this affects the final cost which is calculated. The factors affecting the financial evaluation of road transport relate to the price of fuels on the one hand, and to the limited number of passengers who can be transported by vehicles, on the other. Their absolute number is relatively small, compared to rail or water transport (both sea and river), which affects (raises) the cost per unit rates, i.e. per transportation of a passenger. These findings about the economic parameters of the process also affect transportation costs, hence, transport tariffs as transport prices and are a prerequisite for its cost-effectiveness. The high levels of environmental pollution and noise levels should not be ignored either.

Another widely used option for the transportation of people, which is preferred over medium distances especially, is rail transport. The main characteristics of rail transport which make it a desirable choice are its efficiency, high transport capacity and usability for short distances at a low transportation cost per unit. One of the advantages of this type of transport relates to its economic and organizational benefits, in addition to the purely environmental factors, which render it a priority transport sector providing the balance in the overall transport system. The disadvantages of rail transport refer to its inaccessibility in some areas due to the high investment absorption required for increasing the density of railways and the degree of satisfaction with their performance as well as the low speed of railway transportation. The latter is not a consequence of the lack of scientific or technological progress in the sector. Rather, it results from the financial instability, which impedes the introduction of innovations to the rail infrastructure and the rolling stock. Furthermore, we should not ignore the fact that increased accessibility and speed of trains inevitably result in higher fares which end customers are not willing to pay. When approaching the problems related to rail transport from the point of view of customers, a rational solution would be combining rail transport with road transport, when organizing the traffic.

Other modes of transport can certainly be included when trying to make the transport scheme more rational. Their choice will mainly depend on the overall condition of transport facilities and infrastructure within a region.

Air transport relates to maximum security, reliability and high quality of the provided service when the necessary ground facilities and flight crews are available. In recent years, air transport has become the major transport service used by international passengers due to the high speed of aircraft, which provides more advantages when travelling over longer distances.

The development of air transport is also accompanied by a number of drawbacks, such as its strong dependence on climate and weather; the need to use other vehicles at the point of passengers' arrival and departure; the high cost of transportation and, hence, the higher transportation prices compared to the other modes of passenger transport, etc.

Water transport also relates to similar constraints, its major advantage being the low cost of both sea and river transport. Sea and river transport is more attractive to

passengers as a cruise option due to its unlimited carrying capacity which is typical of sea routes. We should also take into account the low environmental footprint of that mode of transport which is perceived by modern society to contribute to nature conservation and therefore renders them preferable alternatives for travel, other things being equal.

Within the context of sustainable development, the transport system has the potential to provide all modes of passenger and freight transportation while producing a minimum impact on the environment. To this end, processes need to be purposefully managed, adequately controlled and properly combined.

1.2. Effects of the activities designed to improve the transportation system and indicators of its sustainable development

The development of the transport sector directly relates to modern infrastructure solutions which contribute to applying a sustainable mobility approach. It is therefore necessary to introduce measures which would reduce the need to travel (i.e. fewer trips), promote modal transport solutions; reduce travel duration and raise the efficiency of the transport system. Road facilities, such as bridges, viaducts, trestles, overpasses, underpasses, tunnels, culverts, retaining walls, fortification and drainage facilities and purification facilities, contribute considerably to reducing the length of travel from start to end points.

Tunnels, which are 'covered artificial facilities for underground or underwater road traffic, whose length in general significantly exceeds their transverse dimensions' (Ministry of Transport, 2007). They play an important role in reducing the distance which vehicles cover. They are constructed under hills, mountains, islands as well as in seas and rivers, which helps reduce the distance travelled by vehicles and the time required for reaching a certain destination.

It is possible to evaluate the results of creating new infrastructure (road, rail, tunnel, overpass, etc.) through a set of indicators whose values measure achieved economic, social and environmental effects (see Table 2).

The deployment of new natural resources in result of building new infrastructure relates on the one hand to the provision of logistics support which ensures access to raw materials, resources, etc., and, on the other hand, to moving those raw materials, resources, etc. to industrial buyers.

As a result of this two-way dynamics, conditions are created for the accelerated development of a particular territorial area. Such regions become more attractive to both citizens and economic players and investors from different economic spheres – commerce, manufacturing, construction, services, etc. The higher attractiveness of regions relates to the creation of new jobs (due to the more diversified portfolio of employers); improved connections between regions, which enhances the mobility of citizens and promotes exchange processes due to expanding markets, increasing supply, etc. The operation of market mechanisms results in the increased scale of business activity in a number of economic sectors and raises the need for international contacts with contractors to sell ready produce.

Table 2
Classification of types of effects of activities aimed at improving passenger and freight transport

Activities	Type of effect
1. Developing new infrastructure (road, railway, tunnel, overpass, etc.)	1.1. Use of new natural resources. 1.2. Emergence of new industries. 1.3. Accelerating the development of regions by increasing their attractiveness as a result of the construction of new road facilities. 1.4. Changing the number of jobs in the region. 1.5. Improving interregional relations. 1.6. Improving foreign economic relations. 1.7. Increasing real estate prices. 1.8. Saving time for movement of the population, respectively freight and improving customer service. 1.9. Social effect in relation to unifying the level of development of the regions (improving medical, commercial, and household services provided for the population, creating favourable conditions for recreation, etc.). 1.10. Improving the economic and strategic security of the state. 1.11. Negative impacts on the flora and fauna, the atmosphere, the earth's surface and waters.
2. Speeding up transportation and improving passenger services during journeys and stays	2.1. Saving time. 2.2. Reducing fatigue due to transportation and increasing workforce productivity. 2.3. Recreational effect.
3. Enhancing transportation safety	3.1. Reducing transport accidents and emergency situations, as well as the impact on the environment. 3.2. Reducing harmful effects on human health, incl. that of passengers. 3.3. Reducing losses of passenger and freight delays during transportation.
4. Activities aiming at environmental protection	4.1. Reducing environmental pollution (air, land, water). 4.2. Reducing the impact of pollution, noise and vibrations on human health, flora and fauna. 4.3. Preventing resource depletion. 4.4. Expropriating lands and other natural resources.

Source: (Adapted and supplemented after Persianov, 2014, pp. 340-341).

The economic advance of a region directly affects real estate prices. These effects can also be observed within towns and villages. For example, the construction of

each metro-diameter of an urban metropolitan line affects the real estate market by raising property prices. This is mainly due to the improved communication within that region, which helps local residents save travelling time and raises the quality of passenger services in urban areas.

In addition to the positive economic results, the construction and exploitation of new infrastructure also generates purely social effects, which are equally important to citizens. Easier access to a territory makes it attractive and increases the benefits to society by making better healthcare services accessible; expanding the diversity of product ranges; providing higher quality facilities, more opportunities for recreation and entertainment, etc.

The benefits provided from new infrastructure solutions also have an impact on the safety of the state. These benefits refer to the options available for designing strategies and tactics in a situation of uncertainty or risk. The density of transport connections on a national scale makes it possible to identify a number of rational solutions for organizing the movement of logistics flows.

Time is a crucial factor when taking action in current economic and social conditions. Modern theory and practice approach time as a resource which has its price and can be spent similar to other resources, and is therefore limited to certain quantities. Increasing the speed of transportation helps reduce the time spent on travel and thus increases the time available for performing activities of economic and social utility.

Higher travel speed and better passenger service affect the overall condition of passengers. They help reduce travel fatigue and increase labour productivity indicators by creating the prerequisites for increasing the quantity of goods and services which are produced by one unit of labour over a given period of time.

Another immediate impact of the activities designed to improve passenger transportation and raise the quality of the services provided during their journeys and stays is in terms of the more intense process of recreation which is thus made possible and consequently contributes to the improved physical and mental health of people.

The measures and activities we have identified so far have their positive impact upon individuals as they enable them to shorten the time required for travelling and focus on more creative goals; reduce the impact of travel fatigue; increase labour productivity and provide more opportunities for recreation.

Any measures designed to increase the safety of passengers are essential when identifying the effects of increasing the speed of passenger transport. To ensure that safety, it is necessary to improve the quality of available transport infrastructure and rolling stock.

The condition of the infrastructure is a key factor to reducing the number of travel accidents and the environmental footprint and to accelerating the process of transportation. This implies higher indicators of the density of high-capacity roads and increased passenger satisfaction with them, as well as more investments in tunnelling facilities, aqueducts, railroad crossings, etc., to help reduce the travel distance. A similar approach will establish the conditions required for changes in:

- The quantitative indicators of expected cost-efficiency in terms of time and funds spent on transportation, which will allow the re-allocation of resources to resolving other economic and social issues;

- The environmental impact upon the atmosphere, the soil and the biodiversity by reducing the number of exploited vehicles;

- The health status of the population, including passengers, which will provide opportunities for resolving issues related to the quality of life;

- Life expectancy, which is likely to increase when the number of fatal traffic accidents is reduced.

The improved quality of the infrastructure will have an overall positive impact upon the development of all spheres of life – the economy, tourism, culture, commerce, education, etc., since it is part of the equipment required for ensuring the dynamics of those processes.

Vehicles are no less important to the transportation of passengers and freight. Their condition is essential to achieving higher performance results in terms of their economic, social and environmental effects. Hence, modern transport fleet should be in compliance with the requirements set by national and international legislation: The Road Traffic Act, The Railway Transport Act, The International Convention on Load Lines, etc.

The effects of the measures adopted to improve transportation in terms of the sustainable development of freight and passenger transportation should be measured quantitatively.

According to Eurostat, the major indicators of sustainable transport development include: the share of transport in the GDP; the share of energy consumption in the GDP; the share of each mode of transport on the market; investments made in transport infrastructure and the volume of harmful emissions (see Table 3).

Some of the major indicators set in the Framework for the sustainable development of freight and passenger transportation include 'Energy consumption to GDP', 'Safety and security' and 'Environment indicator'.

The employment of the 'Energy consumption to GDP' indicator seeks to accomplish two major objectives: 'To ensure the high mobility of freight and passengers' and 'To reduce the harmful effects of the transport sector upon the environment'.

The accomplishment of the first objective is measured through the indicators employed to assess the accomplishment of operational objectives, which are as follows: 'The relative share of the different modes of transport in the total volume of freight transport' and 'The relative share of the different modes of transport in the total volume of passenger transport'. The assessment indicators employed are 'The volume of freight transport in the GDP' and 'The volume of passenger transport in the GDP'.

'Economic efficiency of transport' indicators are calculated by applying the resource and cost approach to the indicators which are subject to analysis. When calculating the value of 'Energy consumption by mode of transport' indicator, the equivalent of thousands of tonnes of oil (TOE) is used. The value of the 'Investments in transport infrastructure' indicator is calculated in national currency.

The second objective of the 'Energy consumption to GDP' indicator is to reduce the harmful effects of transport on the environment. The indicator of the achievement of the operational objective is 'GHG emissions by type of transport' and the evaluation indicators are: 'Emissions of nitrogen oxides (NOx) from transport', 'Emissions of particulate matter from transport', and 'Average CO_2 emissions per km from new cars'.

Table 3
Framework indicators of the sustainable development of freight and passenger transport

Leading indicator	Indicators of the achievement of operational objectives	Evaluation indicators
Energy consumption to GDP	**OBJECTIVE: ENSURING HIGH MOBILITY OF FREIGHT AND PASSENGERS**	
	Percentage of the different modes of transport in the total volume of freight transport Percentage of the different modes of transport in the total volume of passenger transport	Volume of freight transport to GDP Volume of passenger transport to GDP
	Economic efficiency of transport	Energy consumption by mode of transport
		Investments in transport infrastructure
	OBJECTIVE: REDUCING THE HARMFUL IMPACTS OF TRANSPORT ON THE ENVIRONMENT	
	Greenhouse gas (GHG) emissions by mode of transport	Emissions of nitrogen oxides (NOx) from transport
		Emissions of particulate matter from transport
		Average CO_2 emissions per km from new cars
Security and safety	Number of road traffic accidents (RTA)	Number of people killed or injured in RTA
Environment indicator	Price indexes in transport	

Source: (Eurostat, Sustainable transport, 2017).

