SUSTAINABLE TRANSPORT INDICATORS

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Summary:This article is focused on sustainable transport issues. In sustainable transport there still exist adequation gap between observed phenomena and indicators used in practice. The objective of this contribution is to provide an overview of indicators that are monitored on international level by significant international organizations, and they are also monitored on the national level. In the final section of this contribution the obtained findings are evaluated and an impulse for further research is submitted.

Key words: sustainable transport, indicators, transport policy.

INTRODUCTION

Sustainable transport is closely interlinked with sustainable development issue. It is a complex and multi-layered subject. It is also understood and defined in various ways.

Schipper (1996, cited in Youssef and Tarshan, 2010) states that sustainable transport is the transport whose users pay full social costs including costs that would be otherwise paid for by future generations. In a similar way it is possible to understand sustainable transport as an ability to meet the primary mobility needs of persons or goods without giving up important human or ecology values, both today and in the future (European Commission, 2004; WHO 2004).

From a different point of view – concentrating on the social pillar of sustainability – it is possible to define sustainable transport as a price affordable approach both to personal and to cargo transport, transport that is fair and friendly to the environment (Bell, Delaney and Lewis, 1997, cited in the Committee for the Conference on Integrating Sustainability into Surface Transport Planning, 2004).

1. REVIEW OF LITERATURE

With regard to the multi-dimensional understanding of sustainable transport that includes a number of complex relations and inputs it seems to be suitable to concentrate gross primary data (Čiegis, Ramanauskiene and Startiene, 2009) and to utilize indicators for decision-making processes in public administration both on the international and the national levels and also in and for communication processes between decision makers and target groups.

Sustainable transport indicators are currently the unification element in strategy and tactical planning in transport policy (Gilbert et al., 2002) and they have their importance both on the national and the regional levels (Santos, Ribeiro, 2015). From the point of view of

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planning and decision-making it is essential to work with such indicators that, according to Tuominen, Leonardi and Rizet (2008), correspond to the defined purpose, are suitable for decision making in transport and allow, in the decision-making processes, to take into consideration economic, social and environmental impacts (Mikulski, 2012) and to be pro-active (Macario, 2005, cited in Macário and Viegas, 2007).

Calderon, Pronello a Goger (2009) define sustainable transport indicators as quantifiable variable variables symbolising the environment or transport planning, variables that make possible the monitoring of the target value and make possible to execute its prediction.

The creation of the above-mentioned indicators is in many cases based on practical experience and it is not based, according to Perrels, Himanen and Lee-Gosselin (2008), on explicit sustainable transport vision. Scientific knowledge is often ignored and indicators are defined based on political objectives (Sager a Ravlum, 2005; Eliasson and Lundberg, 2012).

In comparison with general definitions of sustainable development indicators sustainable transport indicators are more focused on objectives, plans or policies for achieving sustainable transport and they represent a decision-making supporting tool. Klooz and Schneider (2000) recommend using, with the exception of the decision-making fields, indicators as a tool for coordination of policies, for increasing the awareness of sustainable transport and as a tool for general public involvement.

When creating sustainable transport indicators it is essential, according to Joumard and Gudmundsson (2010), to see the usability of such indicators as the fundamental characteristic – they should adequately generalize the represented phenomenon and they should be easily useable also in relations with all relevant target groups, primarily with the general public.

On the theoretical level Gilbert et al. (2002), Black (2003) or Litman (2016) deal with the creation of sustainable transport indicators.

The focus of interest has shifted with time from a general focus on sustainable transport to more partial topics. This is the reason why in other publications authors focus on sustainable personal transport and indicators related to this type of transport. Litman (1999), Hart (2006) or Holden, Linnerud and Banister (2013) deal with this topic.

The objective of this contribution is to create lists of sustainable transport indicators that are recommended by international organizations and at the same time used in the Czech Republic conditions.

2. METHODS AND DATA

The research has been executed with the utilization of three basic methods. These methods are - the logical construction method, the monographic method and the document analysis method.

