Mokslas – Lietuvos ateitis / Science – future of Lithuania
ISSN 2029-2341 / eISSN 2029-2252
2018 Volume 10, Article ID: mla.2018.3360, 1–8
https://doi.org/10.3846/mla.2018.3360

Environmental engineering
Aplinkos inžinerija

ASSESSMENT OF SUSTAINABLE URBAN MOBILITY PLANS BY SUSTAINABLE APPROACH

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Received 19 March 2018; accepted 02 April 2018

Abstract. This article focussed on Sustainable Urban Mobility Plans of Lithuania cities. These plans started to prepare in 2016 and now the need to assess their technological, economic, environmental and social aspects has emerged. To assess prepared Sustainable Urban Mobility Plans and their efficiency established different assessment systems that identify the very effective urban mobility measures and their impact to city development. These assessments do not indicate whether the measures are appropriately chosen according to the structure, characteristics, existing transport system of the city, the assessment shows the significance of the mobility measures to urban development.

Keywords: criteria, SUMP, mobility, sustainable development, urban mobility measures.

Introduction

Europe's cities – home to 70% of the Europe Union (hereafter – EU) population and generating over 80% of the Union's GDP – are connected by one of the world's best transport systems. However, mobility within cities is increasingly difficult and inefficient. Urban mobility is still heavily reliant on the use of conventionally-fuelled private cars. Only slow progress is being made in shifting towards more sustainable modes of urban mobility (European Commission, 2013).

The challenge to ensure ever-increasing mobility needs, while at the same time reducing traffic accidents and pollution, is the goal of cities across Europe.

In 2013 European Commission (2013) approved Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions "Together towards competitive and resource-efficient urban mobility" (Communication) (European Commission, 2013). This Communication aims to reinforce the support to European cities for tackling urban mobility challenges. A step-change in the approach to urban mobility is needed to ensure that Europe's urban areas develop along a more sustainable path and that EU goals for a competitive and resource-efficient European transport system are met.

Having regard to Communication and European guidelines of developing and implementing sustainable Urban mobility plans (Wefering, Rupprecht, Bührmann, & Böhler-Baedeker, 2013). In 2015 Lithuanian Minister of Transport and Communications approved the Guidelines on the Preparation of Sustainable Urban Mobility Plans in Lithuania (Guidelines) (Lietuvos Respublikos susisiekimo ministerija, 2015), where recommended prepare the sustainable Urban mobility plans (hereafter – SUMP) for Lithuanian cities with the population over 25.000 and for towns having the status of a resort, and implement the provided mobility measures. The envisaged mobility measures must provide more significant economic benefits, contribute to environmental improvements and increase social equity.

1. The object of research and methodology SWOT

By Guidelines, in Lithuania where are 18 towns that are recommended to prepare SUMP – 5 cities (with the population over 100.000), 4 resorts and 9 middle-size towns (25.000–40.000 inhabitants). Guidelines consist of four parts:

- Analysis of the current mobility situation in the city – an analysis of the valid territorial planning documents and development programmes and strategies; an assessment of the traffic and passenger flows; an assessment of access to city district centres as well as the main centres of attraction (schools, hospitals, bus

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or railway stations etc.) by each mode of transport or on foot using the present transport infrastructure; an assessment of the traffic accidents; an analysis of strengths, weaknesses, opportunities and threats (SWOT); a determination of the trip structure by modes of transport; a public opinion survey on urban mobility and an analysis of its results; a setting of the residents' trips indicators (average number of trips, average trip length, and distribution of trips in the area under consideration); an analysis of the noise levels and air pollution within the city area;