The last two indicators are 'Safety and Security', which is measured with the indicator of the achievement of operational objective 'Number of road traffic accidents' (RTA), the indicator 'Number of people killed or injured in accidents' and the 'Environment indicator' measured with 'Price indexes in transport'.

The theoretical overview of the issues related to the nature of the transport system within the context of sustainable development and a systematic review of some of the effects of accelerated transportation and the indicators of sustainable development provide the basis for conducting some research based on official statistical information.

2. Research of the Indicators of Sustainable Development of the Transport Sector in Bulgaria

2.1. Analysis of sustainable transport development indicators which aim to ensure high mobility of freight and passengers

According to methodology employed by Eurostat to the analysis of sustainable transport development indicators in terms of higher mobility of freight and passengers, the leading indicator 'Energy consumption to GDP' is measured by the indicators of the achievement of the following operational objectives: percentage of the different modes of transport in the total volume of freight transport, respectively in the total volume of passenger transport, and economic efficiency of transport.

The data presented in Table 4 indicates that road transport has been the most preferred option by transport operators in Bulgaria in recent years, which was not the case in the sector at the beginning of the new century.

Table 4

Structure of freight transported, and work performed by mode of transport for the 2008 – 2015 period (%)

Freight transported								
Modes of transport	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Land transport	87.630	89.731	90.877	94.171	95.307	97.484	98.396	98.508
Rail transport	15.942	13.689	14.802	13.965	11.634	11.233	11.951	11.662
Road transport	52.675	56.366	54.970	58.107	60.906	65.877	66.110	67.916
Pipeline transport	19.013	19.676	21.104	22.099	22.768	20.375	20.334	18.931
Water transport	12.366	10.250	9.110	5.821	4.687	2.512	1.603	1.488
Maritime transport	8.755	5.892	5.612	3.011	1.899	0.609	0.641	*
River transport	3.611	4.358	3.498	2.810	2.789	1.903	1.556	*
Air transport	0.004	0.020	0.013	0.008	0.006	0.003	0.002	0.004
Work performed								
Modes of transport	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Land transport	21.826	31.116	45.812	57.984	70.058	87.236	96.970	97.057
Rail transport	4.952	4.720	6.254	7.398	7.179	8.976	10.359	9.658
Road transport	11.634	20.819	31.931	40.335	51.836	65.064	73.657	76.058
Pipeline transport	5.241	5.578	7.626	10.250	11.042	13.197	12.955	11.341
Water transport	78.170	68.868	54.172	42.001	29.930	12.753	3.021	2.929
Maritime transport	76.128	66.176	50.471	38.804	26.481	9.446	10.289	*
River transport	2.043	2.693	3.701	3.197	3.449	3.307	2.925	*
Air transport	0.003	0.015	0.016	0.016	0.012	0.011	0.009	0.013

Key: "": data from NSI not available.*

Source: Calculations by the author based on data from NSI.

Gradually, over the years, the relative share of road transport, both in terms of the freight which is transported and the related volume of work, has increased. This trend in the development of road transport is considered to be positive since it is the result of passengers' and carriers' growing interest in this mode of transport, which is the consequence of the lower rate of utilising alternatives modes of transport (railroad and water transport in particular), rather than an upsurge in the economy of the country.

The main reason for giving priority to freight road transport is a consequence of the limited volumes of economic activity of enterprises which prevent them from benefiting from the main advantage of rail transport in terms of the lower cost per unit of freight. On the other hand, the reasons for the decline in railroad transport may be attributed to the close relationship and the deteriorated condition of the infrastructure and the rolling stock. Hence, the conclusion that there has been no 'revival of the railways' in Bulgaria yet, as required by the European Commission in its White Paper.

In the case of water transport, the lack of economic interest in this mode of transport is related to the general state of Bulgarian economy, given the impact of major sectors of the economy whose output is subject to import or export, such as:

• The petroleum processing industry (import of oil and export of petroleum products),

• The metallurgy (imports of ore, coke and other products of the metallurgical industry and exports of the metallurgical products and scrap);

• The power industry (coal imports);

• Construction (cement exports, domestic transportation and exports of inert materials, import and export of building materials and constructions);

• Agriculture (export and import of cereals and fodder); chemical industry (export and, to a lesser extent, import of fertilizers);

• The light industry and other sectors of the industry (import and export of freight as common cargo or in special containers).

The lack of basic raw materials in the country is a prerequisite for preserving the current or similar volumes of imports from Russia and Ukraine. The partial recovery of Bulgarian production positions on the Russian market was expected to produce a positive impact on transport. However, the EU has imposed a number of restrictive measures since March 2014 in response to the illegal annexation of the Crimea and the deliberate destabilization of Ukraine.

Thus the share of bus transportation stands out in terms of the number of transported passengers and the volume of work done when compared to the other modes of transport. Its share fluctuates between 58.576% (2012) and 63.724% (2008) in the structure of land transport, which renders it a competitive alternative of railway transportation (see Table 5).

As a matter of fact, railways have retained their average relative volume of 3.529% in terms of the number of passengers transported, which is evidence of their insignificant share in the transportation of Bulgarian citizens. This could also be attributed to low customer satisfaction with the provided service. The latter is determined by:

- The complex nature of the service, i.e. the possibility to combine different services provided to customers by railways in exchange for purchasing a train fare;

Table 5

Structure of passengers transported and work performed by modes of transport for the 2008 – 2015 period (%)

Passengers transported								
Modes of transport	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Land transport	67.371	66.295	65.049	64.632	62.066	62.486	63.656	65.470
Rail transport	3.647	3.661	3.583	3.662	3.490	3.598	3.482	3.106
Bus transport	63.724	62.634	61.466	60.970	58.576	58.889	60.174	62.364
Water transport	0.027	0.028	0.020	0.022	0.026	0.020	0.013	0.016
Maritime transport	0.001	0.000	0.002	0.002	0.003	0.003	*	*
River transport	0.027	0.028	0.018	0.020	0.023	0.016	*	*
Air transport	0.285	0.255	0.277	0.336	0.291	0.313	0.336	0.309
Urban electric transport	32.317	33.422	34.655	35.009	37.617	37.154	35.995	34.205
Work performed								
Types of transport	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Land transport	74.473	72.044	69.300	69.097	71.355	70.362	72.093	74.931
Rail transport	10.751	12.265	11.447	11.063	10.832	10.581	9.332	8.271
Bus transport	63.721	59.779	2815.121	2611.571	2570.189	2472.842	2333.478	66.660
Water transport	0.005	0.006	0.011	0.011	0.017	0.012	0.011	0.011
Maritime transport	0.003	0.004	0.010	0.010	0.016	0.010	*	*
River transport	0.001	0.002	0.001	0.001	0.002	0.001	*	*
Air transport	20.568	21.240	23.303	24.063	21.583	23.311	19.979	19.420
Urban electric transport	4.954	6.710	7.386	6.829	8.257	7.967	5.839	5.638

Key: "": data from NSI not available.*

Source: Calculations by the author based on data from NSI.

- The time factor (travel time, promptness and regularity of the travel service, etc.);
- The balance which should be sought between the quality of provided services and the prices of train fares;
- The overall condition of the environment in which transportation takes place – the interior and the cleanliness of wagons, compartments, common parts, sanitary facilities, etc.;
- The individual approach and the training of the staff engaged in the transportation process;
- Safety, etc.

The guidelines we have identified so far leave room for imposing higher standard requirements to Bulgarian National Railway Company, although the company has been taking effort to adapt its product portfolio to the market conditions by offering opportunities such as (BDZ, 2017):

- InterRail, a ticket option available for multiple train journeys (and certain ferries) in 30 European countries.
- The CityStar offer, which allows significant discounts on return tickets to some

European countries, such as the Czech Republic, Slovakia, Romania, Greece, and Hungary.

- The Balkan Flexipass, which is a fare paid for travelling by train on the territory of Bulgaria, Romania, Macedonia, Greece, Turkey, Serbia, Montenegro, Bosnia and Herzegovina and Republika Srpska.
- A regional ticket issued for a second-class passenger and express trains, valid for travelling on Tuesdays, Wednesdays and Thursdays.
- RailPlus cards providing 25% discounts for young people (RailPlus '-26M'), adults (RailPlus 'S') and permanent customers (RailPlus 'O') for train journeys across Europe (Austria, Belgium, Bulgaria, Great Britain, Northern Ireland, Germany, Greece, Denmark, Spain, Ireland, Italy, Latvia, Lithuania, Luxembourg, Macedonia, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Hungary, Ukraine, Finland, France, Croatia, Netherlands, the Czech Republic, Switzerland, Sweden).
- Possibility to purchase tickets from the system of the German Railways (DB Bahn) directly from Bulgaria.

Although we should not underestimate the effort on behalf of the company, reported interest in railroad transport was the lowest in 2015, which contradicts the principles of sustainable transport development, given the increased interest of passengers in the services provided by bus carriers.

Increasing passengers' preference to bus transport may be attributed to several major factors:

- The flexibility and accessibility of the service in towns and villages without the need to use other modes of transport at the start and at the end point of a journey.
- The density of the national road network, hence the route options providing door-to-door transportation of citizens without the need to change the mode of transport.
- Speed of movement.
- Balance between ticket prices and the quality of transportation services, etc.

Considering the fact the territory of Bulgaria is 111,000 km^2, it is possible to reach any place in the country within 24 hours, given the high rate of road construction. This makes transportation by bus preferable. We should note, though, that the major issues to be resolved by the state relate to the quality, rather than the quantity parameters of the roads used in the traffic of vehicles.

Another transport option whose significance is gradually growing is air transport. Its relative share is not high in terms of the total number of passengers due to the less affordable plane fares, yet it accounts for approximately 1/5 of the total volume, measured in million passenger-kilometres, in terms of performance. This fact, of course, is due to its main advantage, i.e. the opportunity to cover long distances within relatively short time periods.

Electric transport in urban territories reports similar results. Its relative share is high - more than 30% of all transported passengers during the entire researched period. However, the volume of overall performance does not exceed 8.257% (2012). The limited traffic perimeter of movement within towns and villages with infrastructure built-in for the operation of this mode of transport is the main cause for the low volume of performance, which is directly related to the length of the average transport distance measured in kilometres.

The specific nature of public transport in urban areas is predetermined by the need to ensure the transportation of citizens in towns and villages by employing regular schedules and routes. Furthermore, a distinctive feature of electric transport in urban areas is the equipment required to exploit the capacity of that mode of transport. This renders electric transport less flexible and adjustable in terms of introducing some changes to the traffic or responding to some factors of the external environment. Hence, the specific infrastructure required for electric transport relates to a number of constraints.

Whatever the underlying reasons, we need to focus on the imbalance in the existing passenger transport system in Bulgaria as well as on the impact it has upon the environment. The fact that Bulgarian citizens give priority to bus transport is indicative of the pollution accumulated in the atmosphere. In order to solve this serious problem in the field of passenger transport, customers need to be encouraged to use available options for railroad transportation as they are a more environmentally friendly alternative. This could be achieved by making the necessary investment and introducing relevant innovations so as to transform the railroad transportation provided by the national transport system into a fast, convenient and attractive service which is in high demand.

In line with the methodology designed by Eurostat for measuring the first few framework indicators for sustainable transport development, whose objective is to ensure the high mobility of freight and passengers, we should next research the 'Volume of freight transport to GDP' and 'Volume of passenger transport to GDP' evaluation indicators (see Table 6).