In practice a number of international organizations deal with the development of sustainable transport indicators on a world-wild scale. In Europe the major player is the European Union.

In the Czech Republic sustainable development and sustainable transport policies are in accord with the European Union initiatives. Sustainable development indicators are included in the Strategic Framework for Sustainable Development in the Czech Republic that was approved by the Czech Republic government ruling no. 37 from November 1, 2010. This Framework is the umbrella document for political decisions resulting from the Czech Republic‘s membership in the European Union or in the UN. The Framework, which is currently being updated, includes the specification of sustainable development indicators. It is focused on five priority axes: Society, people and health; Economy and innovation; Spatial development; Landscape, ecosystems and biodiversity; A stable and secure society. In Priority Axis 2 one of the monitored indicators is „Transport intensity in transport”. The monitoring of this indicator allows evaluating if there is any separation of the GDP development and transport performance. In Priority Axis 3 there is indicator “Passenger transport by public road and rail transport”. The monitoring of this indicator has a major significance for evaluation of transport services (The Ministry of Regional Development of the Czech Republic, 2010).

The current version of The Strategic Framework for Sustainable Development in the Czech Republic is approached as an above state departments document with impacts to all departments, and it focuses, as well as the Sustainable Development Strategy, on transport outputs while at the same time it takes no notice of transport infrastructure development issues.

The transport policy of the Czech Republic exclusively concentrates on the transport area. Indicators that are monitored under this policy have been subjected to changes in recent years.

3. RESULTS

Available information sources make it possible to compile a summary of areas that are primarily monitored and evaluated with the use of indicators. A short summary of sustainable transport indicators is presented in Table 1. (Background colouring indicates the inclusion of the monitored area in the indicator set.). The Table is based on main international and European initiatives – it summarizes information from the Organisation for Economic Co-operation and Development (OECD), The United Nations organization (UN), The World Bank Group (WBG), the European Union (EU) and The European Environment Agency (EEA).

Table 1 - Sustainable transport indicators

Topic	Indicators	Organisation				
		OECD	UN	WBG	EU (SDIs)	EU (EEA)
Freight transport	Rail freight transport	■	■	■		■
	Road freight transport	■	■			■
	Inland waterway freight transport	■	■			■
	Pipeline transport	■				■
	Coastal freight transport	■				
	Rail container transport	■				
	Marine container transport	■	■			
	Number of trucks		■			■
	The number of take-off in air transport			■		
	Air freight transport			■		
	Modal split of freight transport				■	
	Volume of freight transport relative to GDP				■	
	The average annual price index of transport				■	■
Passenger transport	Rail passenger transport	■	■	■		
	Private car transport	■				
	Bus line transport	■				
	Road passenger transport	■	■			
	Land passenger transport	■				■
	Number of cars		■			■
	The number of take-off in air transport			■		
	The number of passengers in air transport			■		
	Modal split of passenger transport				■	
	Volume of passenger transport relative to GDP				■	
Negative externalities	Traffic accidents in road transport, resulting in injuries	■	■			
	Traffic accidents in road transport causing death	■	■		■	
	Carbon dioxide emissions from transport		■	■	■	■
	Nitrogen oxide emissions from transport				■	
	Emissions of ozone precursors and particulate emissions				■	
	Greenhouse gas emissions from transport by transport modes				■	■
	Energy intensity according to transport modes				■	■
	Exposure to traffic noise					■
Investment	Expenditure on maintenance of transport infrastructure	■				
	Investment into transport infrastructure	■		■		■
Infrastructure	The total length of railways in kilometers			■		

Source: Author using OECD (2015); United Nations Economic Commission for Europe (2016); The World Bank (2016); Eurostat (2016); EEA (2016)

From the international overview it is obvious that indicators primarily deal with the following issues: demand for transport and co-modality principle, modal split in personal transport and related personal vehicle transport issues, negative externalities (emissions and traffic accidents) and transport infrastructure investments. From the European Union' s point of view these areas are in accord with the Transport Strategy 2050 and with the White Paper Road to a Single European Transport Area - towards a competitive and resource efficient transport system (European Commission, 2011b). This White Paper is the fundamental strategic document of the European Union and it defines requirements and objectives for sustainable development in transport.

