Periodica Polytechnica
Transportation Engineering

43(3), pp. 138-145, 2015
DOI: 10.3311/PPtr.7825

Sustainability Indicators in Assessing Urban Transport Systems

Attila Buzási[1*], Mária Csete[1]

RESEARCH ARTICLE

Received 18 November 2014; accepted 01 December 2014

Abstract

Transport systems are key elements of urban areas, therefore their sustainability has a pivotal role in achieving complex urban sustainability. Nowadays the assessment of urban sustainability is a hotspot in different scientific fields despite of lack of comprehensive and widely accepted definitions of both urban sustainability and sustainable transportation. The use of divergent indicators for evaluating sustainable urban transportation has been emerged as a core of urban studies. The main aims of this paper is to analyze sets of sustainable urban transport indicators developed in the scientific area worldwide, to collect variables for assessing urban transport sustainability in Hungary, finally to do recommendations in order to be able to evaluate sustainability of transport systems in Hungarian urban areas in a more effective manner.

Keywords

Sustainability, urban transport, indicator

[1] Department of Environmental Economics,
Faculty of Economic and Social Sciences,
Budapest University of Techology and Economics,
Magyar tudósok krt. 2., H-1117 Budapest, Hungary

[*] Corresponding author, e-mail: buzasi@eik.bme.hu

1 Introduction

Understanding processes in urban areas are key step to put forward our cities to a sustainable and resilient future (Csete and Horváth, 2012). Since cities are largely complex systems, assessment and measurability of their subsystems are crucial for implementing efficient decisions. One of these subsystem is the urban transport system, what is the key element in moving goods and people within and between cities. So arising the question based on Tóth-Szabó and Várhelyi (2012) whether there is sustainable transport system, while the city is not? Is it possible that a city is growing in a sustainable manner while its transport system is not? However, according to the 2014 Revision of World Urbanisation Prospects (UN, 2014), 54% of world's population live in cities and this number is projected to reach 66% by 2050. The proportion of urban population varies regarding regions, so 73.4% of Europe's population live in urban areas with a projection of 80% by 2050. Consequently, more and more people use these systems from day to day, hence the pressure on urban transport system increasing steadily and become the major driver of sustainable cities.

Most of the European cities have to face congestions and air pollution due to individual motorized transport modes (Gössling, 2013), and large part of the population spend hours to reach their destinations, due to constant congestions (Miranda and da Silva, 2012; Domanovszky, 2014; Gumz and Török, 2015). However there is an international agreement that technological opportunity of decreasing GHG emissions are not enough to able to decrease these emissions efficiently, hence there is a need of behavioural changes both on people and decision-making scale. Knoflacher (2007) interpreted the consequences of the renewal of the downtown in Wien, where most of the streets were transformed into pedestrian streets, making one of the most liveable and vibrant urban structures in Europe. Nowadays two thirds of people arrive by public transportation, cycling or shows the importance of deliberated decisions regarding urban transport system in order to promote sustainability on urban scale.

Alonso et al. (2015) stated that in urban areas, where pollutants and consequently the impacts - generated by unsustainable transport structure - are existing in a concentrated way, the

sustainable mobility is a prerequisite of achieving sustainable cities. Shiau and Liu (2013) confirmed these statements, and identified technological change and reduced demand as proper and efficient measures for achieving sustainable transport system. White Paper Transport (EC, 2011) published by European Union provides the main requirements for achieving sustainable urban transport, such as pedestrian- and cycling-oriented infrastructure, smaller amount of vehicles with internal combustion engines and promotion of public transportation. However some linkages between transportation activity and environmental degradation have been found still unclear, the main pillars of sustainability and the complex relation between them can be clearly identified. Steadily increasing number of analyses of transportation sector in terms of sustainability (Pálvölgyi and Szendrő, 2012; Szendrő and Török, 2014) indicates the importance and relevance of the topic not only at international scale, but also in Hungary.

In the following sections different interpretations of sustainable transportation, and requirements of indicator selection are highlighted.

The main aim of this paper is to analyse sets of sustainable urban transport indicators developed in the scientific area worldwide in the near past, moreover to collect variables for assessing urban transport sustainability in Hungary. This latter analysis based on the available indicators from Hungarian Central Statistical Office (KSH), what is completed with a recommendation in order to be able to evaluate sustainability of transport systems in Hungarian urban areas. These parts of the study are presented in section 3, 4 and 5.