Table 6
Volume of freight and passenger transport relative to GDP over the 2008-2014 period

2005 = 100

Region/Years	2008	2009	2010	2011	2012	2013	2014
Freight transport in EU-28	98.7	91.3	93.9	92.4	90.5	91.5	90.6
Freight transport in Bulgaria	93.0	111.5	120.9	120.1	135.7	146.7	147.1
Passenger transport in EU-28	97.3	102.7	99.7	97.9	97.0	97.9	97.9
Passenger transport in Bulgaria	90.4	101.1	101.8	101.9	105.8	106.9	111.3

Source: (Eurostat, Volume of passenger transport relative to GDP, 2017), (Eurostat, Volume of freight transport relative to GDP, 2017)

The 'Volume of Freight Transport to GDP' indicator is calculated as the ratio between freight transport (in tonne-kilometres) and the gross domestic product (GDP) (chain volumes at exchange rates for 2005) and indexed for one reference year (2000). The fact that the volume of work performed in transport is used as a variable, shows that transport distance is also important since this indicator characterizes the spatial movement of freight to a certain distance. Similarly, the 'Volume of passenger transport to GDP' is defined as the ratio between the volumes of domestic passenger transport, measured in passenger-kilometres and GDP (chain volumes, at exchange rates for 2005). It includes transportation on national territory by cars, buses and trains.

In terms of its dynamics, the 'Volume of freight transport to GDP' indicator recorded relatively close levels during the first year for the EU-28 and Bulgaria over the period from 2008 to 2014. However, it gradually came to differ by 56.5 points, which is unfavourable to our country. Over the same period, the 'Volume of passenger transport to GDP' indicator, measured for EU-28, was below the levels recorded in 2005, except for 2009, while for Bulgaria the results exceeded benchmark estimates after 2008 and reached a level of 111.3 in 2014.

Therefore, the performance of the transport sector of the country in terms of both passengers and freight exceeded the growth in the GDP, which measures the quantity of produced goods and services provided.

The results which have been reported so far are indicative of the need to invest in transport infrastructure and rolling stock so as to reduce the rates of energy consumption and switch to the exploitation of renewable energy sources.

When analysing the indicators of sustainable transport development which aim at ensuring the high mobility of freight and passengers, we should also refer to available statistical data about the structure of total energy consumption by sectors. Transport is the sector with the highest relative share. In fact, the total energy consumption by the transport sector exceeds the overall energy consumption by industry and agriculture (see Table 7).

Table 7

Structure of total energy consumption in Bulgaria by sectors for the 2008-2015 period

(%)

Sectors	2008	2009	2010	2011	2012	2013	2014	2015
Industry	35.600	28.600	29.232	29.757	28.486	29.967	29.463	28.835
Transport	30.100	32.700	31.399	30.077	31.748	30.293	33.205	34.750
Households	22.600	2.600	25.940	26.420	26.286	26.256	24.692	23.625
Agriculture	2.000	2.200	2.110	2.254	2.190	2.245	2.171	2.007
Services	9.700	10.400	11.319	11.492	11.291	11.238	10.469	10.783

Source: (NSI, Final energy consumption by sectors, 2017).

To calculate the indicator, data about gross domestic energy consumption is used based on the real volumes of consumption recorded, which is indicative of the fact that transport is a serious energy consumer, its growth rate amounting to 4.650% in recent years. It is therefore important to comply with the major indicator of the sustainable development of freight transport, which is 'Energy consumption to GDP', in order to relate the energy cost of transportation to the quantity of goods and services produced (see Table 8).

This indicator is defined as the ratio between the energy consumption by the transport sector and GDP (chain volumes/indexes, at 2010 exchange rates or constant prices). The energy consumed by all modes of transport, i.e. by road, rail, inland waterways and by aviation is taken into account, including commercial, individual and public transport, except for sea and pipeline transport. This indicator compares the growth of energy consumption in transport with that of GDP at constant prices.

Table 8
Energy consumption of transport relative to GDP for the 2008-2015 period

2010 = 100

Region/Years	2008	2009	2010	2011	2012	2013	2014	2015
EU-28	101.3	102.5	100	97.9	95.4	94.2	93.9	93.4
Bulgaria	105.7	103.1	100	100.4	105.5	94.7	104.2	110.1

Source: (Eurostat, Energy consumption of transport relative to GDP, 2017).

Annual data shows the final energy consumption by modes of transport for all products (crude oil, petroleum products, natural gas, electricity, solid fuels and renewable energy sources). Data on the main energy quantities are in physical units and are converted into energy units, i.e. tonnes of oil equivalent to allow the addition of different types of fuel.

Figure 2 shows opposite directions of movement along the curves reflecting the energy consumption relative to GDP in EU-28 and in Bulgaria for the 2008-2015 period.

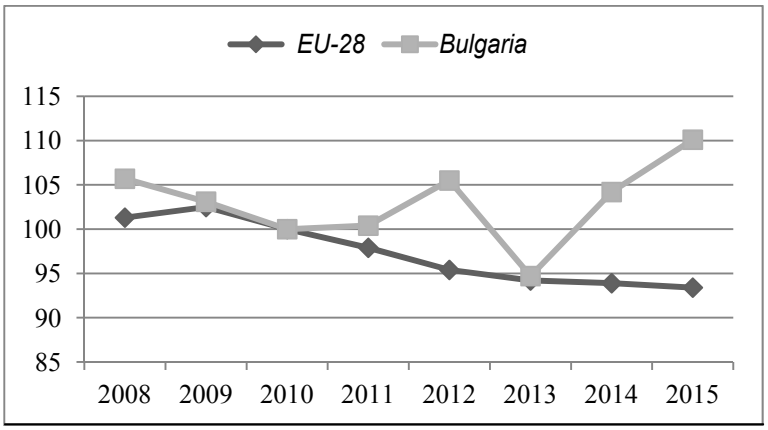

Figure 2. Energy consumption in transport relative to GDP for the 2000-2015 period

Since 2009, the Union has decreased the values of this indicator by 9.1%, while in 2015, Bulgaria reported the highest values of 110.1%, which is an increase compared to 10.1% for the base 2010 year. In practice, this indicates an energy deficit in the country in performing activities in the transport sector, i.e. the growth rate of energy consumption by the transport exceeds the growth rate of GDP at constant prices.

The performance of the transport sector is in line with the energy consumption. At the end of the period, a decline in the energy consumption was recorded by both railroad and air transport, in comparison to the figures reported in 2008, in contrast to the increased energy consumption by road transport (see Table 9).

The reasons behind these trends relate to the volume of transported freight. It has decreased over the years for rail and air transport and increased for road transport. Despite the fact that road transport is subject to much criticism due to its environmental footprint, it should be noted that it is the only mode of transport in Bulgaria

Table 9
Relative share of energy consumption by modes of transport for the 2008-2015 period

(%)

Years	2008	2009	2010	2011	2012	2013	2014	2015
Total transport, including	100	100	100	100	100	100	100	100
rail	2.189	1.840	1.644	1.470	1.463	1.229	0.987	1.198
road	89.866	91.811	91.673	91.514	92.442	92.204	92.918	92.965
air	7.945	6.349	6.684	7.017	6.095	6.567	6.095	5.837

Source: (NSI, Total energy balance, 2017).

which consumes energy from renewable energy sources as well, according to the official statistics.

The use of renewable energy in transport improves the security of energy supply by reducing the dependence on oil imports. According to Ordinance RD-16-869 from 02.08.2011 (The Ministry of Economy, Energy and Tourism, 2011) on calculating the overall share of energy from renewable sources in the gross total consumption of energy and the consumption of biofuels and energy from renewable sources in transport, biofuels are as follows:

- Bioethanol (ethanol produced from biomass).
- Bio-ETBE (bio-ethyl-tertiary-butyl-ether).
- Biomethanol (methanol produced from biomass used as biofuel).
- Bio-MTBE (bio-methyl-tertiary-butyl-ether, produced on the basis of biomethanol).
- Bio-DME (dimethylether produced from biomass used as biofuel).
- Bio-ETBE (bio-ethyl-tertiary-butyl-ether).
- Biobutanol (butanol produced from biomass used as biofuel).
- Biodiesel (a methyl ester produced from vegetable or animal oil, with the quality of diesel fuel used as biofuel).
- Biodiesel extracted by means of the Fischer-Tropsch reaction (synthetic hydrocarbon or a mixture of synthetic hydrocarbons produced from biomass).
- Hydrogenated vegetable oil (vegetable oil thermochemically treated with hydrogen).
- Pure vegetable oil (oil produced from oil crops by compression, extraction or similar procedures, unrefined or refined but chemically unchanged when compatible with the type of engine and the corresponding emission requirements).
- Biogas (combustion gas produced from biomass and/or biodegradable fraction of waste which can be purified to a natural gas product used as biofuel or, respectively, wood gas generator).

Over the period from 2012 to 2015, the share of renewable energy in the consumption of transport fuels increased by 5.9%. This increase was due to the Ordinance on the sustainability criteria for biofuels and bioliquids which became effective in 2013 (see Table 10).

Table 10
Percentage of renewable energy in fuel consumption by transport for the 2008-2015 period (%)

Indicator	2008	2009	2010	2011	2012	2013	2014	2015
Percentage of renewable energy in fuel consumption by transport	0.9	1.0	1.4	0.8	0.6	6.0	5.0	6.5

Source: (NSI, Percentage of renewable energy in fuel consumption by transport, 2017).

Article 1 of the Ordinance on the Sustainability Criteria for Biofuels and Bioliquids sets the sustainability criteria for biofuels and bioliquids as well as the conditions and order for:

1. The process of collecting and providing information on behalf of economic agents, including the measures adopted to protect soil, land, water, air, etc.;

2. The conduction of a compliance audit of the use of biofuels and bioliquids in line with the sustainability criteria;

3. Issuing and withdrawing certificates of the compliance of raw materials, biofuels and bioliquids with the sustainability criteria as well as the contents of those certificates.

As a matter of fact, our country is still far from reaching the target of a 10-per-cent share of renewable energy in transport, but its increasing share in the consumption of transport fuel indicates that a similar target can be reached over a relatively short period of time. The need to switch to this type of energy is determined by the need to reduce the volume of CO_2 emissions, the demand for fossil fuels, gross domestic gas consumption, etc.

The energy consumption by the different modes of transport and the share of renewable energy in the consumption of transport fuels depend on the condition of the infrastructure and the rolling stock which are required for ensuring the performance of the different modes of transport.

In this respect, the estimates of the condition of Bulgaria's transport infrastructure, which are comparatively low for all modes of transport, there being a slight positive trend in the development of infrastructure for road, port and airport transport. The promptness of deliveries declined in the period from 2014 to 2016 and according to that indicator, Bulgaria currently ranks at the bottom among other EU countries, there being only one country with a lower score than Bulgaria. The TEN-T core network performance indicators are below the average for the EU for all modes of transport except for inland waterways for which the compliance with performance indicators was 100%.

The ratings of 'Quality of rail, road, airport and port infrastructure' are based on a survey of the World Economic Forum (Word Economic Forum, 2016), which employs a grading scale from 1 (extremely poorly developed) to 7 (extensive and effective). The EU value is calculated as the average for all Member States.

The current quality parameters of the railway infrastructure in Bulgaria are rated

at 3.05, the maximum possible grade being 7 and the average grade for the EU-28 being 4.30 points (see Fig. 3).

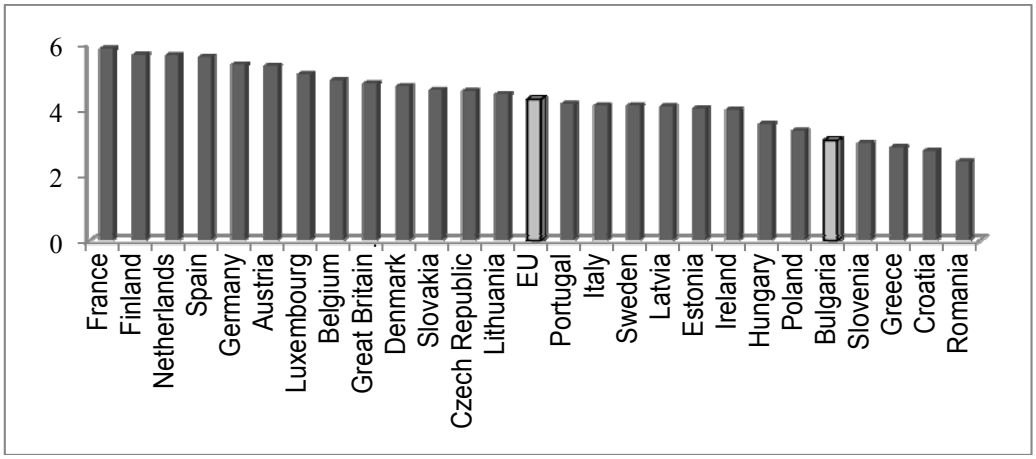

Figure 3. Ratings of the railway infrastructure quality of the EU countries for the period 2015 – 2016[1]

This indicates that the most environmentally-friendly mode of land transport has not been sufficiently developed in terms of modern railways and station facilities. Hence, customer satisfaction with the provided service has been declining as well. That, too, is the result of the state of the infrastructure as it relates to important quantity parameters such as speed, length of transportation time, length of route, etc.