– Analysis of thematic parts – depending on the size of the city under consideration, its population, development prospects, characteristics of the transport system, and the results of the current mobility situation analysis, a detailed description of the thematic parts of the plan and the feasibility of their integration and a graphic part shall be provided. Thematic parts of the plan: promoting public transport; integration of non-motorised vehicles; trip structure by modes of transport; traffic safety and security; improvement of traffic organisation and mobility management; urban logistics; promoting universality of the transport system and including people with special needs; promoting alternative fuels and vehicles that are more environmentally friendly; assessing the need for the implementation of the intelligent transport systems (ITSs) in urban areas;
– Urban mobility scenarios by 2030 – an assessment of the long-term transport system prospects (by 2030) shall be made based on the analysis of the thematic parts; the strategy for the attaining of the objectives identified in the White Paper and the best practices on the preparation of the plans in foreign countries shall be discussed; opportunities for a more efficient use of the urban spaces and the existing infrastructure shall be discussed; the targets to be achieved and the efficiency indicators (quality of and access to transport services and infrastructure, use of information systems, land use and territorial planning, traffic safety and security, energy system, the environment, social inclusion and equal opportunities, economic development, health care) shall be defined;
– Action plan by 2020 – according to the selected urban mobility scenario, establish a roadmap for the implementation of mobility measures up to 2020, with indicators of mobility measures, a period of implementation and costs.

In 2017 prepared 9 SUMPs: Jonava, Druskininkai, Birštonas, Tauragė, Visaginas, Kėdainiai, Mažeikiai, Utena and Palanga towns. Urban mobility measures established in all SUMP should improve urban mobility system and make it more efficient.

To assess prepared SUMP and their efficiency, scientist together with transport experts, local government representatives and various research agencies established different assessment systems that identify the beneficial urban mobility measures and their impact to city development.

Specialists of international management consulting firm "*Arthur D Little*" and International Association of Public Transport (UITP) has developed an evaluation system of urban transport services, composed of 19 mobility measures that are assigned a certain number of points. The system shows the significance of mobility measures of common transport system and ability to ensure an increasing demand for sustainable mobility. The results of evaluation highlighted that on average, less than half of the potential of urban mobility systems is unleashed today (Van Audenhove, Korniichuk, Dauby, & Pourbaix, 2014).

Shiau, Huang and Lin (2015) used the extended rough set theory and identified the 26 mobility criteria with a high impact for a sustainable transport system (Greco, Matarazzo, & Slowinski, 2001). Shiau and Liu (2013) classified them according to their economic, environmental, social and energetic aspects and defined the weights (values) of these criteria by Analytic Hierarchy Process. This system allows municipal authorities to evaluate and monitor the city's transport system and improve the weakest areas.

Greek scientists used programme "Urban Transport Benchmarking Initiative", which developed and assessed sets of indicators for cities of different population size-classes (Taylor, 2006). Scientists classified urban mobility measures according to sustainable development areas – economic, environmental and social aspects. Indicators are normalized because the dimensions of most indicators are different. Each normalized indicator is assigned a rating of 1 to 5 according to a certain range of values of the indicator. These values are also set according to the same programme "Urban Transport Benchmarking Initiative". The proposed methodology is implemented in a case study for the city of Serres, a typical medium-sized city of Greece. The results are presented with spider diagrams, which provide a more explicit indication of the coherence of the transport system and identifies key indicators that have the most significant impact on the whole system (Karagiannakidis, Sdoukopoulos, Gavanas, & Pitsiava-Latinopoulou, 2014).

Burinskienė, Gaučė and Damidavičius (2017) with colleagues analysed science publications, researches and assessed different sets of urban mobility measures. They have developed a standard set of measures and classified them according to the basic principles of sustainable development: economic benefits, environmental improvement, and social equality. Most sustainable urban mobility measures are significant not only for some particular sustainable development principle of the above mentioned three ones but, simultaneously, may be more or less relevant to some of those; thus, the measures are of higher (H) or lower (L) significance under the principles of sustainable development. For example, *New cycling routes* have a low economic impact, but at the same time have a high environmental and social impact, *Parking fees* have a high economic and environmental impact, but have a low social impact (Table 1).