And this is the reason why The Transport Policy of the Czech Republic for 2014-2020 with forecast up to 2050 (Ministry of Transport of the Czech Republic, 2012) has as its main objectives the shift from monitoring equal conditions as stated in the previous document towards harmonization of conditions. Further this new transport policy focuses on strengthening the railway and water transport under the modal split, on safety issues and on transport development in regions.

Until year 2013 the Transport Policy for the Czech Republic 2005-2013 was in effect (Ministry of Transport of the Czech Republic, 2005). The Transport Policy of the Czech Republic for 2014-2020 with forecast up to 2050 (Ministry of Transport of the Czech Republic, 2012) has replaced the above mentioned policy.

Identical or similar indicators can be found in both policies (they are presented in the summary Table 2). Both policies however contain also indicators that are not mutually consistent.

Table 2 - Comparison of indicators of transport policies of the Czech Republic

Indicators of Transport Policy for the Czech Republic 2005-2013	Indicators of The Transport Policy of the Czech Republic for 2014-2020 with forecast up to 2050
Number of public logistics centers	Number of public multimodal terminals satisfying the AGTC parameters, connected to regular lines of continental multimodal transport
Number of km of roads with distancebased charging	Number of km of roads with distancebased charging
CO2 emissions from transport	CO2 emissions from transport, in thous. tons
Share of population exposed to excess noise from transport	Share of population exposed to excess noise from transport
Equipment roads telematic systems to help solve the problem of congestion	Number of km of road and motorway network equipped with dynamic traffic control
The number of passengers using public transport	Share of public passenger transport in total passenger transport performance, in %
Traffic performance of public transport in person-km	Performance of public passenger transport, in millions of person-km

Indicators of Transport Policy for the Czech Republic 2005-2013	Indicators of The Transport Policy of the Czech Republic for 2014-2020 with forecast up to 2050
Share of the volume of public transport to private car transport in Prague, Brno, Ostrava and Plzen	Share of the volume of public transport to private car transport in cities over 100 thousand inhabitants
Share of traffic performance of rail transport operated under the public service on the basis of tenders	Percentage of the volume of railway passenger transport operated on the basis of tenders or in open market mode
The volume of the rail transport in the total volume of freight transport	Share of the volume of the rail and waterborne transport in the total volume of freight transport over 300 km
The volume of the waterborne transport in the total volume of freight transport	
The volume of the combined transport in the total volume of freight transport	Performance of combined transport (thousand ton-km)
Percentage of GDP used for maintenance of the road infrastructure	Increase of funds for maintenance of the transport infrastructure
	Increase of funds for repairs and maintenance of the road infrastructure, in CZK mill.
	Increase of funds for repairs and maintenance of the railway infrastructure, in CZK mill.
The ratio of completed railway corridors and the length of motorways and expressways	Number of completed projects (km) of the core TEN-T road network, in %
	Number of completed projects (km) of the core TEN-T railway network for freight transport
	Number of completed projects (km) of the core TEN-T railway network for passenger transport
Amount in CZK from public budgets to pay for services in the public interest calculated per 1,000 passenger kilometers in public bus transport	Number of person-km per one Crown spent from public budgets in line bus transport in public interest
Amount in CZK from public budgets to pay for services in the public interest calculated per 1,000 passenger-kilometers in rail transport	Number of person-km per one Crown spent from public budgets in the railway transport
Amount in CZK from public budgets to pay for services in the public interest calculated per 1,000 passenger kilometers in public transport	Number of person-km per one Crown spent from public budgets in public transport
Use of the Cohesion Fund and the European Regional Development Fund to finance the transport infrastructure	Use of the Cohesion Fund and the national envelope of “cohesion” CEF to finance the transport infrastructure
Use of private capital to finance the transport infrastructure	Use of private capital to finance the transport infrastructure – number of projects
Development of accident rate (number of fatalities, seriously wounded)	Development of accident rate (number of fatalities, seriously wounded)