Furthermore, the results obtained regarding the quality of the railway infrastructure are generally influenced by the obsolete conventional approach which is applied to the transportation of passengers and the lack of real prerequisites for introducing the exploitation of high-speed trains.

A comparison between Bulgaria and other former socialist countries such as Slovakia, the Czech Republic and Lithuania, indicates that the results reported by the other countries are higher than the average for the EU-28. Thus the Swedish model which Slovakia adopted resulted in dividing the national railway company into two independent companies. One of them, ZSR, is in charge of infrastructure management, and the second one, ZSSK, is responsible for transportation and commercial activity which are organised in three departments (DOP for passengers' transportation, DNO for freight transportation and DZKV for the rolling stock.

The process of restructuring the railroad transport in Bulgaria is in progress, too, in compliance with the changes introduced by the Railway Transport Act from 01.01.2012, according to which the Bulgarian National Railway Company (Natsionalna Kompaniya Balgarski Darzhavni Zheleznitsi – NK BDZ) was divided into (BDZ Holding Group, 2015, p. 11):

- The National Railway Infrastructure Company (Natsionalna Kompaniya

[1] Cyprus and Malta do not have railway infrastructure.

Zhelezopatna Infrastruktura – NK ZI), which inherited the assets and liabilities of the former Bulgarian National Railway Company (BDZ) as stated in its balance sheet from 30.11.2001, in section railway infrastructure.

- Bulgarian State Railways EAD (Balgarski Darzhavni Zheleznitsi – BDZ EAD), which inherited the assets and liabilities of the former Bulgarian National Railway Company (BDZ) as stated in its balance sheet from 30.11.2001, in the section railway transportation of passengers and freight. The Bulgarian state is the sole owner of the capital of BDZ EAD and the powers are exercised by the Minister of Transport, Information Technology and Communications.

In 2007, BDZ EAD was transformed and divided into the following three daughter companies that were established and registered:

- BDZ – Passenger transport EOOD.
- BDZ – Freight transport EOOD.
- BDZ – Rolling stock (Locomotives) EOOD.

The name of the company was changed from Bulgarian State Railways EAD to Holding Bulgarian State Railways with Decision-Making Record No.151/22.10.2011 of the Minister of Transport, Information Technology and Communications.

The adopted model of organization of Bulgarian railroad transport has definitely not achieved the results reported by other European countries which employ similar approaches to structural reforms.

Road transport has the highest relative share in the structure of ground transport in Bulgaria, yet, 'The quality of the product offered by the road network is unsatisfactory mainly due to the state of the road surface and the insufficiently developed network of motorways and roads with more than two lanes' (The Ministry of Transport, Information Technology and Communications, 2010, p. 23).

According to the World Economic Forum, in the period from 2015 to 2016, the national road network could not be rated as 'extensive or efficient', but rather as 'extremely underdeveloped', which has an impact on the performance of car transport because the efficiency of the use of the rolling stock of this mode of transport, its speed of movement, the productivity and cost of the goods transported, etc. depend on the state of the road and motorway network.

Fig. 4 clearly shows that Bulgaria ranks below the EU average by 1.40 points, and the only countries with lower ratings according to this indicator are Latvia, Malta and Romania. All the other countries in the former Eastern bloc reported higher results. This indicates that Bulgaria is lagging behind in terms of transport network quality parameters. This fact is strategically unfavourable as the country does not have a substantial resource base for fulfilling its production potential and this implies investing in transport infrastructure to stabilize the economy by encouraging passenger and freight traffic from and to Europe.

Reported results in terms of the quality of the national port infrastructure are unsatisfactory, too (see Fig. 5).

By this indicator, Bulgaria ranks 23rd with a total score of 4.01. In fact, our country is lagging behind all EU Member States with a sea border, which is logical given the weaknesses of the ports systematized in the Strategy for the Development of the

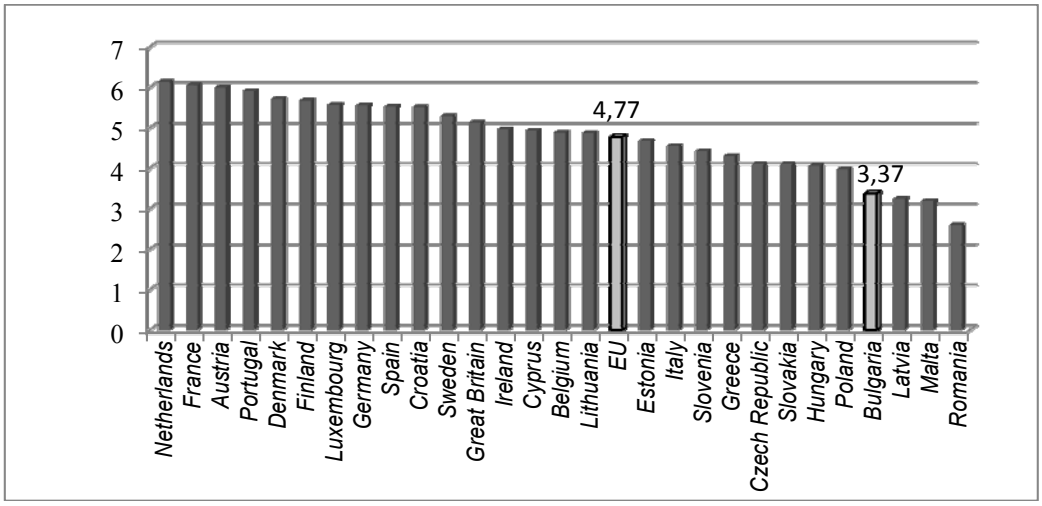

Figure 4. Ratings of the road infrastructure quality of the EU countries for the period 2015 – 2016

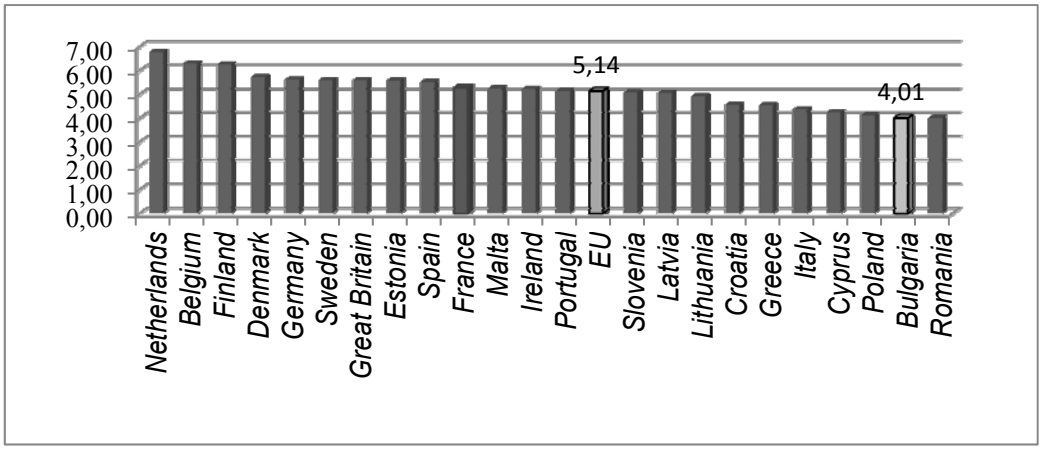

Figure 5. Ratings of the sea port infrastructure quality of the EU countries for the period 2015 – 2016.[2]

Transport System of the Republic of Bulgaria until 2020, namely: the insufficient specialization of the terminals; the unsatisfactory condition of the port facilities and the reloading equipment, which does not correspond to the current trends in the structure of the freight turnover; the insufficient depth of the aquatory and approaches to the ports; the outdated organization which does not meet the current market requirements; the limited opportunities for development of some of the terminals located in the central urban areas of the respective settlements; the shortage of modern logistic and information systems of the ports (Ministry of Transport, Information Technology and Communications, 2010, p. 23).

[2] The Czech Republic, Luxembourg, Hungary, Austria and Slovakia do not have sea ports.

From a strategic point of view Bulgarian airports were built at geographical locations which have the capacity to attract passengers and cargo. In terms of quality, however, the airports in Bulgaria for the period 2015 – 2016 received a rating of 4.14, which was the same for Croatia too (see Fig. 6). Romania and Slovakia were the only EU member states which were rated lower and that is sufficient evidence of the need to implement the development plans declared by Fraport Twin Star Airport Management AD as a concessionaire and operator at the international airports in Varna and Bourgas. It is imperative to analyse the condition of the airports in Sofia and Plovdiv and to take into account the current framework of the other airports and flight platforms in the country, which are currently facilities not ready for exploitation.

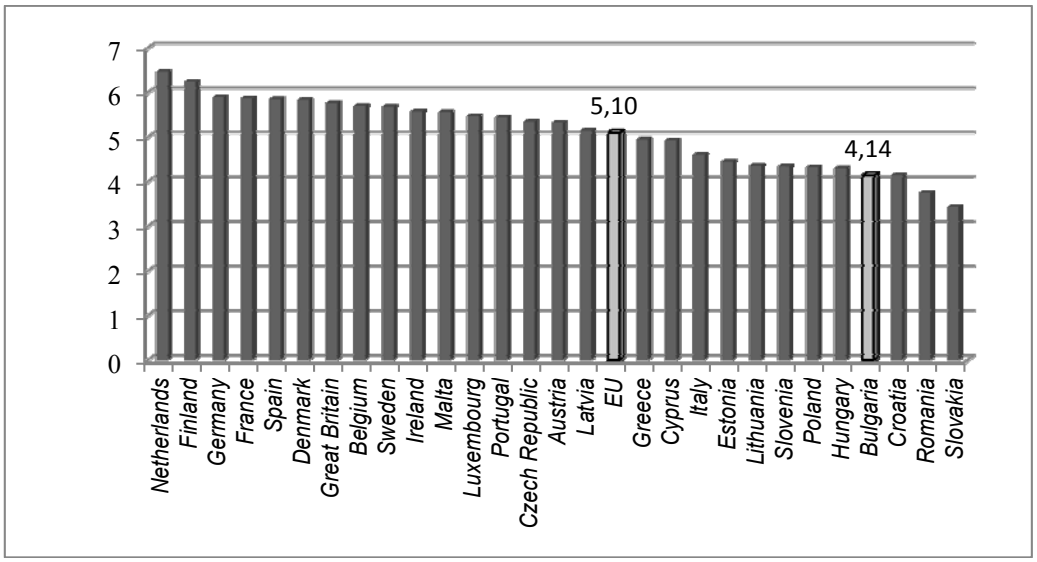

Figure 6. Ratings of the airport infrastructure quality of the EU countries for the period 2015 – 2016

Improving the quality of the overall transport infrastructure will allow the further development of the Trans-European Transport Network (TEN-T) corridors and will provide the opportunity for modernization through the introduction of state-of-the-art management and high technology.

The question why Bulgaria failed to acquire the transit flows between Europe and the Middle East, Asia and Russia, finds its answer in the state of transport infrastructure, which is rated as one of the EU-28 lowest in terms of its quality. The fact that Bulgarian roads, railways, ports and airports do not meet the European quality standards is indicative of the need for carrying out an appropriate state policy, which is to focus on those sites strategic for the economy. For this purpose, it is necessary in the medium term to concentrate investments in the transport sector to modernize the infrastructure, which will be able to record high returns in a future time horizon.