2 Definition of sustainable transportation

The first step in exploring main challenges, barriers and intervention points in a transport sector in cities is to identify the notion of sustainable urban transportation. As Zegras (2006) emphasized, it is important to clearly identify whether on what aspects we need to focus considering the interdependence between urban areas, transportation sector and sustainability. Is there a focus on transport sustainability in general or on the details in urban areas, as a narrower interpretation of sustainable transportation? There is no scientific agreement about a clear definition regarding sustainable transport system, hence more widespread and comprehensive collection of available definitions and features are key part of the solution. Since the conceptualization is not the aim of this study, therefore collection of definitions do not purpose of elaborating a clear concept, but undoubtedly useful for understanding the different approaches and indicators used in divergent studies.

Shiau and Liu (2013) cited the definition of transport sustainability provided by European Council of Ministers of Transport which describes the concept with the following features:

- from social side, a sustainable transport system provide basic accessibility of individuals, companies and society, moreover makes connection between present and future generation;
- from economic side, it enhances competitiveness and regional development through affordable and efficient operation;
- finally from environmental side, it promotes the use of renewable resources and the limit of emissions and waste in terms of planet's absorption ability, moreover through these features future negative impact can be prevented.

Nevertheless Zegras (2006) emphasized accessibility as the main feature of sustainable transportation and did not provide approaches concerning economic and environmental dimension of sustainability. However most of the studies regarding sustainable transportation concentrate on the environmental impacts of motorized transportation modes (Török, 2014), hence it can be seen, that sustainable development reflect only to the environmental impacts (Tóth-Szabó and Várhelyi, 2012). This barrier was mentioned by Litman (2013), who stated that some of the variables and conceptions suggested in different studies reflect to and monitor the environmental aspects, consequently decision making processes provide ecologically effective, but economically ineffective solutions. Frome other side, another indicators reflected to economic situation may result ecologically ineffective decisions.

According to Zito and Salvo (2011), the following are necessary for reaching sustainable mobility: decreased demand of transport needs, encouragement of modal shift, decrease of trip length and incentive of more efficiency. To avoid unilateral and uncommon definitions, the broadest concept of sustainable transportation may be accepted, as *"satisfying current transportation and mobility needs without compromising the ability of future generations to meet their own needs"* (Zito and Salvo, 2011, p.180). This concept is a light transformation of general sustainable development definition provided by the Brundtland Commission in 1987. The interpretation of this concept allows us to take into account the main pillars of sustainable transportation, such as economic, environmental, social and institutional dimensions. This approach is accepted and used in this study in related to analysis of set of indicators on urban scale and the following recommendations.

3 Using indicators to assess urban transport sustainability

The most competent way for assessing and evaluating the sustainability of a given transport system in a given city and helping decision making processes is to use indicators, or complete set of indicators. Szendrő et al. (2014) determined core indicators (fossil fuel consumption; length of motorway system; number of vehicles; HDI) to evaluate the adaptive capacity of Hungarian road transport sector by applying a data-driven approach in selecting variables. Consequently it

can be declared, that selection, use, normalisation and revision of used variables depends on the limits, availability of them, moreover on various criteria.

Simplification of the complex issue of sustainability is a way for using indicators effectively (Santos and Riberio, 2013). Using set of indicators is suggested by Litman (2009), thus a single indicator is not as effective as a complex indicator system, with which the aims can be better evaluated. As it can be seen above, there is no agreement in definition of sustainable urban transport, hence there are different approaches in collecting and defining indicators what are able to assess it in efficient manner. Accepting the statement provided by Tóth-Szabó and Várhelyi (2012), indicators are constructed for describing a situation of certain concern or its changes over time. Nevertheless there is an increasing need to develop new and more efficient assessment tools for helping the decision making processes which are able to give answers to the new challenges regarding climate change, and through this, in related to sustainability. Zito and Salvo (2011) declared that there is no internationally agreed standard for collecting, evaluating and normalizing indicators, however these steps are crucial in identifying cost-, and time-effective set of indicators.