The scientists used R. Hickman urban planning model (UPM), which are identified four significant scenarios for

Table 1. Sustainable urban mobility measures and their significance

No.	Title	Economic		Environmental		Social		Scenario
		H_ec	L_ec	H_en	L_en	H_sc	L_sc	
1	Traffic accident prevention	x			x	x		2
2	Car-sharing penetration		x	x		x		3
3	Managing delivery services		x		x		x	1
4	Density of the street network		x		x		x	1
5	Population education about sustainable development		x	x		x		3
6	Alternative fuel vehicle infrastructure	x		x			x	4
7	Facilities for bicycle parking		x		x	x		1
8	New cycling infrastructure		x	x		x		3
9	Security cameras for public safety		x		x	x		1
10	Improvement in public space (street pavements, lighting, removing barriers)		x		x	x		1
11	Improvement in public transport quality (air conditioning, cleanliness, overcrowding)	x		x		x		4
12	Renewable energy consumption in public transport	x		x			x	4
13	New public transport routes		x	x		x		3
14	Special lines for public transport	x		x			x	4
15	Quality of public transport stations		x		x	x		1
16	Public transport time and frequency		x	x		x		3
17	Improvement in public transport for users with special needs		x		x	x		1
18	Improvement in signage and information systems for drivers (electronic/conventional)		x		x	x		1
19	Information available to the population		x		x	x		1
20	Mobility promotion campaigns	x		x		x		4
21	Park & Ride	x		x			x	4
22	Parking fees	x		x			x	4
23	Parking spaces to users with special needs		x		x	x		1
24	Pedestrian-only zones	x		x		x		4
25	Priority to cyclist and public transport		x	x			x	3
26	Reduced black spots	x			x	x		2
27	Reduced freight transport traffic in the city centre	x		x			x	4
28	Reduced noise level		x		x	x		1
29	Reduced parking places		x	x		x		3
30	Reduced traffic speed in the city centre		x		x	x		1
31	Traffic speed cameras		x		x	x		1
32	Plans for the tourists seasons	x		x		x		4
33	Tourist shuttle	x			x	x		2
34	Road safety education program	x			x	x		2
35	Congestion charges	x		x			x	4
36	Transport fleet age (companies, public authorities)		x	x			x	3
37	Transport plans for companies/schools	x		x		x		4

urban mobility management, supplemented it with the same significance of measures (High/Low environmental improvements, High/Low economic benefits and High/Low social equality) (Figure 1) (Burinskienė et al., 2017; Hickman, Hall, & Banister, 2013). The model suggests that technology development and environmental friendliness have the most significant impact.

The benefit of the model includes result-oriented planning of the very effective urban mobility measures taking into account urban specificity and development opportunities. This model is useful for cities which designing SUMP for the first time and to the institutions responsible for methodological recommendations.

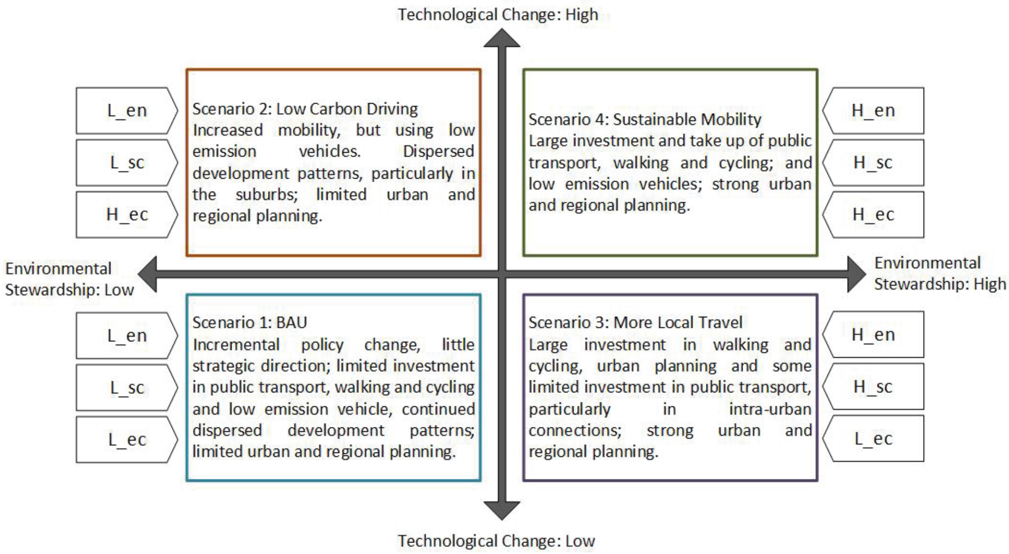


Figure 1. A model for urban development scenarios and sustainable urban mobility measures inherent in them