To this end, the European Union is targeting funds to support the development of the Bulgarian infrastructure from the Cohesion Fund (CF) and the European Regional

Table 11
Overview of the investment strategy of 'Transport and Transport Infrastructure 2014 – 2020' Operational Programme

Priority axis	Fund	Support by the Union (in euros)	Percentage of the general support by the Union for the Operational Programme	Thematic goal/ investment priority/specific goal
1	CF	572 343 631.00	35.67%	07 – Promoting sustainable transport and removing bottlenecks in key network infrastructures 7i – Providing support for multimodal Single European Transport Area by investing in the TEN-T 1 – Attracting passenger and freight traffic by improving the quality of railway infrastructure in line with the TEN-T
2	CF	572 343 630.00	35.67%	07 – Promoting sustainable transport and removing bottlenecks in key network infrastructures 7i – Providing support for multimodal Single European Transport Area by investing in the TEN-T 1 –Removing the 'bottlenecks' along the road TEN-T
3	ERDF	361 300 000.00	22.52%	04 –Supporting the shift to a low-carbon economy in all sectors 4e– Promoting low-carbon emission strategies in all types of territories, in particular in urban areas, incl. promoting sustainable multimodal urban mobility and adaptation measures related to climate change mitigation 1 – Increasing the use of the underground 07 – Promoting sustainable transport and removing bottlenecks in key network infrastructures 7a – Providing support for multimodal Single European Transport Area by investing in the TEN-T 1 – Increasing the use of intermodal transport

4	ERDF	57 944 591.00	3.61%	07 – Promoting sustainable transport and removing bottlenecks in key network infrastructures 7c – Developing and improving environmentally friendly, incl. low-noise and low-carbon transport systems, incl. inland waterways and maritime transport, ports, multimodal links and airport infrastructure in order to promote sustainable regional and local mobility 1 – Improving transport management through the introduction of innovative systems 7d – Developing and rehabilitating comprehensive, high-quality and interoperable railway systems and promoting noise-reduction measures 2 – Improving railway network management
5	ERDF	40517316.00	2.53%	1 – Ensuring the necessary conditions for the successful completion of OPT 2007-2013 and implementation of OPTTI 2014-2020, enhancing administrative capacity and public support

Source: (EU, European Regional Development Fund, Cohesion Fund, 2014, pp. 32-33).

Development Fund (ERDF). Table 11 summarizes the main investment priorities of 'Transport and Transport Infrastructure 2014-2020' Operational Programme.

The effects of targeted investments are expected to result in promoting sustainable transport and removing bottlenecks in key network structures by improving transport infrastructure and its integration into the TEN-T, the shift to a low-carbon economy in all sectors, etc.

The investment strategy of the 'Transport and Transport Infrastructure 2014-2020' Operational Programme is strongly focused on the development of all modes of transport in accordance with the principles of sustainability.

2. 2. Analysis of the indicators for the sustainable development of the transport sector, aiming at reducing the harmful effects of transport, enhancing safety and security and taking into account the environment conditions.

The comprehensive analysis of the transport system sustainable development implies the study of indicators measuring the harmful effects of transport on the environment, such as the emissions of harmful substances, particulate matter in the atmosphere released from vehicles, etc.

Fine particulate matter (PM_{10} and $PM_{2.5}$) and ozone (O_3) are the most

problematic pollutants in terms of human health, followed by benzo(a)pyrene (indicator of polycyclic aromatic hydrocarbons) and nitrogen dioxide (NO_2). The ozone (O_3), ammonia (NH_3) and nitrogen oxides (NOx) high concentrations affect the most the ecosystems and forests in high-mountainous areas (Executive Environment Agency, 2014).

Bulgarian legislation implements regulations which have adopted threshold limit values (TLV) for fine particulate matter concentration and TLV for harmful substances in the atmospheric air of settlements.

Such a document is Regulation No.12 of July 15, 2010 (prom. SG. 58 on July 30, 2010) which adopts TLV norms for fine particulate matter. The introduced TLVs aim to prevent their harmful effects on human health and the environment. The following TLVs for particulate matter are regulated:

PM_{10}:

- Average daily rate (ADR) – 50 mcg/m^3 (not to be exceeded more than 35 times a year);
- Average annual rate (AAR– 40 mcg/m^3).

$PM_{2.5}$: AAR + T – 30 mcg/m^3

Another document, Regulation № 14 (SG, 88/1997) (amend. SG, 46/1999) (amend. and suppl. SG, 8/2002) adopts norms for threshold limit values (TLV) of pollutants in the atmospheric air of settlements. The following TLVs of total suspended particulates are regulated:

- maximum single TLV– 0.5 mg/m^3;
- average daily TLV (for 24 hours) – 0.25 mg/m^3.
- average annual TLV (for one calendar year) – 0.15 mg/m^3.

Therefore, a legal framework has been developed in Bulgaria to regulate the TLV for fine particulate matter and harmful substances in the atmosphere, which affects the 'particulate matter emissions from vehicles' indicators (see Fig. 7).

The high degree of use of road transport, which is characterized by its adverse effect on the environmental parameters, requires, in a comparative manner, to trace the relative shares of the emissions of harmful substances estimated using a calculation method on the basis of the following indicators: fuels consumed, calorific value, quantity of produced output and input raw materials as well as emission factors applicable for the respective pollutants, released in the atmosphere of Bulgaria by road and other transport (see Table 12).

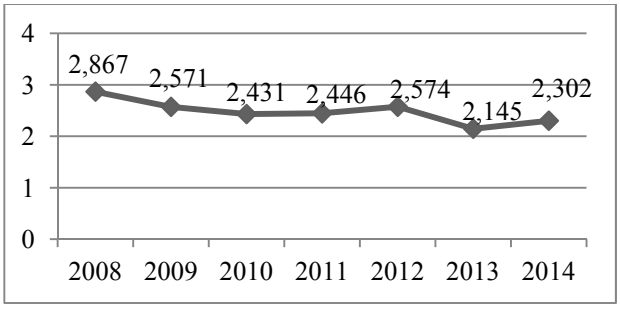

Figure7. (Eurostat, Emissions of particulate matter from vehicles, measured in tonnes

Source: (Eurostat, Particulate matter emissions from vehicles, 2017).

Table 12
Relative share of the emissions of pollutants in the atmosphere of Bulgaria from road transport (RT) and other transport (OT) for the period 2008 – 2015[3] (%)

Pollutants	2008	2009	2010	2011	2012	2013	2014	2015
Sulphur oxides (SOx) RT	71.131	74.851	55.805	47.734	49.327	43.575	44.811	21.329
Sulphur oxides (SOx) OT	28.869	25.149	44.195	52.266	50.673	56.425	55.189	78.671
Nitrogen oxides (NOx) RT	93.507	93.964	94.487	93.286	93.379	93.14	93.421	93.797
Nitrogen oxides (NOx) OT	6.493	6.036	5.513	6.714	6.621	6.86	6.579	6.203
Non-methane volatile organic compounds (NMVOC) RT	99.051	99.354	99.304	99.305	99.191	99.319	99.423	99.446
Non-methane volatile organic compounds (NMVOC) OT	0.949	0.646	0.696	0.695	0.809	0.681	0.577	0.554
Methane (CH_4) RT	99.563	99.736	99.733	99.726	99.652	99.744	99.815	99.724
Methane (CH_4) OT	0.437	0.264	0.267	0.274	0.348	0.256	0.185	0.276
Carbon monoxide (CO) RT	99.155	99.265	99.299	99.069	98.976	98.93	99.049	98.994
Carbon monoxide (CO) OT	0.845	0.735	0.701	0.931	1.024	1.07	0.951	1.006
Carbon dioxide (CO_2) RT	98.711	99.187	99.163	99.25	99.12	99.324	99.532	99.438
Carbon dioxide (CO_2) OT	1.289	0.813	0.837	0.75	0.88	0.676	0.468	0.562
Nitrous oxide (N_2O) RT	86.505	90.029	89.891	90.743	89.327	91.806	94.144	93.089
Nitrous oxide (N_2O) OT	13.495	9.971	10.109	9.257	10.673	8.194	5.856	6.911
Ammonia (NH_3) RT	100	100	100	100	100	100	100	100
Ammonia (NH_3) OT	0	0	0	0	0	0	0	0

Source: Author's own calculations based on NSI data.

The data in the table shows that over 90% of nitrogen oxides, non-methane volatile organic compounds, methane, carbon monoxide, carbon dioxide and ammonia are released from road transport and only in nitrous oxide there are years in which the levels are lower, but they also gravitate in the range of 86.505% (2008) and 94.144% (2014) and in the case of sulphur oxides there is a downward trend in road transport from 75.851% (2009) to 21.329% (2015) and an upward trend in the other modes of transport, respectively from 28.869% (2008) to 78.671% (2015).

The major threats posed to the climate, the environment and human health by the other modes of transport are mainly due to the air and water transport. They are expected to increase their greenhouse gas emissions and air pollutants such as carbon dioxide (CO_2), nitrogen oxides (NOx) and sulphur oxides (SOx) as well as noise pollution. Carbon dioxide emissions from both sectors currently account for 5% of global

[3] The emissions are calculated according to the latest edition of the CORINAIR methodology.

emissions, and according to a study by the European Parliament, air and maritime transport will be responsible for 22% and 17% of the global CO_2 emissions by 2050 (Policy Department, 2015).

Specifically, emissions of SOx in the exhaust gases of internal combustion engines result from oxidation of the sulphur contained in the fuel during the combustion process. Therefore, the amount of sulphur oxides in the gases depends entirely on the sulphur content of the fuel used. In this respect, the full penetration of petrol and diesel fuel with a maximum sulphur content of 10 mg/kg contributes to the reduction of SOx harmful emissions after 1 January 2009 in the EU, which is laid down in Directive 2003/17/EC of the European Parliament and of the Council of 3 March 2003 amending Directive 98/70/EC relating to the quality of petrol and diesel fuels (see Fig. 8).

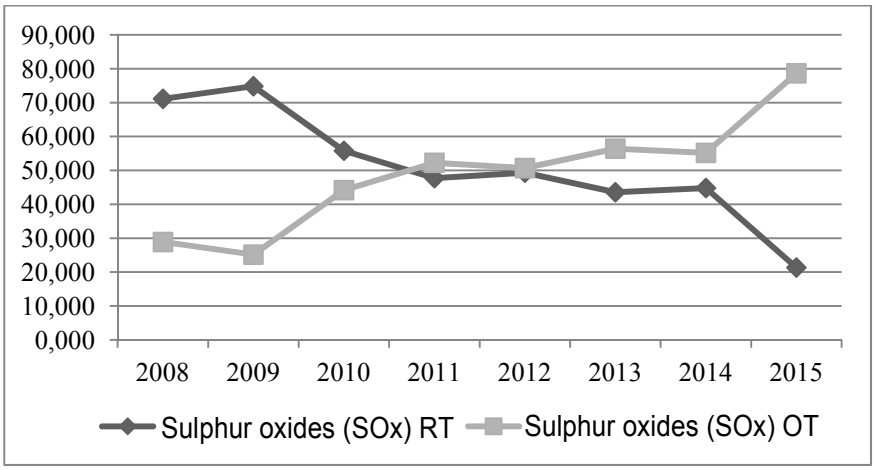

Figure 8. Dynamics in the relative share of SOx emissions in the atmosphere of Bulgaria from road transport (RT) and other transport (OT) for the period 2008–2015.

In the other modes of transport, measures have also been taken to reduce emissions, for example for maritime transport, the Parties to the International Maritime Organization (IMO) have agreed to a substantial revision of MARPOL Annex VI at the end of 2008 (COM/2011/0441 final). This revision recommends a gradual reduction of sulphur content in fuels used in all seas to 0.50% as of 2020 and up to 0.10% in SECA[4], as of January 2015.