Firstly, it is highly important to be able to isolate the borders of a given city, hence the limits of our analysis. Secondly, isolating the evaluated systems, for example distinguishing urban transportation from larger transportation systems or the separation of person-transport system from freight transportation (Zegras, 2006). Since every cities are different from each other, these steps depend on the aims and objectives of a given study. The third step concerns the identification of used indicators and there are many approaches in the international studies. Indicators can be quantitative or qualitative, they can be used to assess the reality in absolute or relative way. Hangshenas and Vaziri (2012) have collected the main requirements for indicators from different international studies. According to these collection, effective and useful indicators are: easily understandable, reasonable, measurable, possible to quantify, accessible, comprehensive, reflect various aspect of study, sensitive to changes over time, independent, standardized for comparison, clearly defined and capture long-term processes. Joumard et al. (2012) determined the main features of indicators used to define environmental dimension of sustainable transportation:

- based on measurements;
- pointing clearly the potential and actual impacts;
- being accurate as possible.

According to Tóth-Szabó and Várhelyi (2012) indicators have three main functions: simplification, quantification and communication. Zito and Salvo (2011) suggested requirement regarding variables, what are the followings: comprehensive, high quality of data, comparable, easy to understand accessible and transparent. Joumard et al. (2011) determined criteria for indicator assessment and selection as well. 3-3 criteria refer to the measurement and monitoring feature, finally 4 criteria have been identified in terms of management. From measuring point of view, indicators should be valid, reliable and sensitive for the important changes. Based on the monitoring function, measurability, data availability and ethical concerns have been identified. From the management point of view, selected indicators shall be transparent, interpretable, relevant and actionable. These latter considerations are highly relevant in terms of institutional aspect of urban transport sustainability, which approach was undervalued in the past. Other important considerations are provided by Litman (2009) regarding indicator selection, namely the cost and the quality of the variables. These are highly relevant, because as Haghshenas and Vaziri (2012) mentioned, the lack of databases is one of the biggest difficulty concerning assessing urban transport sustainability. Inter alia Nicolas et al. (2003), Joumard et al. (2011), Gudmundsson (2003), Alonso et al. (2014), or Miranda and da Silva (2012) mentioned barriers regarding data availability. However, there are some international database regarding urban transport sector, but the lack of comprehensive database impedes comparison of transport sustainability between different cities. Finally, Gudmundsson (2003) summarized problems related to measurement of complex features of transport sustainability through environmental (determining the limits of the environment), economic (allocation problems through different sectors) and social ("isolating" transportation from the rest of society) considerations taken into account in a comprehensive analysis.

4 Urban transport sustainability indicators in the reviewed literature

There is a steadily increasing number of international studies analysed sustainability indicators or created composite indices to evaluate transport systems in urban areas. Variability of their aims and objectives cover a broad range from one-dimension analysis to interdisciplinary ones. In this paper, 18 studies were collected from North-America through South-America and Europe to Asia to collect variables regarding sustainable urban transport and to investigate the relationship between climate-related and sustainability indicators in this field. All in all 535 variables were provided by analysed studies, some of them are overlapping with each other, but most of them are unique due to the divergent aims of those papers. This divergence indicates an important principle regarding urban planning, since features and related challenges vary from cities to cities, thus unique variables and composite indices shall be compiled.

Following paragraphs include a short description about analysed papers in lights of aims, used indicators, classification of them and methodologies. Table 1 shows number of indicators from reviewed literature grouped by main sustainability dimensions moreover "other" dimension has been identified for grouping indicators which are related to sectors non-classified in

classic sustainability pillars, such as planning, co-benefits, congestion or accessibility. Where authors used different approach in classification from classical dimensions of sustainability, indicators have been grouped in the above- mentioned 4 main pillars.

