Sustainable development indicators of selected European countries in the field of transport sector

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Abstract

Sustainable development is based on three pillars: economic pillar, environmental pillar and social pillar. EUROSTAT defined two important indicators of sustainable development which are related to transport sector. The first indicator is the share of collective transport modes in total passenger land transport. The indicator measures the share of collective transport modes (buses, coaches, trolley-buses and trains) in total inland passenger transport performance, expressed in passenger-kilometers. The second indicator is the share of rail and inland waterways activity in total freight transport. The indicator measures the share of rail and inland waterways in total inland freight transport, expressed in tonne-kilometers. The aim of the article is to analyse the development of these indicators between 2005 and 2015 in selected European countries and compare the states among themselves and with the average of 28 countries of European Union.
KEY WORDS: *sustainable development, sustainable development indicator, transport sector, EUROSTAT, European Union*

1. Introduction

Olawumi & Chan [1] stressed the importance of Brundtland Report for the World Commission on Environment and Development in 1992 where the term of "sustainable development" was introduced. The concept of sustainable development nowadays increasingly gained importance among organizations and their stakeholders around the world [2]. The concept of sustainable development encompasses three dimensions of welfare – economic, environmental and social – and involves complex synergies and trade-offs among them [3-6].

Stevens [3] differentiated six effects in relation to sustainable development areas, there are: effects of economic activity on the environment (e.g., resource use, pollutant discharges, waste); environmental services to the economy (e.g., natural resources, sink functions, contributions to economic efficiency and employment); environmental services to society (e.g., access to resources and amenities, contributions to health, living and working conditions); effects of social variables on the environment (e.g., demographic changes, consumption patterns, environmental education and information, institutional and legal frameworks); effects of social variables on the economy (e.g., labour force, population and household structure, education and training; consumption levels, institutional and legal frameworks); effects of economic activity on society (e.g., income levels, equity, employment).

Transport has significant economic, social and environmental impacts and represents a significant factor of sustainability [7]. Sustainable transport is characteristic by the fact that it does not represent any threat to public health or to ecosystems, but at the same time it provides for transport needs in such manner that competitiveness and regional development are supported [8].

It is worth to trace and evaluate the development in transport sustainability on the international, on the national and on the regional levels; sustainable transport indicators can be utilized for this [9, 10]. Calderon, Pronello and Goger [11] define sustainable transport indicators as variables by means of which it is possible to monitor target values in the area of sustainable transport; such indicators also represent an important tool for decision-making. According to Litman [7] they are variables selected and defined to measure progress towards an objective. Joumard and Gudmundsson [12] consider indicators to be statistical measures that give an indication of the sustainability of economic, environmental and social development.

The article analyses the development of two indicators (*the share of collective transport modes in total passenger land transport* and *the share of rail and inland waterways activity in total freight transport*) between 2005 and 2015 in selected European countries and compares the states among themselves and with the average of 28 countries of European Union.

2. Materials and methods

The United Nations Conference on Sustainable Development (Rio+20) resulted in a nonbinding document in which the governments of various countries declared their commitment to create a set of sustainable development goals [13]. These goals were integrated into the framework of the Millennium Development Goals after 2015 [14]. EUROSTAT [15, 16] defined seventeen groups of sustainable development indicators, there are: Group 1 – No poverty; Group 2 – Zero hunger; Group 3 – Good health and well-being; Group 4 – Quality education; Group 5 – Gender equality; Group 6 – Clean water and sanitation; Group 7 – Affordable and clean energy; Group 8 – Decent work and economic growth; Group 9 – Industry, innovation and infrastructure; Group 10 – Reduced inequalities; Group 11 – Sustainable cities and communities; Group 12 – Responsible consumption and production; Group 13 – Climate action; Group 14 – Life below water; Group 15 – Life on land; Group 16 – Peace, justice and strong institutions and Group 17 – Partnership for the goals. Each group of indicators consists of several sub-indicators that are focused on a particular area of sustainable development.

In this article attention is given to two selected indicators by means of which it is possible to monitor and to evaluate transport sustainability. These are the following indicators: *share of collective transport modes in total passenger land transport* and *share of rail and inland waterways activity in total freight transport*. Both indicators are put into a group of indicators characterizing sustainability of industry, innovation and infrastructure (Group 9). The characteristic of both of these indicators is stated in Table 1.