Source: Author using Ministry of Transport of the Czech Republic (2005); Ministry of Transport of the Czech Republic (2012)

Next to the indicators presented in Table 2 also other indicators were monitored under the Transport Policy for the Czech Republic 2005-2013. Those indicators were focused on the overall situation (e.g. expenditures for research and development), on negative externalities (noise, emissions and traffic accidents), on public transport and its accessibility (barrier free access) and also on infrastructure (Ministry of Transport of the Czech Republic, 2005).

Indicators mentioned exclusively in The Transport Policy of the Czech Republic for 2014-2020 with forecast up to 2050 (Ministry of Transport of the Czech Republic, 2012) document focus on transport network modernization on mobility and on negative externalities (Ministry of Transport of the Czech Republic, 2012).

DISCUSSION

When executing the analysis it has come to light that the researched into indicators are in many cases defined in a very general manner. In the same manner indicators' connection to defined objectives is mostly very general. The reason for that is, very often, political accent in the process of adopting external indicators (Hindls et al., 2006). In the process of creation of these indicators any duplicities are not taken seriously and treated with due care, and some indicators get more emphasis than other indicators (currently indicators monitoring greenhouse gases emissions are much more frequent than any other indicators). The creation and the selection of indicators are very dramatically limited by available data. This limitation is translated into difficult quantification of environmental and social indicators.

CONCLUSIONS

There exist a lot of recommendations on how to create indicators and indicator sets related to sustainable development issues. A number of international organization deal with the creation of indicators. In the Czech Republic indicators are also subject of a lot of policies. The objective of such indicators is to map sustainable development issues and at the same time to fill in existing gaps in monitoring of demographic, socio-economic, economic and environmental indicators.

Sustainable development indicators sets stress sustainable transport as one of the important elements of sustainable development. Significant international organizations deal with sustainable transport indicators sets creation, this effort is also realized on the Czech Republic level. The importance of sustainable transport indicators on the national level is even more significant since they are used for evaluation purposes in the European Union Operational Programs. Despite that research findings and practice are not dealt with sufficiently and in a coordinated manner in the Czech Republic. This situation thus opens space for further research into this area both on the territory management level and on the individual self-governing bodies level.

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REFERENCES

(1) BLACK, William Richard, 2003. *Transport: A geographical analysis*. New York: Guilford Press. ISBN 15-723-0848-6.

(2) CALDERON, E. J., C. PRONELLO a T. GOGER, 2009. *Integrated assessment of environmental impact of traffic and transport infrastructure*. Madrid: Servicio de Publicaciones ETS Ingenieros de Caminos, Canales y Puertos, Universidad Politécnica de Madrid. ISBN 978-847-4934-014.

(3) ČIEGIS, Remigijus, Jolita RAMANAUSKIENE a Grazina STARTIENE, 2009. Theoretical Reasoning of the Use of Indicators and Indices for Sustainable Development Assessment. *Inzinerine Ekonomika-Engineering Economics*. (3), 33-40. ISSN 1392 – 2785.

(4) COMMITTEE FOR THE CONFERENCE ON INTEGRATING SUSTAINABILITY INTO SURFACE TRANSPORT PLANNING, 2004. *Integrating sustainability into the transport planning process*. Washington: Transport Research Board. ISBN 978-030-9094-184.

(5) EEA, 2016. EEA indicators. *Evropská komise* [online]. Copenhagen: The European Environment Agency [cit. 2016-09-12]. Available from: http://www.eea.europa.eu/data-and-maps/indicators/about

(6) ELIASSON, Jonas a Mattias LUNDBERG, 2012. Do Cost–Benefit Analyses Influence Transport Investment Decisions? Experiences from the Swedish Transport Investment Plan 2010–21.*Transport reviews*. **32**(1), 29-48. DOI: 10.1080/01441647.2011.582541. ISSN 1464-5327.