Monzón et al. (2009) identified a composite index including 8 variables regarding environmental and social costs of different transport modes in Madrid. These indicators were applied to Madrid Region in 2004 for modelling transport demand in the city. However the main focus was on environmental and social aspects, two of collected indicators are related to economic pillar, due to the overlapping feature of it with other dimensions. The aim of the research of Shiau and Liu (2013) was to elaborate an indicator system to assess and monitor urban sustainability at local (county) level. 21 indicators have been used, divided into 4 main categories: economic, environment, social and energy. Energy sector has been distinguished from other sectors in order to emphasize its relevance in decision-making process, moreover to get governance attention, but through this paper, energy-related indicators have been transferred into environment sector. Alonso et al. (2014) used 9 indicators for creating a composite index to measure sustainability aspects of urban passenger transport systems through 23 European cities. As it can be seen, their study focused on a narrower range of sustainable transportation, but its relevance is unquestionable regarding urban transport systems due to the highly relevant feature of public transport systems in the operation of cities. The second main output of their study is a determination regarding most frequently used transport sustainability indicators based on literature review, such as number of accidents form social aspect, land consumption of infrastructure from environmental side and finally costs of transport sector in lights of economic sustainability. Similar to this study, d'Arcier (2014) measured the performance of urban public transport regarding French cities with altogether 28 indicators. The division of variables is completely different from sustainability dimensions, but used indicators have been classified into them. It can be noted that there is a lack of clearly economic indicators, what is a really unique approach of assessing urban transport systems and their performance. Zegras (2006) specified 23 variables from the SPARTACUS project to build composite index. On the second part of his study accessibility has been determined as a key part of urban transport system that has been distinguished in a later definition of it. In case of initial index, he used the classical three dimensions (environment, social, economic) in grouping indicators. Tóth-Szabó and Várhelyi (2012) developed a set of indicators to monitor and assess sustainability of transport systems through Swedish cities. Their framework distinguished six categories as elements of a sustainable urban transport system, such as efficiency, accessibility, safety, liveability, emissions and resource use. Indicators collected by the authors have been reclassified into environmental, social, economic and institutional categories, in order to be comparable with other papers examined in this study.

Zito and Salvo (2011) created a set of indicator involving 32 indicators in 8 macro categories, namely: city planning, planning and development of public transport, transport demand management, economy, private transport supply, externalities, energy consumption and co-benefit indicators. The aim of their paper is to compare urban transport systems through European cities, which analysis has been conducted in case of 14 capital cities. Marletto and Mameli (2012) examined a methodology regarding participative procedure in selecting indicators for sustainable urban mobility in Italy. A survey-based selection method has been examined based on stakeholders' appraisal from different fields, regarding performance indicators and policy aims. The outcome of this analysis is an index with 13 variables, mostly from environmental dimension. Miranda and da Silva (2012) created a sustainable urban mobility index that includes 87 indicators grouped into 37 themes and further 9 domains. Every indicators, themes and domains are weighted by Brazil, Portuguese, German, American and Australian experts. The study focused on the application of the index in case of Curitiba, Brazil for identifying benchmarks concerning further urban planning objectives. Gössling (2013) suggested indicators regarding non-motorized urban transport modes, particularly for cycling in case of Copenhagen. The supply side has been mentioned with great emphasis regarding high importance in promoting non-motorized transport modes and creating viable and vibrant downtown areas which contributes to achieve mitigation, moreover adaptation goals by substituting individual motorized modes with larger GHG emissions and attracting competitive businesses.

Nicolas et al. (2003) assessed the sustainability of daily trips around Lyon, which analysis was based on survey results. They have applied 21 indicators for evaluating complex transport infrastructure and services in Lyons conurbation, through environmental, social and economic aspects. Particular service- and organization-related variables have been divided into "mobility" dimension. However they were facing the lack of adequate data which constitutes to an incomplete assessment regarding noise. Santos and Ribeiro (2013) provided an assessment index with 20 indicators used to assess the transport-related actions in climate plan of Rio. Selection of used variables based on a comprehensive literature review, regarding their applicability. Similar to the latter study, they were facing the limited applicability of indicators in assessment process, which was found as the main barrier. Dobranskyte-Niskota et al. (2007) have collected 56 indicators through economic, social, environmental, institutional and operational dimensions to assess transport sustainability performance in the EU. They examined the general role of indicators and summarised selection criteria and existing transport indicator initiatives.

Nathan and Reddy (2011) collated 54 indicators and suggested a multi-view Black-box framework for developing variables to evaluate urban transport system in Mumbai, India.