Table 1 Selected sustainable development indicators [15, 16]

Indicator	Description of indicator
Share of collective transport modes in total passenger land transport by vehicle	The indicator measures the share of collective transport modes in total inland passenger transport performance, expressed in passenger-kilometers (pkm). Collective transport modes refer to buses, including coaches and trolley-buses, and trains. Total inland transport includes transport by passenger cars, buses and coaches, and trains. All data should be based on movements within national territories, regardless of the nationality of the vehicle. The data collection methodology is voluntary and not fully harmonized at the EU level. Other collective transport modes, such as tram and metro systems, are also not included due to the lack of harmonized data.
Share of rail and inland waterways activity in total freight transport	The indicator measures the share of rail and inland waterways in total inland freight transport, expressed in tonne-kilometers. Inland transport includes transport by road, rail and inland waterways. Road transport is based on all movements of vehicles registered in the reporting country. Rail and inland waterways transport is generally based on movements on national territory, regardless of the nationality of the vehicle or vessel, but there are some variations in definitions from country to country. Neither sea nor air freight transport are currently represented in the indicator.

This article analyses the development of these indicators in selected European countries and compares these countries among themselves and also with the EU-28 average. The development of these two selected indicators is traced and evaluated for the period 2005-2015. The analysed data are taken from reports published by the statistical office of the European Union (EUROSTAT) [15, 16].

The standard deviation is used for the calculation of the amount of variation or dispersion of a set of data values. Standard deviation σ is usually defined as the square root of the variance $D(X)$ of a random variable X – (Equation 1); standard deviation σ can be also calculated using the mean value $E(X)$ or $E(X^2)$ – (Equation 2, 3) [17]:

$$\sigma = \sqrt{D(X)} \tag{1}$$

$$\sigma = \sqrt{[E(X^2) - (E(X))^2]} \tag{2}$$

$$\sigma = \sqrt{[1/n \,.\, \sum (x_i - (1/n \,.\, \sum x_i))^2]} \tag{3}$$

Average values of both analysed indicators I_{ij}, where i is the number of indicator and j is the number of country, are compared with the average values of 28 countries of European Union $\emptyset_{ij}$. Countries that meet the following condition (Equation 4) are best rated, because these countries have average indicators values higher than average values of 28 countries of European Union $\emptyset_{ij}$. Countries that meet the condition (Equation 5) have a middle rating, because

these countries have only one average indicator value higher than average values of 28 countries of European Union $\emptyset_{ij}$. Countries that meet the condition (Equation 6) have the worst rating, because these countries have average indicators values lower than average values of 28 countries of European Union $\emptyset_{ij}$.

$$I_{1j} > \emptyset_{I1j} \wedge I_{2j} > \emptyset_{I2j} \quad (4)$$

$$I_{1j} < \emptyset_{I1j} \wedge I_{2j} > \emptyset_{I2j} \vee I_{1j} > \emptyset_{I1j} \wedge I_{2j} < \emptyset_{I2j} \quad (5)$$

$$I_{1j} < \emptyset_{I1j} \wedge I_{2j} < \emptyset_{I2j} \quad (6)$$

In the following chapter there are summarized and discussed the results from presented research.

3. Results and discussion

The first analysed indicator is the *share of collective transport modes in total passenger land transport by vehicle*. The results are presented in Table 2.

Table 2 Values of indicator *share of collective transport modes in total passenger land transport by vehicle* (% of total inland passenger-km) [authors based on 15, 16]