With respect to carbon dioxide, Directive 2003/17/EC of the European Parliament and of the Council of 3 March 2003 amending Directive 98/70/EC introduced requirements on the quality of petrol and diesel fuels and reported the progress towards reaching the Community target of 120 g/km for average vehicle CO_2 emissions (see Fig. 9).

According to Eurostat data for Bulgaria, the average CO_2 emissions per km of new passenger cars in 2014 fell to 35.5 g/km, bringing the country closer to the

[4] Due to the specific contribution of shipping emissions to acidification problems in northern Europe, the IMO has defined the Baltic Sea, the North Sea and the Channel as SECA in the EU.

European average carbon dioxide emissions per kilometre of new passenger cars registered for the respective year.

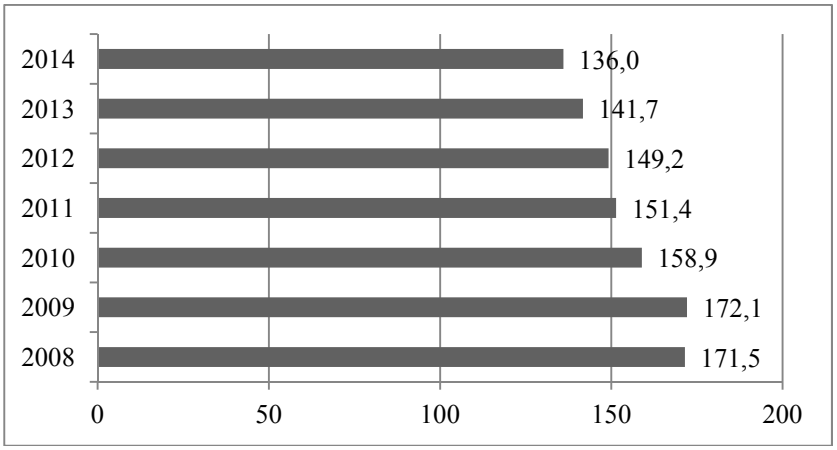

Figure 9. Average CO_2 emissions per km from new passenger cars for Bulgaria
Source: (Eurostat, Average carbon dioxide emissions per km from new passenger cars, 2017).

It should be noted, however, that this progress does not place the country in a favourable position, given the results of the other EU Member States, which reached 107.3 g/km (the Netherlands), 108.2 g/km (Greece) and 108.8 g/km (Portugal), etc. in the last reporting year, or on average in 2014 the value of the indicator for the EU is 124.7 g/km.

In this respect, Fig. 10 records the dynamics of the CO_2 emissions in the atmosphere of Bulgaria and the freight transported on land (RT) for the period 2008 – 2015. There is a decrease in the amount of carbon dioxide per unit of transported freight. The data shows that CO_2 per 1 tonne of transported freight from 0.118 t (2008) reached the levels of 0.103 t (2015) for the whole surveyed period, with the lowest values in 2013 being 0.086 tonnes of CO_2 per tonne of transported freight. At the same time, taking into account the fact that the average transportation distance increased by 167,933 km, estimated at the end of the period compared to 2008, this practically means that the CO_2 harmful emissions per 1 km distance decreased.

Electric cars and hybrid cars can contribute to the CO_2 emissions in the atmosphere, but as of 2016 the number of cars powered by petrol engines in Bulgaria is the greatest – 1,851,331. Diesel vehicles are 1,639,619, and the registered petrol cars equipped with gas systems are 63,617. The number of electric vehicles in Bulgaria is 217, while the diesel-electric hybrids are 58. The hybrids using a combination of a petrol engine and an electric motor are 1862.

Objectively, it can be claimed that the measures taken by the EU for limiting the harmful impact of transport activities within the Community have also affected the current picture of the state of harmful gas emissions within the boundaries of Bulgaria.

The last two leading indicators for sustainable transport development are not related to reducing the impact of transport on the environment but are no less important.

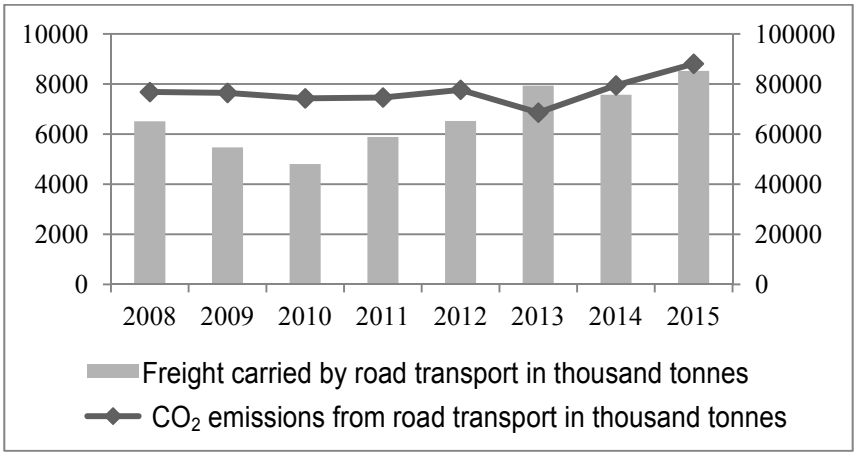

Figure 10. Dynamics in the CO_2 emissions in the atmosphere of Bulgaria and of the freight transported by road transport (RT) for the period 2008–2015.

One is the 'Security and Safety' indicator, measured in terms of the number of road accidents (RAs) of the indicators for achieving operational goals and the 'Number of deaths and injuries in road accidents' as an indicator of assessment.

The 'Road accident deaths' indicator measures road safety by showing the change in the number of fatal consequences in road accidents. It reflects the quality of road infrastructure, vehicle safety standards, the regulatory framework, the enforcement of laws as well as the behaviour of drivers.

During the period 2008 – 2016, the number of people killed in road traffic accidents in 2012 and 2013 was the lowest, but in the last two years of the surveyed period this indicator marked an increase, which was accompanied by an increase in the number of road accidents and of injured persons (see Table 13).

Table 13
Dynamics of traffic accidents, deaths and injuries for the period 2008 – 2016

Years	Traffic accidents	Deviations % compared to 2008	Number of deaths	Deviations % compared to 2008	Number of injured	Deviations % compared to 2008
2008	8045	~	1061	~	9952	~
2009	7068	-12.144	901	-15.080	8674	-12.842
2010	6610	-17.837	776	-26.861	8079	-18.820
2011	6640	-17.464	658	-37.983	8301	-16.590
2012	6717	-16.507	601	-43.355	8193	-17.675
2013	7012	-12.840	601	-43.355	8770	-11.877
2014	7020	-12.741	661	-37.700	8640	-13.183
2015	7226	-10.180	708	-33.270	8973	-9.837
2016	7404	-7.968	708	-33.270	9374	-5.808

Source: (Ministry of the Interior, 2017).

A number of factors problematic for the country have an impact on the number of the victims of road accidents. These are: old car fleet, poor road surface, insufficient road signalling in areas with increased concentration of traffic accidents and last but not least – drivers' behaviour on the road.

The last leading indicator of sustainable development is the so-called 'Environment Indicator', which is measured via the producer prices of transport services. The indices are calculated based on the data for the prices of representative services collected on a sample basis from enterprises classified in the respective economic activities weighted by the sales revenues of enterprises of the base year. Producer price indices are used as deflators in the national accounts system and in services they are defined as a price index that measures the average change in prices of manufactured and sold services by resident producers. The prices mainly observed are those of services intended to be used by businesses.

A detailed definition of the indicator is given in Regulation (EU) No 1503/2006.

The data in Table 14 shows quarterly data of services producer price indices for the last three years by modes of transport, and we note that for air and freight road transport the figures exceed those recorded in base year 2010, while for maritime transport the price levels are much lower.

Table 14
Services producer price indices by quarters for the period 2014 – 2016.

2010 = 100

Economic activeties	Quarters of 2014				Quarters of 2015				Quarters of 2016			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
Freight road transport	106.05	106.45	106.92	106.19	105.78	05.07	104.86	104.75	103.85	103.50	103.82	103.98
Maritime transport	63.44	63.07	60.28	60.54	62.55	66.10	68.39	68.02	65.82	64.72	65.07	66.91
Air transport	127.32	127.95	133.06	134.08	134.86	34.86	134.86	137.58	138.56	138.12	137.92	137.93
Storage of goods	103.44	102.41	102.09	102.54	102.57	02.57	102.67	102.67	102.67	102.67	103.04	103.07
Freight processing	107.38	107.38	107.38	107.45	107.23	08.30	108.48	108.48	111.07	110.43	110.47	110.47

Source: (NSI, Producer price indices, 2017).

Obviously, the competitive environment has an impact on the price-setting in the different segments of the transport sector. In a functioning market economy, such as the Bulgarian economy, demand and supply laws determine the price levels in each business sphere, including in transport. The large number of economic players operating on the freight road transport market charge high prices for their services, mainly due to the prices of fuels, which are the most dynamic value in transport pricing. This is one of the reasons for air traffic price indices in 2015 to be at levels higher by 38.56 percentage points compared to 2010. To a certain extent, it can be argued that higher price levels are a factor affecting the demand volume, i.e. to a certain extent the consumption of services provided by the two transport modes that are least environmentally-friendly is expected to be limited.

The economic analysis of the transport sustainable development indicators forms a common framework of the state of the transport system, within which some main problems are specified and need to be emphasized regarding the imbalance between the transport alternatives in freight and passenger transport, the low quality of transport infrastructure, the need to further stimulate the consumption of renewable energy, etc. Undoubtedly, there are changes in the sector after the Bulgaria's accession to the EU, which are in the right direction, but our country is still not comparable with most European countries.

3. Opportunities for Sustainable Development of the Transport Sector in Bulgaria

3.1. Opportunities for improving the quality of transport infrastructure in Bulgaria

Solving each of the infrastructure problems in line with the EU quality standards and requirements is a step towards the competitive positioning of Bulgaria on the European transport market. Transport is one of the mechanisms for the country to unlock its economic potential and to attract Europe's logistics flows by offering modern solutions, quality roads, railways, airports and ports integrated into an intermodal transport network. In this respect, it is necessary to adopt measures focusing on some major trends (see Fig. 11).

Roads play a key role in the national economy as they mediate the transfer of goods and services, creating the link between production and consumption and enabling businesses to reduce transport costs. The quantitative and qualitative characteristics of the national road network are extremely important for the economic growth because they help to decentralize investment and create jobs in smaller settlements. Therefore, the construction of roads is of strategic importance.

This issue is related to the quality of roads in Bulgaria, the average cost of the motorways completed in 2015 is 3.3 m Euros per kilometre, which includes construction costs but not the costs for expropriating real estates, planning, designing, building additional infrastructure, etc. On a comparative basis, the cost/kilometre ratio is relatively low, which affects the final product. In fact, the newly constructed roads do not meet

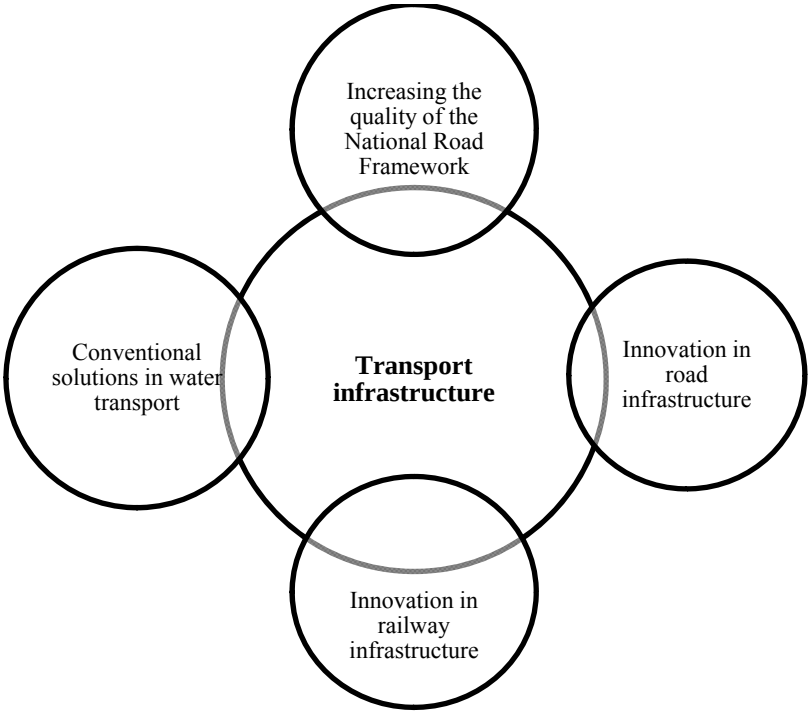

Figure 11. Opportunities for improving the quality of transport infrastructure in Bulgaria

the standards adopted in other European countries. In order to ensure the operational efficiency of the motorways, they should be between 55 and 85 cm thick, depending on the climate and the local soil, in order to create a strong bottoming to withstand the daily load. It is also important to apply engineering rules for the construction of motorways affecting the slope, the banking, the minimum radius, etc., in order to increase the speed of the vehicles. For this purpose, steep hills should be replaced with smooth slopes with a maximum incline of 4%.