Table 1 Number of applied indicators in reviewed literature grouped by sustainability indicators

	Econ.	Soc.	Env.	Inst.	Other	Total
Nicolas et al., 2003	6	3	6	0	6	*21*
Zegras, 2006	7	12	4	0	0	*23*
Litman, 2009	10	11	13	0	0	*34*
Shiau and Liu, 2012	10	4	7	0	0	*21*
Miranda and da Silva, 2012	0	5	6	7	69	*87*
Tóth-Szabó and Várhelyi, 2012	4	7	14	1	15	*41*
EEA, 2013	11	6	13	7	3	*40*
Santos and Ribeiro, 2012	6	8	6	0	0	*20*
Litman, 2013	21	11	9	0	0	*41*
Gössling, 2013	0	2	0	0	8	*10*
Marletto and Mameli, 2012	2	3	8	0	0	*13*
Zito and Salvo, 2011	5	3	5	0	19	*32*
GreenApple, 2008	7	3	6	0	1	*17*
Monzón et al., 2009	2	2	2	0	2	*8*
Nathan and Reddy, 2011	19	18	17	0	0	*54*
Dobranskyte- Niskota et al., 2007	20	13	16	4	3	*56*
Alonos et al., 2014	3	3	3	0	0	*9*
d'Arcier, 2014	0	8	5	0	15	*28*
∑	***133***	***122***	***140***	***19***	***141***	***555***

The collected indicators mainly reflect to local features across three dimensions, such as social wellbeing, economic performance and ecological sustainability. Since Mumbai is one of the most rapidly growing city in the world, the existence of effective and sustainable, therefore adaptive transport system is crucial in the operation of the city. The European Environmental Agency publishes a report namely Transport and Environment Reporting Mechanism (TERM, 2013) since 2000 with the aim of assessing transport sustainability. The main objective of the report is to provide information regarding demand, pressure and impacts of transport sector for policy makers. There are 40 variables without grouping, therefore indicators have been classified into 4 main categories. An other organization, namely GreenApple Canada published its report regarding smart transportation (GreenApple Canada, 2008) in related to innovative solutions in Canadian cities concerning urban transport sector. Similarly to the EEA, the GreenApple did not provide classification to the 17 collected indicators, but they can be classified easily into the sustainability dimensions. Finally, two papers from Litman (2009, 2013) have been reviewed concerning evaluation of transport sustainability. Cost and quality of indicators was an important consideration about selection. Both studies divided the indicators into economic, social and environmental dimensions, but the balance between categories moved toward the economic dimension, because more than half of the indicators are related to economic sustainability.

Based on results showed in Table 1, total amounts of applied indicators in reviewed literature greatly therefore an important conclusion can be declared based on these numbers. As it can be seen, only 4 of 18 set of indicators included variables regarding institutional dimension. According to the analysis, total number of indicators regarding institutional measures applied in reviewed literature is 19, which is equal to slightly more than 3% of total amount of variables. However it can be noted that political aspects in transport-oriented decision-making processes are as relevant as the technological background.

5 Revision of transport indicators applied in Hungary

Table 2 represents indicators collected from Hungarian Central Statistical Office (KSH) in order to compare them with the variables above and to try to develop a set of indicator for assessing urban transport sustainability through Hungarian cities with them. These indicators are available on the website of Hungarian Central Statistical Office (KSH, http://www.ksh.hu), most of them in Hungarian, partly in English. It must be emphasised that these variables are originally not collected for the purpose of the evaluation of sustainability in transport sector, however they are related to transportation, therefore the availability of them are largely limited with regards to sustainability. However these indicators originate from different databases, such as long time series or publications released at regular intervals. In summary it must be noted that collected variables are all available from KSH website.

Originally 67 indicators of KSH concern mobility with particular emphasis on freight transport as an important sector of total economy. The total number of indicators then have been reduced from sustainability point of view and have been reclassified through the four main categories, such as economic, social, environmental and institutional. After the end of this process, altogether 43 indicators have been classified, 22 of them in the economic, 14 of them in the environmental and 7 of them in the social dimension. It can be declared after a revision of Table 2, that some of the indicators are overlapping, such as total costs of individual transport and costs of individual transport in % of total transport costs, but this review of variables focuses only the availability. One of the main conclusion of this classification is the total lack of institutional variables in KSH webpage regarding transport sector which is a relevant weakness because of the role of the sector in achieving sustainability goals. If there is no possibility for monitoring efficiency of decision making processes in such important sector, achieving both local and global sustainability is highly impeded.