(7) EUROPEAN COMMISSION, 2011a. Bílá kniha: Plán jednotného evropského dopravního prostoru – vytvoření konkurenceschopného dopravního systému účinně využívajícího zdroje. *EUR-Lex: Přístup k právu Evropské unie* [online]. Brusel: European Commission [cit. 2016-08-14]. Available from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0144:FIN:CS:PDF

(8) EUROPEAN COMMISSION, 2011b. Doprava 2050: Komise předkládá ambiciózní plán na zvýšení mobility a snížení emisí. *Evropská komise* [online]. Brusel: European Commission [cit. 2016-09-08]. Available from: http://europa.eu/rapid/press-release_IP-11-372_cs.htm

(9) EUROSTAT, 2016. Sustainable development - transport. *Evropská komise* [online]. Lucemburk: Eurostat [cit. 2016-07-14]. Available from: http://ec.europa.eu/eurostat/statistics-explained/index.php/Sustainable_development_-_transport

(10) EVROPSKÁ KOMISE, 2004. The EU Sustainable Development Strategy: A framework for indicators. *United Nations* [online]. Stockholm: Agriculture, fisheries, Structural Funds and environment statistics [cit. 2016-06-14]. Available from: http://www.un.org/esa/sustdev/natlinfo/indicators/egmIndicators/crp4.pdf

(11) GILBERT, Richard et al., 2002. Sustainable Transport Performance Indicators. *Lousiana Transport Research Center* [online]. Baton Rouge: TRB, [cit. 2016-06-19]. Available from: http://www.ltrc.lsu.edu/TRB_82/TRB2003-001700.pdf

(12) HART, Maureen, 2006. *Economy indicators* [online]. West Hartford [cit. 2016-08-06]. Available from: http://www.sustainablemeasures.com Database/ Economy.html

(13) HINDLS, Richard et al., 2006. *Statistika pro ekonomy*. 7. edition. Praha: Professional Publishing. ISBN 80-869-4616-9.

(14) HOLDEN, Erling, Kristin LINNERUD a David BANISTER, 2013. Sustainable passenger transport: Back to Brundtland. *Transport Research Part A: Policy and Practice*. **54**, 67-77. DOI: 10.1016/j.tra.2013.07.012. ISSN 09658564.

(15) JOUMARD, Robert a Henrik GUDMUNDSSON (eds.), 2010. *Indicators of environmental sustainability in transport: an interdiciplinary approach to methods*. Bron cedex: INRETS Institut national de Recherche sur les Transports et leur Sécurité. ISBN 978-285-7826-842.

(16) KLOOZ, Daniel a Thomas SCHNEIDER, 2000. The Sustainable Development Barometer and the Key-Indicator-Set: Two Tools and their Application in the City of Winterthur. In: *Making Sustainable Regional Development Visible: Evaluation Methods and Indicators in the Regional Context*. Institute für Verfahrenstechnik: Leibnitz, s. 37-48.

(17) LITMAN, Todd, 2009. A Good Example of Bad Transport Performance Evaluation. *Victoria Transport Policy Institute* [online]. Victoria: Victoria Transport Policy Institute [cit. 2016-08-07]. Available from: http://www.vtpi.org/per_ind.pdf

(18) LITMAN, Todd, 2016. Well Measured: Developing Indicators for Sustainable and Livable Transport Planning. *Victoria Transport Policy Institute* [online]. Victoria: Victoria Transport Policy Institute, [cit. 2016-10-04]. Available from: http://www.vtpi.org/prestige.pdf

(19) MACÁRIO, Rosário a José M. VIEGAS, 2007. Political and planning interventions in urban mobility: weighing local context in the transferability of local solutions. *Red Iberoamericana de Estudios de Polos Generadores de Viaje* [online]. Lisbon: Red Iberoamericana de Estudios de Polos Generadores de Viaje [cit. 2016-07-13]. Available from: http://redpgv.coppe.ufrj.br/index.php/es/produccion/articulos-cientificos/2007-1/331-mobilidade-urbana-transferencia-de-soluco/file

(20) MIKULSKI, Jerzy, 2012. *Telematics in the transport environment: 12th International Conference on Transport Systems Telematics, TST 2012, Katowice-Ustroń, Poland, October 10-13, 2012. Selected papers*. New York: Springer. ISBN 978-364-2340-505.