Authors analysed all Lithuanian SUMPs prepared in 2017 and compiled a common set of 37 measures and compared to set of measures analysed in the paper by Burinskienė, Gaučė and Damidavičius (2017). Benchmarking has shown that 30 mobility measures coincide and further these measures were analysed by the supplemented UPM and principles of sustainable development: economic benefits, environmental improvement, and social equality. Measures which do not coincide – bike-sharing facilities, bicycle maintenance and repair infrastructure, infrastructure for measuring cyclist flows, installation of traffic lights, public transport e-ticket, traffic monitoring and management system. These measures are less cost-effective in economic, environmental or social aspects, either the cost of their installation is higher, and therefore they are not included in the assessment systems proposed by researchers and scientists. This is a sign for cities that need to think again before starting to implement these measures in their transport system.

1.1. The assessment by the supplemented R. Hickman urban planning model

In this assessment, calculated the number of urban mobility measures of prepared SUMPs which are in line with specific UPM scenarios. The urban mobility measures that are in line with each specific UPM scenarios are calculated in each SUMP (Eq. (1)) and determined percentage of it from all urban mobility measures that are in line with UPM scenarios (Eq. (2)).

$$S_{i,j} = \sum K_{i,j}, \text{ when } i = 1, 2, \ldots, 9;\ j = 1, 2, 3, 4, \qquad (1)$$

where $S_{i,j}$ – the amount of urban mobility measures that are in line with UPM scenario j of SUMP I; $K_{i,j}$ – urban mobility measure of SUMP i that are in line with UPM scenario j.

$$N_{i,j} = \frac{S_{i,j}}{S_i} \cdot 100\%, \qquad (2)$$

where $N_{i,j}$ – the percentage of urban mobility measures that are in line with UPM scenario j of SUMP i; $S_{i,}$ – the amount of urban mobility measures of SUMP i.

To further by 4 UPM directions (High/Low technological changes, High/Low environmental stewardship) (Figure 1) technological and environmental aspects evaluate urban mobility measures:

Low environmental stewardship of SUMP i,

$$M_{i,Le} = N_{i1} + N_{i2}, \qquad (3)$$

high environmental stewardship of SUMP i,

$$M_{i,He} = N_{i3} + N_{i4}, \qquad (4)$$

low technological changes of SUMP i,

$$M_{i,Lt} = N_{i1} + N_{i3}, \qquad (5)$$

high technological changes of SUMP i,

$$M_{iHt} = N_{i2} + N_{i4}. \qquad (6)$$

Results are presented in Table 2 Part A and visually in radar diagrams (Figure 2a).

1.2. The assessment according to the principles of sustainable development

In this assessment, the significance (high or low) of urban mobility measures, developed by Burinskienė, Gaučė and Damidavičius (2017) was used to evaluate SUMPs by significance under the principles of sustainable development. Assessment is performed by counting the significances of specific UPM scenarios in each SUMP (*H_ec; L_ec; H_en; L_en; H_sc; L_sc*), for example, if the city (provided in their SUMP) plans to install *bicycle parking facilities* it belongs to 1st scenario and it, as a low economic (*L_ec*) and environmental (*L_en*), but a high social (*H_sc*) significance (Equations (7)–(12). Results are presented in Table 2 Part B and visually in radar diagrams (Figure 2b).

high economic significance of SUMP *i*

$$\sum H\_ec_i \, , \tag{7}$$

high environmental significance of SUMP *i*

$$\sum H\_en_i \, , \tag{8}$$

high social significance of SUMP *i*

$$\sum H\_sc_i \, , \tag{9}$$

low economic significance of SUMP *i*

$$\sum L\_ec_i \, , \tag{10}$$

low environmental significance of SUMP *i*

$$\sum L\_en_i \, , \tag{11}$$

low social significance of SUMP *i*

$$\sum L\_sc_i \, . \tag{12}$$

The obtained results are presented in radar diagrams, which visually represent the most significant UPM scenario of SUMP by technological and environmental aspect and the significance of the proposed mobility measures in economic, environmental and social terms (Figure 2).