Harazin and Kósi (2013) emphasized the lack of corporate-based indicators in Hungary regarding evaluation systems,

Table 2 Applied indicators in reviewed literature grouped by sustainability indicators

Indicators	*Category*
Annually freight transport performance (income)	Economy
Monthly traffic of Liszt Ferenc Airport	
Volume index gross value added by freight transport	
Environmental protect investment in freight transport	
Environmental taxes	
Costs of individual/public transport per capita	
Total annual transport expenditure	
Costs of transport per household	
Total costs of individual transport	
Costs of individual transport in % of total transport costs	
Annual urban transport performance (no. of passengers)	
No. of registered companies in freight transport sector	
No. of operating companies in freight transport sector	
Gross added value by freight transport sector	
Value of investment at current prices	
Foreign trade turnover	
Net sales value	
No. of employees and their average wages in freight transport sector	
Monthly average fuel price	
Pavement condition index	
Road roughness index	
Number of inland ports	
No. of passengers in interurban passenger transport	Environment
No. of passengers in urban passenger transport	
Newly registered cars by fuel type	
Average daily traffic intensity	
Average age of passenger cars	
Average age of lorries	
CO_2 emission	
NO_x emission	
NMVOC emission	
CO emission	
$PM_{2,5}$ emission	
Emitted GHG by freight transport	
Travelled kms by public transport, car and bicycle	
Vehicle occupancy rate	
Average distance	Social
Average travel time	
No. of journeys	
No. of journeys by car	
% of journeys by car	
Vehicle occupancy rate	
No. of accidents	

however this sector and related players and drivers have a pivotal role in transportation sector through the relation between supply and demand and emissions. Moreover Lendel and Varmus (2013) pointed out the innovation as a potential indicator, what is strongly related to corporations in transport industry and emission-reducing goals. Concerning the relation between decisions taken by companies, individuals or public authorities and environmental consequences, Diófási and Valkó (2014) and Kiss (2014) suggested stronger emphasis on green procurement and public participation in reaching sustainability by taking into account these approaches in everyday life.

It can be noted that company-oriented indicators are almost completely lacking in reviewed literature, although companies are highly relevant stakeholders concerning sustainability issues in transportation sector.

Availability of indicators on urban scale have been identified as the second weakness, since some of the variables are available on NUTS3 level, which means the counties and Budapest in Hungary, consequently the values are not available for other cities, except Budapest.

Finally, some recommendations have been made for improving measurability of the transport-related sustainability in Hungarian cities. Concrete indicators have not been identified, due to the lack of information regarding their availability. The following recommendations aim to enhance applicability of a set of indicators which may be useful to assess sustainability of urban transport systems and to eliminate failures of existing methodology, moreover climate-oriented approaches may be taken into account:

- to avoid double counting;
- to establish institutional dimension, what includes indicators regarding decision-making and implementation processes;
- to improve availability of indicators especially in case of medium sized cities;
- to develop standard requirements in collection and inte pretation of each indicators;
- finally to develop a set of indicator what may be useful and available to Hungarian cities and to facilitate the comparison of urban transport sustainability through these cities.

As a matter of fact, the last recommendation is moderately different from other ones, because comparability may not be identified as main aim of assessment of sustainability concerning divergent cities. The most relevant aim shall be the assessment of local features, therefore identification of weaknesses, barriers, strengths and opportunities regarding sustainability of a given city. However availability of indicators is better in case of local-specific indicators compared to use international ones. Nevertheless comparability can be determined as a second level requirement of sustainability assessments in so far as it contributes to revealing best practices through divergent cities.

6 Conclusion

There is no agreement in terms of both the definition of sustainable urban mobility, and the use, the collection, the number and the selection of related indicators as well. Applied definitions and approaches regarding indicators mostly depend on the authors of different studies, therefore there is no coherence between set of indicators applied by these studies. Moreover examined sectors and identified dimensions also vary greatly through transport- related studies on urban scale. Availability of indicators has been assigned as main barrier in the use of sustainability indicators, due to the divergent national and regional features of explanation of a given variable. As it could be seen in the previous sections, large number of authors cited this problem in the phase of indicator collection.

However, mathematical-statistical methodologies, such as cluster, factor and correlation analyses have been efficiently and more widely applied for reducing amount of data need to assess complex system in lights of their sustainability. These statements are valid in Hungary, where the Hungarian Central Statistical Office do not provide set of indicators regarding transport sector from sustainability point of view, although the pivotal role of mobility in urban sustainability is clearly defined. Concerning the above mentioned, some recommendations have been made regarding measurement methodology, nevertheless implementation of them requires further scientific and financial investments both on national and regional scale.