State	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	σ
EU-28	16.70	16.80	16.90	17.30	16.40	16.60	16.70	17.20	17.00	16.90	16.90	0.246
Belgium	20.20	20.80	21.20	20.50	20.50	20.40	20.50	20.70	20.40	19.80	19.20	0.501
Bulgaria	29.10	27.40	26.20	24.80	20.50	20.00	19.40	17.90	16.90	17.70	16.80	4.305
CR	24.50	24.80	24.30	24.00	23.70	27.00	25.60	26.00	26.40	26.90	25.90	1.115
Denmark	20.90	20.90	20.50	20.20	20.00	20.40	20.10	20.00	20.10	19.90	19.20	0.457
Germany	14.20	14.40	14.30	14.40	14.00	14.00	14.10	14.60	14.20	14.30	14.40	0.177
Estonia	23.00	24.00	22.80	20.60	18.30	18.60	18.20	18.60	19.00	18.40	21.80	2.112
Ireland	17.90	17.70	17.60	17.70	17.80	17.40	17.50	17.20	16.80	20.20	19.70	0.990
Greece	21.70	20.80	20.10	19.20	18.10	18.40	18.40	18.40	18.70	18.60	18.50	1.122
Spain	18.00	17.20	19.00	19.80	18.70	17.70	19.10	19.30	19.70	17.30	18.60	0.873
France	14.30	14.70	15.10	15.80	14.60	14.60	14.70	14.90	14.80	14.90	15.20	0.377
Croatia	16.20	16.20	17.10	17.90	16.30	16.30	15.40	14.20	14.60	14.90	14.10	1.158
Italy	18.20	18.50	18.40	18.40	17.20	18.30	18.90	21.10	20.40	19.90	19.20	1.068
Cyprus	:	:	:	:	:	:	:	:	:	:	:	x
Latvia	23.80	21.10	18.50	19.50	18.50	19.80	21.70	21.00	20.60	19.00	17.70	1.675
Lithuania	10.20	9.10	9.00	8.80	7.70	8.30	9.10	8.00	8.60	11.80	10.80	1.183
Luxembourg	14.50	14.70	15.20	15.70	15.70	16.60	16.90	17.00	17.20	16.50	17.10	0.940
Hungary	35.80	34.40	32.50	32.50	30.90	31.50	31.70	32.40	32.50	32.50	31.80	1.318
Malta	:	:	:	:	:	:	:	:	:	:	:	x
Netherlands	11.80	12.30	12.50	12.80	12.70	13.10	13.50	13.80	14.00	14.50	13.80	0.787
Austria	20.70	20.70	21.10	21.70	21.10	21.60	21.70	22.20	22.50	22.40	22.20	0.625
Poland	30.60	30.00	29.30	28.10	25.30	23.90	23.40	23.20	22.00	21.80	21.50	3.324
Portugal	10.70	10.30	10.60	10.70	10.60	10.90	10.80	10.50	10.60	10.20	10.60	0.193
Romania	24.50	23.60	22.60	27.80	23.50	21.90	21.50	21.80	21.10	21.50	20.10	2.008
Slovenia	14.30	14.40	14.00	13.60	13.30	13.30	13.30	13.40	13.70	13.70	13.90	0.376
Slovakia	30.70	29.20	28.00	27.00	22.40	22.00	22.70	22.70	22.20	22.50	24.20	3.075
Finland	15.10	15.10	15.00	15.50	15.10	15.10	14.80	15.10	15.10	14.80	15.00	0.177
Sweden	14.40	14.90	15.10	15.70	15.80	16.00	16.10	16.40	16.60	16.50	16.80	0.730
UK	11.70	11.70	12.10	12.80	12.90	13.70	13.80	13.90	13.90	13.90	14.00	0.885
Iceland	:	:	:	:	:	:	:	:	:	:	:	x
Norway	11.60	11.50	11.30	11.50	11.40	11.70	11.50	10.20	10.30	10.30	10.60	0.569
Switzerland	21.60	22.10	22.50	22.30	22.50	22.70	22.70	22.30	24.30	24.30	24.80	0.999
FYRoM	20.80	19.60	22.20	24.70	24.40	25.40	25.10	22.70	20.00	16.00	16.90	3.109
Turkey	47.60	46.00	45.10	43.70	43.10	40.70	40.80	38.30	36.30	35.10	32.30	4.639
Maximum	47.60	46.00	45.10	43.70	43.10	40.70	40.80	38.30	36.30	35.10	32.30	4.639
Minimum	10.20	9.10	9.00	8.80	7.70	8.30	9.10	8.00	8.60	10.20	10.60	0.177
Median	19.20	19.05	18.75	19.35	18.20	18.35	18.65	18.50	18.85	18.05	18.10	x
Explanatory notes	σ (standard deviation), EU-28 (28 countries of European Union), CR (Czech Republic), FYRoM (Former Yugoslav Republic of Macedonia), UK (United Kingdom), : (not available), x (not calculated)											

The average value of the first indicator (*share of collective transport modes in total passenger land transport by vehicle*) of 28 countries of European Union increased by 0.2 percentage point in comparison years 2015 and 2005.

Turkey has the highest standard deviation (4.639) between 2005 and 2015. This means that there were the biggest fluctuations during the years 2005-2015 in the analysed indicator. On the other side, Germany (0.177) and Finland (0.177) have the lowest standard deviation values of the analysed indicator. This means that Finland and Germany have the most constant values. Turkey reached the highest indicator values in all analysed years (2005-2015). Lithuania reached the lowest indicator values between 2005 and 2013 and Portugal reached the lowest indicator values between 2014 and 2015. Switzerland achieved the greatest increase of indicator value between 2015 and 2005; it was a growth of 3.2 percentage points. Turkey achieved the largest decline of indicator value between 2015 and 2005; it was a decrease of 15.3 percentage points.

The second analysed indicator is the *share of rail and inland waterways activity in total freight transport*. The results are presented in Table 3.