Part of the funding of such projects can be provided by introducing an electronic toll system for vehicles of a 'free-flow' microwave technology which allows collecting tolls from moving cars. This free-flow system uses microwave antennas mounted on platforms above the motorway that communicate with the onboard units installed on the windscreen of the passing vehicles. The tolling process is fully automatic and does not require the driver's intervention. In this way, the actual costs associated with the construction and maintenance of roads will be taken into account and on this basis the tolls paid by the drivers of vehicles for the use of the road network will also be calculated.

Funds will be provided for the installation of cameras, sensors, electronic signs, communication points and computers that will monitor every aspect of the transport infrastructure. This will create conditions to regulate traffic, avoid congestion, prevent traffic accidents, etc.

The development of technology reveals a serious potential for the creation of a smart infrastructure as a tool for achieving a common goal aimed at the creation of a comfortable transport environment. In this transport environment there is continuous monitoring of the most important infrastructure sites – roads, bridges, tunnels, railways, underground, airports, seaports, communication systems, water supply and power supply aiming to provide optimal resource allocation and safety. The priorities of modern infrastructure are mainly focused on enhanced environmental sustainability, based on a more rational organization of work, use of new technologies to reduce the emission of harmful gases into the atmosphere, more efficient use of energy, protection of human life and health etc. Regardless of the objectives and tasks set, the smart infrastructure needs to have secure and safe cutting-age ICT, with integration interconnection between individual infrastructure sites on the basis of strict compliance with uniform standards and the availability of competent users. The operation of this smart infrastructure requires that new standards, infrastructure sites and ICT solutions be introduced so that the concept itself can be implemented.

In Bulgaria there are currently no conditions for building and exploiting high technology on a national scale, but steps can be taken by introducing innovations in rail transport to increase train speeds and raise customer service levels, which can be implemented through the digitization of railways. The use of information and communication technologies will, for example, provide passengers with real-time access via their smart devices to train location information, configuration of routes that offer the most efficient change points, potential opportunities to combine different transport alternatives, etc.

In road freight transport the so-called electric motorway or eHighway is new and currently abstract for the Bulgarian reality – a bold idea to adapt the existing technologies to power trucks from overhead contact lines when driving on the motorway. This technology does not restrict trucks to one lane only, it allows for overtaking manoeuvres by unhooking from the overhead lines after the driver has given a light signal and then returning to the position by lifting the pantograph back to the cables when the process ends.

A similar revolutionary project is the Wattway technology, which is a self-contained road surface built of several layers. The silicon cells of the photovoltaic panels are placed under a layer made of a variety of resin, and on the inner part are the connecting components. The total thickness of the solar road surface is only 7 millimetres, yet it is extremely durable and provides trouble-free car traffic.

At the same time, the safety of the vehicles is not jeopardized in the event of rain and snow. Thanks to its unique design, Wattway provides better traction than other road photovoltaic pavements and even endures the daily load of passing trucks.

Wattway is protected against moisture, high temperature amplitudes and dust. The silicone cells are fully sealed, and the inner components are protected according to the IP66 standard (high protection against dust and water jets).

Wattway power can be used to power traffic lights, road lighting, roadside outlets, petrol stations, anti-snow and frost heating systems, electric vehicle charging stations using the induction method, etc.

In addition to technology, there are a number of conventional solutions to make Bulgaria an important transport alternative for European partners by providing quick and easy access to the national territory by maintaining the navigable Danube river, increasing the depth of seaports, building a third bridge over the Danube between Bulgaria and Romania, etc.

There are several scenarios for the construction of a new bridge in the Bulgarian-Romanian section, some of which envisage its construction between the towns of Oryahovo and Becket, but the most suitable place chosen is the area of Silistra – Calarasi. The bridge will be a key investment to link the transport corridor from the Middle East through Turkey, the Lesovo-Hamzabeyli border crossing point, through Yambol, Shumen and Silistra – Calarasi to the so-called Northern European roads. In terms of parameters, the bridge is projected to be 20.50 meters above the navigable waters, combined with dual two-lane carriageways and a railway line.

In practice, each bridging structure over the Danube River is a factor for increasing traffic intensity across the country and is a prerequisite for cohesion between the separate transport modules, which will require a real exploitation of the intermodal centres (Yana railway station, Sofia, near the 'Poduyane'station, Dragoman), which will help to achieve the main goals of minimizing the total transport time, minimizing the total transport costs, co-minimizing the time and transport costs, improving the freight transportation from manufacturers to consumers, etc.

Taking into account the advantages of river transport, the maintenance of the Danube river requires the necessary attention, as it needs the construction of proper dredging facilities to help regulate the level in the critical sections of the Danube, such as the fairway near Svishtov and to provide hydrotechnical facilities for water re-routing, construction of thresholds and longitudinal underwater walls, etc., given the tendencies that river-sea transport in the near future will become one of the main directions for the development of inland navigation in the Single European Water Transport System and above all as far as the Danube is concerned (Simeonova, 2010).

The development of maritime transport requires an increase in the ship berths maximal depth of the main sea ports of Varna and Bourgas, which are currently 11.5 m and respectively 12.3 m maximum permissible draft, which is insufficient for many modern vessels to anchor. This is a necessary step given the competition of the Romanian port of Constanta with a draft depth of 14.5 m, which allows the processing of Post-Panamax vessels.

Other equally important options to look for their optimal realization are to link the national transport network more closely with those of the neighbouring countries, to build modern infrastructure points combining a road rail bridge with tunnel facilities, etc., as well as to develop the potential for applying global practices leading to sustainable transport development.

3.2. World practices which lead to the sustainable development of transport

World practices, leading to sustainable transport development, can be applied both at corporate and national levels for the different modes of transport (see Table 15).

Table 15
Localized problems and opportunities for applying best practices, leading to sustainable transport development

Localized problems	Best practices
At corporate level	
Priority use of freight road transport as a consequence of the limited volume of enterprises' economic activities.	Applying the model of industrial symbiosis.
At national level	
Air transport	
Increase in the emissions of greenhouse gases and air pollutants – such as carbon dioxide (CO_2), nitrous oxides (NOx) and sulphur oxide (SOx), as well as noise pollution.	Measuring indicators, reporting the impact of air transport and the adjacent infrastructure on the environment.
Railway transport	
Drop in the indicators of freight and passengers transported and work carried out by passenger railway transport.	Applicable best practices for improving the Bulgarian railway system based on the experience of foreign railways.
Road transport	
High levels of harmful emissions from: • Nitrous oxides (NOx). • Carbon dioxide (CO_2). High levels of consumed energy.	Encouraging the purchase and exploitation of hybrid and other less carbon-intensive technologies.
Other	
High operational activity of road transport.	Implementing combined transport solutions.

One such practice, which can be applied in the activities of the transport companies in Bulgaria, is the so-called industrial symbiosis, which takes the example of nature, where symbiosis means a mutually advantageous coexistence between two different organisms (Humphreys, 2013, November, pp. 32-34). In industry, this is the case when two completely different productions exchange their unused resources for the mutual benefit, usually financial and/or ecological. Links are formed between companies, resulting in the waste of an economic entity becoming material for the production or operation of another. In most cases, the raw material is paid, i.e. the business realizes non-envisaged sales and provides raw materials at much more favourable prices.

Industrial symbiosis implies three major opportunities for resource exchange:

- Reuse of production waste (secondary materials) – exchange of resources between two or more parties;

- Utilization/infrastructure sharing – joint use and management of commonly used resources, such as energy, water and sewage;

- Joint provision of services – covering the same needs in different companies related to service activities such as firefighting, transport and food provision.

For this purpose, an electronic platform is created through which various partners, producers, users can exchange information about their needs and establish a link that will lead to industrial symbiosis between them.

For transport operators in Bulgaria, such an opportunity is provided by the Black Sea Industrial Symbiosis Platform (BSISP), which maintains databases that enable companies in the region to connect with each other and collaborate, with online tools developed such as, for example, the carbon calculator and the trade optimization calculator.

The success of the model depends on the degree of co-ordination that needs to be carried out at national level, while regional teams of experts with practical experience work together, and the whole process is led by advisory groups in which companies are involved. In order for all stages to run smoothly, a legislative system is needed to facilitate the transfer of waste products between enterprises. At present, in Bulgaria companies go through a long procedure with a lot of documents in order to be able to carry out trade exchanges with a product considered waste.

At the same time, protection should also be given to companies providing information, which, ceteris paribus, is called trade secret. This implies signing a confidentiality agreement and guaranteeing the flow of information within the system, as well as providing it to potential partners after permission from the respective company.

At national level, the different modes of transport create prerequisites for the implementation of a number of best practices that are realized in the present and project the future development of the sector in compliance with the natural laws.

• In air transport, the sustainable idea is applied on the basis of a system of indicators used, reporting the impact of air transport and the adjacent infrastructure on the environment (see Table 16).

As for the biodiversity, the study of species and their number as well as the reasons for the birds staying on the territory of each airport and adjacent areas is one of the important events in this aspect. The studies are conducted according to generally accepted ornithological methodologies, which allow the creation of an up-to-date avifauna picture. The report aims to be used in optimizing current and planning future ways of limiting the presence of different bird species in airport areas. Worldwide, it is increasingly necessary to conduct long-term ornithological surveys to determine not only the qualitative and quantitative composition of aeroport avifauna but also to establish monthly and seasonal dependencies in the activity of certain species. Long-term studies can also be used as a control measure in assessing the efficiency of the methods applied for reducing the risk of bird strikes.

With regard to noise monitoring systems, each airport must have the most advanced solutions developed according to modern technology to record noise events. These systems measure via special terminal stations with a built-in microphone, configured on the basis of the air corridors location. Data obtained from the measurements should be updated every half second to one second. The system is required to store information in a database, calculate noise parameters, and record the indicators not only for planes landing and taking-off, but also for planes flying over the specific area.

Table 16
Indicators, reporting the impact of air transport and the adjacent infrastructure on the environment

Component and factor	Measure of monitoring and control	Periodicity
Waters	The quality of the discharged water from the site is determined on the basis of a six-month analysis of the household faecal waters and their subsequent purification; the following indicators are analysed: Active Reaction/pH – 8.5; undissolved substances /mg/l – 84; BOD_5 – mg/l O_2 - 160; Oxidation (permanganate) mg/l O_2 – 75.	On a six-month basis
Waste	The requirements laid down in the WMA and its regulations are fulfilled. 1. Internal rules are established defining separate waste collection, a system for hydraulic compression of household waste is introduced to reduce its volume, which is transmitted to a licensed operator for sorting to recover recyclable components. 2. Separate collection of recyclable waste is organized, and separate waste collection bins are provided for this purpose.	According to a predefined schedule
Biological diversity	Infrastructure development should be tailored to the landscape architecture close to the site as a system of all-natural components (rocks, soil, air, water, vegetation and animals) that changes over time under the influence of natural factors and human activity.	Annually
Noise	Noise impact control is based on measurements in accordance with the requirements of the national system for environmental noise monitoring and on the requirements for conducting own monitoring and providing information by industrial sources of environmental noise.	Constantly

The constant measuring of indicators by key water, waste, biodiversity and noise components is an important step to record the impact of air transport and adjacent infrastructure on the environment.