Acknowledgement

This study was supported by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences.

References

Alonso, A., Monzón, A., Cascajo, R. (2015) Comparative analysis of passenger transport sustainability in European cities. *Ecological Indicators*. 48. pp. 578-592. DOI: 10.1016/j.ecolind.2014.09.022

Csete, M., Horváth, L. (2012) Sustainability and green development in urban policies and strategies. *Applied Ecology and Environmental Research*. 10 (2). pp.185-194. DOI: 10.15666/aeer/1002_185194

Diófási, O., Valkó, L. (2014) Step by Step Towards Mandatory Green Public Procurement. *Periodica Polytechnica Social and Management Sciences*. 22 (1). pp. 21-27. DOI: 10.3311/PPso.2151

Dobranskyte-Niskota, A., Perujo, A., Pregl, M. (2007) Indicators to Assess Sustainability of Transport Activities. Part 1: Review of the Existing Transport Sustainability Indicators Initiatives and Development of an Indicator Set to Assess Transport Sustainability Performance. *JRC Scientific and Technical Reports*. Available from: http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/10416/1/indicators%20report_green%20template.pdf [Accessed: 30th August 2014]

Domanovszky, H. (2014) Gas propulsion or e-mobility is the solution on the way of clean and carbon free road transportation?. *Periodica Polytechnica Transportation Engineering*. 42 (1). pp. 63-72. DOI: 10.3311/PPtr.7254

EC (2011) *White Paper. Roadmap to a Single European Transport Area – Towards a Competitive and Resource Efficient Transport System*. COM (2011) 144 final, Brussels, European Commission.

Faivre d'Arcier, B. (2014) Measuring the performance of urban public transport in relation to public policy objectives. *Research in Transportation Economics*. 48. pp. 67-76. DOI: 10.1016/j.retrec.2014.09.033

Gössling, S. (2013) Urban transport transitions: Copenhagen, City of Cyclists. *Journal of Transport Geography*. 33. pp. 196-206. DOI: 10.1016/j.jtrangeo.2013.10.013

GreenApple Canada (2008) *Smart Transportation Ranking Report.* Appleton Charitable Foundation. Available from: http://www.appletonfoundation.org/Files/GreenApple%20Canada%202008%20SMART%20Transportation%20Ranking%20Report.pdf [Accessed: 25th September 2014]

Gudmundsson, H. (2003) Making concepts matter: sustainable mobility and indicator systems in transport policy. *International Social Science Journal*. 55 (176). pp.199-217. DOI: 10.1111/j.1468-2451.2003.05502003.x

Gumz, F., Török, Á. (2015) Investigation of Cordon Pricing in Budakeszi. *Periodica Polytechnica Transportation Engineering*. 43 (2). pp. 92-97. DOI: 10.3311/PPtr.7579

Haghshenas, H., Vaziri, M. (2012) Urban sustainable transportation indicators for global comparison. *Ecological Indicators*. 15 (1). pp.115-121. DOI: 10.1016/j.ecolind.2011.09.010

Harazin, P., Kósi, K. (2013) Social Challenges: Social Innovation through Social Responsibility. *Periodica Polytechnica Social and Management Sciences*. 21 (1). pp. 27-38. DOI: 10.3311/PPso.2154

Joumard, R., Gudmundsson, H., Folkeson, L. (2011) Framework for Assessing Indicators of Environmental Impacts in the Transport Sector. *Transportation Research Record: Journal of the Transportation Research Board*. 2242. pp. 55-63. DOI: 10.3141/2242-07

Kiss, G. (2014) Why Should the Public Participate in Environmental Decision-Making? Theoretical Arguments for Public Participation. *Periodica Polytechnica Social and Management Sciences*. 22 (1). pp. 13-20. DOI: 10.3311/PPso.7400

Knoflacher, H. (2007) Success and failures in urban transport planning in Europe—understanding the transport system. *Sadhana*. 32 (4). pp. 293-307. DOI: 10.1007/s12046-007-0026-6

Lendel, V., Varmus, M. (2013) The level of utilization of innovative activities of transport businesses in the Slovak Republic. *Periodica Polytechnica Social and Management Sciences*. 21 (2). pp. 83-90. DOI: 10.3311/PPso.7090

Litman, T. (2009) *Sustainable Transportation Indicator Data Quality and Availability.* Victoria, B.C.: Victoria Transport Policy Institute.