Table 2. Urban mobility measures assessment by the supplemented UPM and principles of sustainable development

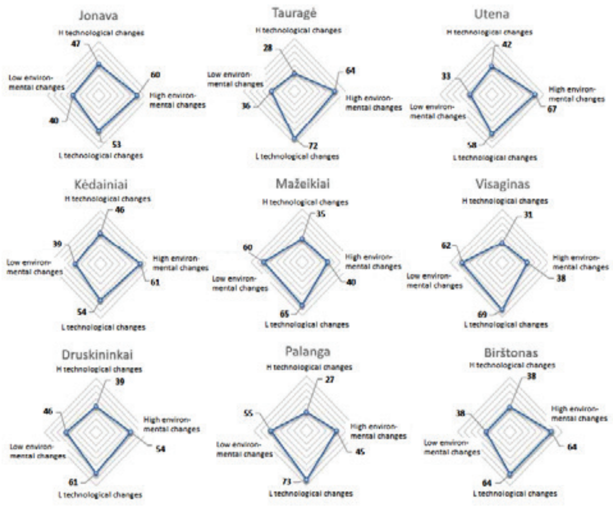
Name of the measure SUMP	Scenario by the urban mobility measure									Urban mobility measure significance
	1. Jonava	2. Tauragė	3. Utena	4. Kėdainiai	5. Mažeikiai	6. Visaginas	7. Druskininkai	8. Palanga	9. Birštonas	
Car-sharing penetration								3		L_ec; H_en; H_sc
Density of the street network					1					L_ec; L_en; L_sc
Electric vehicle infrastructure	4	4	4	4	4	4	4	4	4	H_ec; H_en; L_sc
LNG infrastructure for public transport					4					H_ec; H_en; L_sc
Facilities for bicycle parking	1	1	1		1	1	1	1	1	L_ec; L_en; H_sc
Reconstructed cycling routes				3	3					L_ec; H_en; H_sc
New cycling routes						3	3	3		L_ec; H_en; H_sc
New cycling-pedestrian paths	3	3	3	3	3				3	L_ec; H_en; H_sc
Reconstructed cycling-pedestrian paths	3	3	3	3		3	3		3	L_ec; H_en; H_sc
Security cameras in public places					1			1		L_ec; L_en; L_sc
Reconstructed pedestrian paths		1		1	1	1	1		1	L_ec; L_en; L_sc
Lighting of streets and pavements		1		1	1					L_ec; L_en; L_sc
Road safety measures in passage		1	1		1	1				L_ec; L_en; L_sc
Improvement in public space for users with special needs	1				1		1		1	L_ec; L_en; L_sc
Ecological public transport vehicles	4	4	4	4	4	4	4	4		L_ec; L_en; L_sc
Public transport routes	3	3	3				3		3	L_ec; H_en; H_sc
Public transport stations			1	1	1	1		1		L_ec; L_en; H_sc
Frequent public transport		3	3						3	L_ec; H_en; H_sc
Improvement in public transport for users with special needs					1	1		1		L_ec; L_en; H_sc
Public transport information e-signs	1			1	1	1	1	1		L_ec; L_en; H_sc
Traffic speed cameras and traffic management signs						1	1	1		L_ec; L_en; H_sc
Sustainable urban mobility campaign	4	4	4		4	4	4	4	4	H_ec; H_en; H_sc
Park & Ride				4			4			H_ec; H_en; L_sc
Parking fees									4	H_ec; H_en; L_sc
Parking spaces for users with special needs	1									L_ec; L_en; H_sc
Street reconstruction to pedestrian streets	4			4	4					H_ec; H_en; H_sc
Streets and crossroads reconstruction	2		2	2	2		2		2	H_ec; L_en; H_sc
Reduced freight transport traffic in the city centre	4		4	4	4					H_ec; H_en; L_sc
Reduced traffic speed 20 km/h, 30 km/h	1				1					L_ec; L_en; H_sc
Travel plans for schools	4									H_ec; H_en; H_sc