• In the railway transport of Bulgaria, the current situation is highly complicated and any activity on the part of the National Railway Infrastructure Company and Holding Bulgarian State Railways EAD would be to seek a balance in the transport sector of the country and hence a starting point to a sustainable development of the railway market segment in the country. Some of the best practices adopted by the two companies are summarized in Table 17.

Table 17
Applicable best practices for improving Bulgarian railway system based on the experience of foreign railways

№	BEST PRACTICE
1.	Establishing a new company for passenger rail transport, of mixed ownership with local authorities (municipalities) as a public limited company and issuing municipal bonds to cover past liabilities, which will lead to: - Financial stabilization; - Staff reduction.
2.	Establishing regional state and/or private rail passenger transport operators (operating only in certain regions and/or railway sections) and establishing joint ventures with municipalities/district governing bodies with joint management.
3.	Purchasing new rolling stock for the passenger railway transport with low electric energy consumption, funded by the European Union.
4.	Restructuring of the freight operator by reducing the freight rolling stock maintenance stations and the personnel.
5.	Developing a program for locomotive modernization and landfill improvements and looking for financial sources to implement it.
6.	Purchasing training devices/simulators to train engine drivers along with the purchase of new locomotives for passenger rail transport.
7.	Developing an IT strategy for Bulgarian Railways at all management levels in all companies.
8.	Establishing subsidiary companies for infrastructure repairs and maintenance of railways and implementing a software system for asset management and planning and infrastructure maintenance.
9.	Outsourcing of power system and contact network support.
10.	Establishing a Railway Fund to finance investments in railway infrastructure (the Polish model raises funds from the fuel tax).
11.	Concluding long-term maintenance contracts with companies that have installed new telecommunication and signalling equipment on the modernized lines.
12.	Establishing a separate telecommunications sub-division within the NK ZI, aimed at providing a wide range of high-quality telecommunication services for the needs of the railway infrastructure and its main activity, the railway operators, the business and the population bearing additional revenues: all kinds of voice services; secure and reliable transfer of large volumes of data over a wide range of guaranteed speeds; additional services; smart network services; IP virtual private networks.
13.	Stimulating the national production in the railway sector through concluding framework contracts between private Bulgarian manufacturers and railway companies.
14.	Developing and operating an integrated railway information and control system (including railway infrastructure and railway carriers).
15.	Establishing regional traffic management centres (in Austria they are 5).

16.	Implementing modern measuring equipment for the state of the infrastructure and systems, as well as for the state of the rolling stock and implementing a common information system for reporting, analysis and planning of the repair activities.
17.	Stimulating freight transport intermodality, and link to the ports and developing their infrastructure.
18.	Other.

Source: (Stoycheva, 2017).

The implementation of a set of wide-ranging measures to upgrade the material base and the organizational approach in the railway sector will lead to an improvement in the quality of the rail transport services offered, including the improvement in the quality and function of the rolling stock, and will contribute to achieving consistency between the volume of transport services offered and the market conditions, the behaviour of competitive modes of transport and the idea of sustainable development. Sustainability in rail transport will become a reality when there is return and support of heavy goods transport by improving the quality of services offered, increasing international rail transport (import-export-transit), developing combined transport (containers and block trains along national and international routes) and implementing projects and new technologies for combined transport, optimizing the wagon loads system, increasing the share of transport from sector trains through ports and border posts, etc.

• Best practices leading to the sustainable development of road transport are associated with carbon capture and storage, which can be realized by switching to hybrid and other low carbon technologies (Lackner, K. & J. Sachs, 2005, pp. 215-284). These cars are powered by petrol engines, but the electric propulsion helps them to consume less fuel reducing operating costs, harmful emissions and increased efficiency of the resources used. A typical feature of this type of cars is their low noise levels, but their price is higher than traditional car models. In practice, there are the so-called plug-in hybrid electric vehicles similar to the conventional hybrid electric vehicles, but they have a larger battery and charger that allows electricity from the grid to replace some of the energy propulsion with traditional fuels (Parks, K., Denholm, P. & Markel, T., 2007, p. 1). In these cars Parks, K., Denholm, P. & Markel find out significant reductions in net carbon dioxide (CO_2) emissions, nitrogen oxides (NOx) and sulphur oxides (SOx) emissions, and in the experimental scenarios assessed by them, their levels are equal to or less than those of conventional hybrid vehicles. Therefore, the state should stimulate the purchase and exploitation of these modern transport solutions by central and local authorities and by companies and citizens, through financial levers such as exemption or minimum levels of taxes, fees, etc., as well as non-financial incentives related to providing priority for parking in central city areas, service, free charging stations, etc.

A strong opportunity to implement the sustainable idea in transport is to further stimulate the consumption of energy from renewable sources, which must be subordinate to the common European policy for converting renewable energy into a major player on the European energy market. In particular, renewable energy technologies need to become cheaper, more competitive and, ultimately, market-

oriented (with support schemes being intended for less established technologies) and also to stimulate investment in renewable energies (by phasing out fossil fuel subsidies, a well-functioning carbon market, and the proper setting of energy charges). The reduction of emissions from the transport sector will be assisted by the shift to biofuels with no or limited indirect land use change impacts. The increased use of biofuels in air and heavy road transport (where electricity use is not considered possible) enhances the need to develop advanced biofuels (EC, 2012, p. 14).

Diversification in fuel consumption is an important step for the sustainable development of transport, but to this end, infrastructure, a legislative framework and incentives should be provided for the production and consumption of such energy sources, e.g. biofuels.

• Combined transport, which according to the Bulgarian legislation is freight transport, in which at least two transport modes are used in the transport chain, plays a major role in the saving of energy and the reduction of the harmful emissions in the atmosphere, freight is not processed when the mode of transport is changed, provided that a combined carriage contract is concluded and is organized and/or performed by operators (Ministry of Transport and Communications, 2003, February 10). One of the most common options is the eco-combination between road and rail transport. The most commonly used combined systems within the scope of these two transport alternatives are ISO containers, the Rollende Landstrasse system (RoLa), the transport of removable truck bodies on wagons, road-rail bimodal systems, rail transport of semi-trailer trucks and direct shipment of containers from one mode of transport to another.

The government financial instruments to support combined transport are:

• subsidies for the purchase of low-platforms wagons;

• partial support for enterprises to create systems and cars for combined transport, such as removable bodies;

• support for the modernization of the transfer mechanisms from one mode of transport to another and the reconstruction of the logistic terminals;

• support for the purchase of new equipment, especially for the processing of vehicles with removable bodies;

• subsidies for exploitation of RoIA lines, etc.

The cause of the transport sector sustainable development is further enhanced by a modern solution that deepens the integration processes and is associated with intermodal transport, which can, in fact, be seen as a “door-to-door mixed freight transport under the direction of an operator with common transport documents and the adoption of a uniform freight rate” (Rezer, 1994, p. 315). This transport option is in fact largely based on the compactness of the freight transport unit, which underlies modern transport technologies, as this feature generates the common information flows that invariably accompany the material, the reduction of the loading and unloading activities, the choice of the packaging, the rational use of the area of the means of transport, etc., and thus optimizes transport costs in the overall logistics, improves the financial performance and increases the economic efficiency of the transport process as a whole.

These are also some of the reasons why Bulgaria includes measures aimed at developing intermodal transport in the Integrated Transport Strategy for the period until 2030.

Table 18
Measures for achieving the strategic priority 3. 'Development of intermodal transport'

Building and developing intermodal terminals	Construction of intermodal terminals by NRIC, managed by intermodal operators. Use of public-private partnerships and their concession.
	Implementation of intermodal terminals projects to connect ports to the rail network.
	Development of logistics infrastructure.
	Establishing an appropriate normative basis for regulating the interaction between the different modes of transport and transport market participants.
	Specialization and/or completion of terminals in the direction of European transport corridors and construction of new terminals.
Improving the connectivity of the terminals with the national transport network – availability, parameters and infrastructure quality	Supporting the restoration of unsupervised and the construction of new industrial branches. Use of public-private partnership for this purpose.

Source: (Ministry of Transport, Information Technology and Communications, 2017, p. 251).

The government's activity in support of modern transport alternatives is the basis for the adequate integration of the national transport system into a common European system, conceptually based on the idea of 'sustainable, smart and inclusive growth'.

The opportunities for sustainable transport development for Bulgaria are a prerequisite for stabilizing the country, its actual European integration, preserving the Bulgarian nature, as well as finding positions that will actually attract investment, create jobs, expand markets, create added value for products, optimize logistics flows, etc.

Conclusion

Modern society demonstrates a strong commitment to environmental, health and people's life issues. In this context, transport is a sector with an active involvement in the economic and personal life of citizens and economic subjects of each country, and its intensive exploitation is a prerequisite for making prints of strategic importance over a long period of time. This requires looking for opportunities for sustainable development of any national transport system, which will lead to a positive cumulative effect on a global scale.

This paper reveals theoretically the essence of the transport system, discusses and builds upon the scientific opinions to arrive at the conclusion that transport system

includes within its scope all modes of transport for general and special use that can be combined in the process of operation and organization, in order to achieve economic, social and environmental effects. It outlines the advantages and disadvantages of individual transport alternatives for passenger transport and systematized the effects of measures aimed at improving passenger and freight transport as well as framework indicators for the sustainable development of freight and passenger transport.

The study for Bulgaria follows the logic of the Eurostat methodology for measuring the framework indicators for sustainable transport development aimed at achieving two main objectives related to 'ensuring high freight and passenger mobility' and 'reducing the harmful impacts of transport on the surroundings'. Accordingly, the key indicators are: energy consumption to GDP; security and safety and environmental indicator that are differentiated into indicators related to the achievement of operational objectives and assessment indicators.

On the basis of the conducted analyses some more relevant conclusions about the transport system of Bulgaria may be drawn:

1. The country's transport sector is considered to be unbalanced given the high relative share of the freight and passengers carried and the work performed by the road transport, which also records the highest relative share of energy consumption compared to the other modes of transport.

2. As of 2015, the country's transport sector stands out with the highest relative share in the final energy consumption structure by sectors in Bulgaria, and there is energy inefficiency in carrying out the transport sector activities, i.e. the growth in energy consumption in transport outpaces the GDP growth by constant prices but, on the other hand, there is an increase in the share of renewable energy in the fuel consumption of transport.

3. In the course of the analysis, it was found out that over 90% of nitrogen oxides, non-methane volatile organic compounds, methane, carbon monoxide, carbon dioxide and ammonia were released from road transport, and only the relative share of sulphur oxide emissions in the atmosphere of Bulgaria from road transport decreased during the 2008-2015 period.

4. In terms of the dynamics of road traffic accidents, deaths and injuries for the period 2008 – 2016 there is a decrease at the end of the period compared to the base year 2008 as a number of problems for the country have an impact on the number of the victims of road traffic accidents, such as: old car fleet, poor road surface, insufficient road signalling in areas with increased concentration of traffic accidents, and last but not least – the drivers' behaviour on the road.

5. The competitive environment of the Bulgarian transport market creates prerequisites for the functioning of a market mechanism which, to some extent, could be expected to reduce the consumption of services provided by the two transport alternatives that are least environmentally friendly – air and road transport.

Based on the empirical study carried out, some opportunities for sustainable development of the Bulgarian transport sector have been revealed, which are related to the improvement of the quality of the transport infrastructure in Bulgaria and, on the other hand, to the implementation of world practices leading to a sustainable development of transport. In this regard, a potential is localized related to the

construction and operation of quality roads, railways, airports and ports integrated in the intermodal transport network.

For their part, the different modes of transport create prerequisites for applying a variety of best practices that are applicable to the present, and plan the future in the development of the sector in a continuous relationship with observing the natural laws.

This paper is part of a series of theoretical and applied studies conceptually related to the problems of transport and its sustainable development.

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