Litman, T. (2013) *Well measured*. Victoria, B.C.: Victoria Transport Policy Institute.

Marletto, G., Mameli, F. (2012) A participative procedure to select indicators of policies for sustainable urban mobility. Outcomes of a national test. *European Transport Research Review*. 4 (2). pp. 79-89. DOI: 10.1007/s12544-012-0075-8

Miranda, H., Rodrigues da Silva, A. (2012) Benchmarking sustainable urban mobility: The case of Curitiba, Brazil. *Transport Policy*. 21. pp. 141-151. DOI: 10.1016/j.tranpol.2012.03.009

Monzón, A., Fernandez, A., Jorda, P. (2014) Environmental Costs Account: a base for measuring sustainability in transport plans. In: Rauch, S., Monzón, M. M. A. (ed.) *Highway and Urban Environment. Proceedings of the 9th Highway and Urban Environment symposium*, 1st ed. pp. 23-30.

Nathan, H. S. K., Reddy, B. S. (2011) Urban Transport Sustainability Indicators – Application of Multi-view Black-box (MVBB) framework. *Indira Gandhi Institute of Development Research, Mumbai*. Available from: http://www.igidr.ac.in/pdf/publication/WP-2011-022.pdf [Accessed: 10th November 2014]

Nicolas, J., Pochet, P., Poimboeuf, H. (2003) Towards sustainable mobility indicators: application to the Lyons conurbation. *Transport Policy.* 10 (3). pp.197-208. DOI: 10.1016/s0967-070x(03)00021-0

Pálvölgyi, T., Szendrő, G. (2012) Trends and indicators for sustainable mobility in Hungary. *Acta Academiae Paedagogicae Agriensis Nova Series: Acta Oeconomica*. 1. pp. 125-132.

Santos, A., Ribeiro, S. (2013) The use of sustainability indicators in urban passenger transport during the decision-making process: the case of Rio de Janeiro, Brazil. *Current Opinion in Environmental Sustainability*. 5 (2). pp. 251-260. DOI: 10.1016/j.cosust.2013.04.010

Shiau, T., Liu, J. (2013) Developing an indicator system for local governments to evaluate transport sustainability strategies. *Ecological Indicators*. 34. pp. 361-371. DOI: 10.1016/j.ecolind.2013.06.001

Szendrő, G., Csete, M., Török, Á. (2014) The Sectoral Adaptive Capacity Index of Hungarian Road Transport. *Periodica Polytechnica Social and Management Sciences*. 22 (2). pp. 99-106. DOI: 10.3311/ppso.7377

Szendrő, G., Török, Á. (2014) Theoretical investigation of environmental development pathways in the road transport sector in the European Region. *Transport*. 29 (1). pp. 12-17. DOI: 10.3846/16484142.2014.893538

TERM (2013) *A closer look at urban transport*. European Environment Agency. Available from: http://www.eea.europa.eu/publications/term-2013/at_download/file [Accessed: 9th September 2014]

Tóth-Szabó, Z., Várhelyi, A. (2012) Indicator Framework for Measuring Sustainability of Transport in the City. *Procedia - Social and Behavioral Science*s. 48. pp. 2035-2047. DOI: 10.1016/j.sbspro.2012.06.1177

Török, Á. (2014) Environmental comparism of road and railway transport: a case study in Hungary. *IJTTE*. 4 (2). pp. 210-219. DOI: 10.7708/ijtte.2014.4(2).07

UN (2014) *World Urbanization Prospects: The 2014 Revision.* United Nations Department of Economic and Social Affairs, Population Division, New York.

Zegras, C. (2006) Sustainable Transport Indicators and Assessment Methodologies. *Biannual Conference and Exhibit of the Clean Air Initiative for Latin American Cities, Sao Paulo, Brazil,* 25-27 July. Available from: http://www.seedengr.com/Sustainability%20and%20Transportation%20Indicators%20and%20Assessment%20Methodologies.pdf [Accessed: 23rd September 2014]

Zito, P., Salvo, G. (2011) Toward an urban transport sustainability index: an European comparison. *European Transport Research Review.* 3 (4). pp. 179-195. DOI: 10.1007/s12544-011-0059-0