End of Table 2

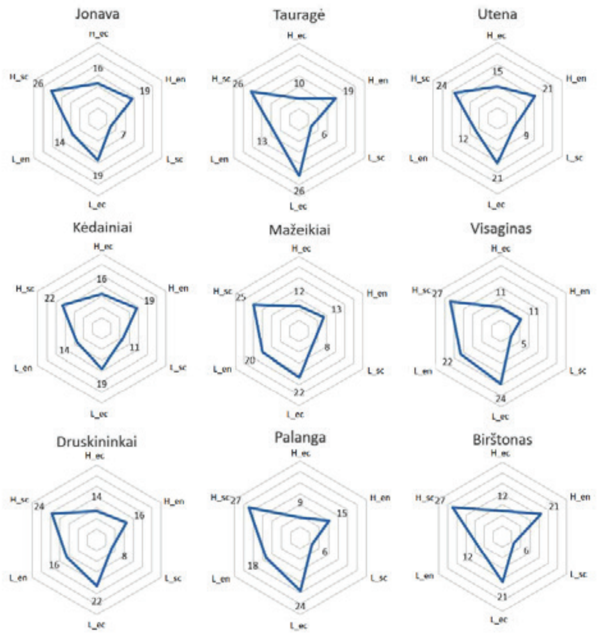
Name of the measure SUMP	Scenario by the urban mobility measure									Urban mobility measure significance
	1. Jonava	2. Tauragė	3. Utena	4. Kėdainiai	5. Mažeikiai	6. Visaginas	7. Druskininkai	8. Palanga	9. Birštonas	
Part A. The assessment by the supplemented R. Hickman urban planning model										
Amount of urban mobility measures of scenario 1 (1)	5	4	3	4	11	7	5	6	3	
Amount of urban mobility measures of scenario 2 (1)	1	0	1	1	1	1	1	0	1	
Amount of urban mobility measures of scenario 3 (1)	3	4	4	3	2	2	3	2	4	
Amount of urban mobility measures of scenario 4 (1)	6	3	4	5	6	3	4	3	3	
Percentage of urban mobility measures of scenario 1 (2)	33	36	25	31	55	54	38	55	27	
Percentage of urban mobility measures of scenario 2 (2)	7	0	8	8	5	8	8	0	9	
Percentage of urban mobility measures of scenario 3 (2)	20	36	33	23	10	15	23	18	37	
Percentage of urban mobility measures of scenario 4 (2)	40	28	34	38	30	23	31	27	27	
Percentage of urban mobility measures determining a high technological changes (3)	47	28	42	46	35	31	39	27	38	
Percentage of urban mobility measures determining a high environmental stewardship (4)	60	64	67	61	40	38	54	45	64	
Percentage of urban mobility measures determining a low technological changes (5)	53	72	58	54	65	69	61	73	64	
Percentage of urban mobility measures determining a low environmental stewardship (6)	40	36	33	39	60	62	46	55	38	
Part B. The assessment according to the principles of sustainable development										
High economic significance (H_ec) (7)	7	3	5	6	7	4	5	3	4	
High environmental significance (H_en) (8)	8	6	7	7	8	4	6	5	7	
High social significance (H_sc) (9)	11	8	8	8	15	10	9	9	9	
Low economic significance (L_ec) (10)	8	8	7	7	13	9	8	8	7	
Low environmental significance (L_en) (11)	6	4	4	5	12	8	6	6	4	
Low social significance (L_sc) (12)	3	2	3	4	5	2	3	2	2	
High economic significance (H_ec), %	16	10	15	16	12	11	14	9	12	
High environmental significance (H_en), %	19	19	21	19	13	11	16	15	21	
High social significance (H_sc), %	26	26	24	22	25	27	24	27	27	
Low economic significance (L_ec), %	19	26	21	19	22	24	22	24	21	
Low environmental significance (L_en), %	14	13	12	14	20	22	16	18	12	
Low social significance (L_sc), %	7	6	9	11	8	5	8	6	6	