Table 3 Values of indicator *share of rail and inland waterways activity in total freight transport* (% of total inland freight tonne-km) [authors based on 15, 16]

State	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	σ
EU-28	24.30	24.50	24.50	24.50	23.10	24.30	25.00	25.30	25.10	25.10	24.80	0.576
Belgium	26.10	27.20	27.20	27.30	23.20	26.60	27.00	27.80	26.90	27.00	27.80	1.210
Bulgaria	49.80	50.50	51.90	51.80	49.60	50.60	43.90	47.10	44.00	45.10	45.30	2.978
CR	31.60	32.00	32.50	32.20	30.60	30.20	30.20	30.60	28.40	28.30	26.50	1.791
Denmark	:	:	:	:	:	:	:	:	:	:	:	x
Germany	30.10	30.20	30.20	30.00	28.30	29.50	28.70	29.20	29.30	28.70	28.70	0.664
Estonia	:	:	:	:	:	:	:	:	:	:	:	x
Ireland	:	:	:	:	:	:	:	:	:	:	:	x
Greece	:	:	:	:	:	:	:	:	:	:	:	x
Spain	:	:	:	:	:	:	:	:	:	:	:	x
France	14.40	14.10	14.10	14.00	13.50	12.50	13.70	13.80	13.60	13.70	14.60	0.527
Croatia	26.10	27.60	28.80	28.60	28.40	31.00	28.80	29.50	27.00	27.30	27.20	1.296
Italy	10.00	11.30	11.90	11.30	9.20	9.30	11.30	12.80	11.90	13.20	13.50	1.393
Cyprus	:	:	:	:	:	:	:	:	:	:	:	x
Latvia	:	:	:	:	:	:	:	:	:	:	:	x
Lithuania	74.10	71.70	71.00	73.10	70.40	72.80	73.70	70.30	66.60	68.10	65.90	2.674
Luxembourg	28.10	30.20	31.50	22.90	19.60	24.50	21.60	16.00	17.80	14.50	14.70	5.806
Hungary	33.50	33.30	32.00	30.80	29.80	34.50	34.20	36.20	36.80	36.60	34.90	2.195
Malta	:	:	:	:	:	:	:	:	:	:	:	x
Netherlands	49.20	49.30	51.80	50.90	47.00	51.60	51.90	53.30	51.70	51.90	52.00	1.693
Austria	39.00	39.20	38.40	37.10	35.60	37.00	36.50	36.40	35.90	36.40	35.10	1.298
Poland	36.60	37.20	36.40	34.00	28.90	29.60	30.00	27.70	26.40	26.60	25.60	4.216
Portugal	:	:	:	:	:	:	:	:	:	:	:	x
Romania	48.40	47.50	46.50	48.60	47.60	63.10	62.80	60.60	59.70	59.20	62.00	6.837
Slovenia	:	:	:	:	:	:	:	:	:	:	:	x
Slovakia	47.50	49.20	46.70	45.10	40.40	44.10	42.70	41.20	43.60	42.90	39.80	2.848
Finland	25.40	29.60	28.10	27.40	26.00	27.00	27.90	29.00	30.50	31.10	27.40	1.699
Sweden	:	:	:	:	:	:	:	:	:	:	:	x
UK	11.40	11.40	10.80	11.30	11.80	11.00	11.80	11.70	12.90	13.00	10.50	0.746
Iceland	:	:	:	:	:	:	:	:	:	:	:	x
Norway	:	:	:	:	:	:	:	:	:	:	:	x
Switzerland	:	:	:	:	:	:	:	:	:	:	:	x
Maximum	74.10	71.70	71.00	73.10	70.40	72.80	73.70	70.30	66.60	68.10	65.90	6.837
Minimum	10.00	11.30	10.80	11.30	9.20	9.30	11.30	11.70	11.90	13.00	10.50	0.527
Median	31.60	32.00	32.00	30.80	28.90	30.20	30.00	29.50	29.30	28.70	27.80	x
Explanatory notes	σ (standard deviation), EU-28 (28 countries of European Union), CR (Czech Republic), UK (United Kingdom), : (not available), x (not calculated)											

The average value of the second indicator (*share of rail and inland waterways activity in total freight transport*) of 28 countries of European Union increased by 0.5 percentage point in comparison years 2015 and 2005. Romania has the highest standard deviation (6.837) between 2005 and 2015. This means that there were the biggest fluctuations during the years 2005-2015 in the analysed indicator. On the other side, France has the lowest standard deviation value (0.527) of the analysed indicator. This means that France has the most constant values of the indicator. Lithuania reached the highest indicator values in all analysed years (2005-2015). Italy and United Kingdom reached alternately the lowest indicator values between 2005 and 2015. Romania achieved the greatest increase of indicator value between 2015 and 2005; it was a growth of 13.6 percentage points. Luxembourg achieved the largest decline of indicator value between 2015 and 2005; it was a decrease of 13.4 percentage points.