(21) MINISTRY OF TRANSPORT OF THE CZECH REPUBLIC, 2005. Dopravní politika České republiky pro léta 2005 - 2013. *Ministerstvo dopravy* [online]. Praha: Ministry of Transport [cit. 2016-05-16]. Available from: http://www.mdcr.cz/NR/rdonlyres/652F57DA-5359-4AC6-AC42-95388FED4032/0/MDCR_DPCR20052013_UZweb.pdf

(22) MINISTRY OF TRANSPORT OF THE CZECH REPUBLIC, 2012. Dopravní politika ČR pro období 2014-2020 s výhledem do roku 2050. *Ministerstvo dopravy* [online]. Praha: Ministry of Transport [cit. 2016-05-23]. Available from: http://www.mdcr.cz/NR/rdonlyres/05F0E9E7-D76B-4A36-84AE-E56710F3D881/0/DP.pdf

(23) OECD, 2015b. *ITF Transport Outlook 2015*. Paris: OECD Publishing. ISBN 978-92-82-10764-5.

(24) PERRELS, Adriaan H., Veli HIMANEN a Martin LEE-GOSSELIN. *Building blocks for sustainable transport: Obstacles, Trends, Solutions*. Bingley: Emerald Group Publishing, 2008. ISBN 9780080447094.

(25) SAGER, Tore a Inger-Anne RAVLUM, 2005. The Political Relevance of Planners' Analysis: The Case of a Parliamentary Standing Committee. *Planning Theory*. **4**(1), 33-65. DOI: 10.1177/1473095205051441.

(26) SANTOS, Andrea Souza a Suzana Kahn RIBEIRO, 2015. The role of transport indicators to the improvement of local governance in Rio de Janeiro City: A contribution for the debate on sustainable future. *Case Studies on Transport Policy*. **3**(4), 415-420. DOI: 10.1016/j.cstp.2015.08.006. ISBN 10.1016/j.cstp.2015.08.006. ISSN 2213-624X.

(27) THE MINISTRY OF REGIONAL DEVELOPMENT, 2010. Strategický rámec udržitelného rozvoje ČR. *Ministerstvo pro místní rozvoj ČR* [online]. Praha: The Ministry of Regional Development [cit. 2016-09-17]. Available from: http://www.mmr.cz/getmedia/cb38b236-b21a-4766-9ba3-b0ab6899bb91/SRUR_CR_vysledny_po_vlade

(28) THE WORLD BANK, 2016. World Development Indicators. *The World Bank Group* [online]. Washington: The World Bank [cit. 2016-09-12]. Available from: https://openknowledge.worldbank.org/bitstream/handle/10986/23969/9781464806834.pdf

(29) TUOMINEN, Anu, Jacques LEONARDI a Christophe RIZET, 2008. Assessing the Fitness-For-Purpose of strategic transport research in support of European transport policy. *European Journal of Transport and Infrastructure Research*. **8**(3), 183-200. ISSN 1567-7141.

(30) UNITED NATIONS, 2016. Sustainable Development Goals. *United Nations* [online]. New York [cit. 2016-10-06]. Available from: http://www.un.org/sustainabledevelopment/

(31) WHO, 2004. *Environmental Health Indicators for Europe: A Pilot Indicator-Based Report*. Copenhagen: WHO Regional Office for Europe.

(32) YOUSSEF, Khaled Ali a Moataz Mohamed TARSHAN, 2010. Developing Street Network in Gharb El-Balad District, Assiut City: Towards Sustainable Transport. In: *Conference On Technology & Sustainability in the Built Environment*. Riyadh: King saud university - College of Architecture and Planning, p. 687-706.

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