Discussion and conclusions

1. In 2016 Lithuanian municipalities started to prepare Sustainable Urban Mobility Plans. Until then traditional transport plans focused on vehicle infrastructure development and increased traffic flows. With the increase of traffic congestion and air pollution, the need to encourage alternative modes of transport has emerged, focusing on ecological and sustainable mobility. In Lithuania, 18 cities are preparing SUMP for the first time, including 5 cities (with the population over 100.000), 4 resorts and 9 middle-size towns (25.000–40.000 inhabitants).
2. To assess prepared SUMP and their efficiency, scientist together with transport experts, local government representatives and various research agencies established different assessment systems: some choose sets of most effective urban mobility measures, other by mobility measures developed sustainable mobility index and some assess according to the principles of sustainable development.
3. By scientist publications and researches, authors analysed and assessed all Lithuanian SUMPs (prepared in 2017) by the supplemented R. Hickman urban planning model, where technology development and environmental friendliness have the most significant impact. The results of assessment shown that Mažeikiai and Visaginas SUMPs mostly represents first urban development scenario, *Business as usual*, where the continuity of current development directions is foreseen with



a) by the supplemented UPM



b) by principles of sustainable development

Figure 2. Assessment of SUMPs

the little investments in public transport, walking, and cycling, incremental policy change, little strategic directions. Tauragė, Utena and Birštonas SUMPs represents third urban development scenario, *More local travel*, where significant investment in the development of bicycles, pedestrians and public transport is foreseen. These cities are characterized by higher traffic flows and more significant supply of attractions. Druskininkai and Palanga resorts equally represent first and third urban development scenarios, therefore be concluded that in these cities great attention is paid to improving the infrastructure of tourist and leisure. Jonava and Kėdainiai SUMPs equally represents third and fourth urban development scenarios where the latter focuses on developing new systems, reducing transport pollution and changing travel habits. These cities are the satellites of the second biggest Lithuania city – Kaunas, therefore be concluded that in these cities, the focus is on those mobility measures that reflect the people mobility needs of both large and middle-sized cities.

4. The assessment according to the principles of sustainable development shown that all prepared SUMPs have a high social significance which emphasizes that these plans are orientated towards improving the people mobility and living environment. However, it is also noticed that all SUMPs have a low economic significance. Therefore, there is a risk that there will be no will to implement and successfully develop sustainable mobility in the short term. The highest social significance is observed in Visaginas, Palanga, and Birštonas SUMPs, the highest economic significance is observed in Jonava and Kėdainiai SUMPs, the highest environmental significance is observed in Birštonas SUMP.

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DARNAUS JUDUMO MIESTE PLANŲ VERTINIMAS DARNOS POŽIŪRIU

J. Damidavičius, M. Burinskienė

Santrauka

Straipsnyje nagrinėjamas Lietuvoje 2016 m. pradėtų rengti Darnaus judumo mieste planų technologinis, aplinkosauginis, socialinis, ekonominis poveikis miestų plėtrai ir jų susisiekimo sistemoms. Pasinaudojus mokslininkų sukurtomis įvairiomis judumo priemonių vertinimo sistemomis, susisteminus visų metodų judumo priemones į vieną bendrą rinkinį ir pasinaudojus darniais miestų plėtros modeliais, įvertinti parengti Darnaus judumo mieste planai. Šis vertinimas neparodo, ar priemonės yra tinkamai pasirinktos pagal miesto struktūrą, charakteristikas ar esamas sistemas. Vertinimas parodo, kokį poveikį šios judumo priemonės turi miesto plėtrai.

Reikšminiai žodžiai: Darnaus judumo mieste planas, judumas, judumo priemonės, kriterijai, darni plėtra.