The results of the assessment of both indicators are presented in the Figure 1 in accordance with the Equation 4-6. The best rated countries that meet the following condition (Equation 4) are: Hungary, Slovakia, the Czech Republic, Poland, Belgium, Romania, Bulgaria and Austria. All these countries have made greater average values than the average values of 28 countries of European Union in both analysed indicators. The worst rated countries that meet the following condition (Equation 6) are France, United Kingdom and Luxembourg. These countries have made lower average values than the average values of 28 countries of European Union in both analysed indicators. Other countries have a middle rating in accordance with Equation 5, because these countries have only one average indicator value higher than average values of 28 countries of European Union.

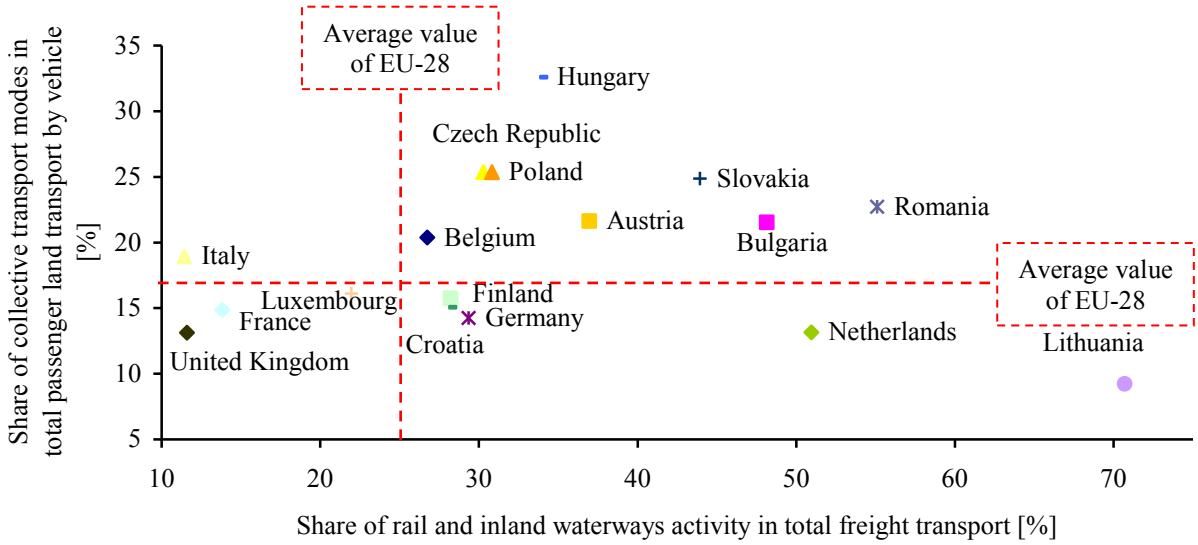

Fig. 1 Comparison of average indicators values [authors]

4. Conclusions

The issue of sustainable development is a very current topic because many subjects are involved in this area. EUROSTAT had defined seventeen groups of sustainable development indicators, but this article focused only on a group of selected indicators in the transport sector; those were: *the share of collective transport modes in total passenger land transport* and *the share of rail and inland waterways activity in total freight transport*. These indicators are closely related to the issue of sustainable transport.

Both indicators' values were analysed between 2005 and 2015 in selected European countries. Both the development of the value of these indicators and the development of the average of the indicators' values for EU-28 were evaluated. Based on this analysis the Visegrad Group countries (V4), Belgium, Austria, Bulgaria and Romania were the best countries in this rating; all of these countries reached greater values than the average value of EU-28 countries in both of the analysed indicators. The average values of both indicators of EU-28 countries between year 2015 and year 2005 had a positive trend. The average value of the first indicator (*the share of collective transport modes in total passenger land transport*) increased by 0.2 percentage point in comparison with years 2015 and 2005. The average value of the second indicator (*the share of rail and inland waterways activity in total freight transport*) increased by 0.5 percentage point in comparison with years 2015 and 2005.

The values of both indicators are affected by the quality of transport infrastructure and transport means, by macroeconomic situation, mobility requirements, by political environment and by legislative bodies and other specific factors in each country. For the future, it would be advisable to increase the indicator values. That would be in agreement with the principles of sustainable development and sustainable transport.

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