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SUSTAINABILITY OF URBAN TRANSPORTATION: KEY COMPONENTS

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Developing sustainable transportation systems is very important for urban areas. The urban population in developing countries is close to 50 % of total population, in developed countries already 75 % of population lives in cities. In such situation, designing sustainable transportation system is one of the most pressing issues faced by contemporary cities. Rapid growth of sprawling, low density suburbs, where commuters rely mostly on car use, are of particular interest. Vehicle emissions, congestion, auto dependency reduce quality of life in urban areas. What types of urban forms are more sustainable, defined by land use and transportation systems, is the issue which has been discussed for quite long time. Definitely, some urban forms are more «efficient» in terms of car use (measured in vehicle-km travelled, VKT), energy use, air emissions, land use, travel cost. This paper is devoted to analyzing key components of sustainable urban transportation system.

Keywords: sustainability, transportation system, urban, car use

Developing sustainable transportation systems is very important for urban areas. The urban population in developing countries is close to 50 % of total population, in developed countries already 75 % of population lives in cities. In such situation, deigning sustainable transportation system is one of the most pressing issues faced by contemporary cities. Rapid growth of sprawling, low density suburbs, where commuters rely mostly on car use, are of particular interest.

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Studies show that with suburbanization, emissions, travel costs, energy use all increase (Miller and Ibrahim 1998, Miller et al. 2004). Contemporary tendencies of urban growth (suburban sprawl, auto dependency) are rather unsustainable. If this «business as usual» practice continues, then the results will be dysfunctional cities, decreasing quality of life, unproductive economy, loss in competitiveness.

There is a clear diagnosis of the problems of contemporary city, but it is not clear what is the prescription for how to move from unsustainable practices of contemporary urban forms towards more sustainable urban forms and transportation, given the complexity of urban systems and the fragmented nature of decision-making in many urban areas.

To define sustainability objectives, it is necessary to establish performance measures. Sustainable transportation indicators have been suggested by many authors and organizations (ex., Alberti 1996, US Environmental Protection Agency (EPA) 1999, European Environmental Agency 2001, Kenworthy and Laube 2001, Kennedy 2002). In fact, sustainability performance measures should vary from region to

region reflecting differences in geography, culture, scale. Kennedy et al. (2005) define the central attributes of performance measures as follows: accessibility, health and safety, cost effectiveness, impacts on competitiveness and generation of wealth, consumption of natural capital, production of pollutants.

Implementing the plans is another challenge. There are many barriers to the implementation of urban sustainability such as inadequate funding, wrong pricing, attitudes towards vehicle ownership, etc. (Bannister 1998). There is no doubt that establishing sustainable transportation practices requires considerable social change. In process of movement towards sustainable urban transportation, there are four critical components, namely:

- effective organizations for integrated land-use transportation and planning;
- adequate funding mechanisms;
- investments in infrastructure;
- local design.

Effective organizations for land use transportation planning

The first component, i.e. effective organizations for land use transportation planning, is a matter of governance. The transportation officer might wish to do something for sustainable transportation but she/he does not have the mandate, power or support to make decisions. The well-known problem is the division of responsibility between land-use planner and transportation authorities. There is a need for integrated land-use transportation planning.

International experience demonstrates that there are cities in the world that have been recognized as achieving integrated land-use and transportation planning. The list of such cities includes Zurich, Singapore, Curitiba, Tama Garden and cities in the Netherland.

Spatial Representation

A balanced representation of local interests of the whole region is very important. No doubt, local community interests can suffer because of regional interest dominance (Jacobs, 1961). On the other hand, local interests might be detrimental to the regional growth and sustainability. The promise of additional revenue from development charges or from expanding population can drive local agendum. Without adequate regional regulation, competition among local governments at the edge of cities can lead to a «race to the bottom» with development of areas that offer the lowest charges.

Structural Form

The structure of organization for land use and transportation can be between a hierarchy and loosely connected structure. Plusses of a hierarchical structure include a higher degree of control over personnel and processes, clear communication lines, and clearly defined responsibilities (Kerzner 2003). To implement top-down sustainability policy, hierarchical structure is almost an ideal form. In this case, all decisions are controlled under one umbrella.

On the other hand, hierarchical structure has its own weaknesses. One of such weaknesses is horizontal integration. Despite effective communication in vertical directions, communications in horizontal directions between functional groups can be not effective (Kerzner, 2003). In the case of transportation policy, the problem is complicated because of many actors with different interests are involved in the process of decision-making. The list of actors can include transportation planning departments, land use departments, environmental departments, housing departments, and other departments as well as communities and the private sector. Negotiations between all actors cannot be settled by hierarchical structure. This problem can be dealt by means of informal communication and negotiation. In this way, decision-making process is improved. This kind of interactions creates a new organizational structure which favours more effective horizontal communications and relations. These informal relationships and coalitions are often referred to as policy networks which involve many different actors. Networks are quite common in different areas of public policy.

According to Dijst and Schenkel (2002), urban governance can become more effective through such policy networks, which include political, economic and social actors. Dijst and Schenkel (2002) argue that urban policies become more effective through understanding relationships between processes in society, behavior of actors and the urban form development. Networking can be complementary to the regulatory processes in urban development.

At the same time, there are strong arguments against such loosely connected structure. One of such arguments is the fact that in a loosely connected system, nobody takes responsibility for congestion and pollution externalities. It is quite clear that to leave policy networks to form by chance is risky since these networks will deal with important public problems.

Democracy

The model of transportation planning can resemble the model of independent central banks. In contemporary world, many central banks have been granted independence from their national finance ministries. Conducting monetary policy in a country requires high skills and experience. And this is best done when central bank is independent (of course, some checks are necessary).

The same arguments can be made in the case of transportation and land use planning in urban areas: skilled professionals are required and excessive political interference is unnecessary.

For developing sustainable cities, public participation is very important. Move to sustainability requires a considerable shift in lifestyles, attitudes, perceptions of the community in general. Planning of sustainable transportation will be more effective when those who use the transport have knowledge on transport system. Combination of public knowledge with knowledge and experience of government actors and

transportation providers is critical in the move towards sustainability.

Market

Depending on market philosophy, a regional transportation organization can be anything between a large public organisation which operates transportation system to a smaller organization that contracts services to the private sector (Kennedy et al., 2005).

There are different opinions on the role of free market in transportation services. Nijkamp and Ursem argue that market solutions exist for sustainable cities, for example, private enterprises running mini-buses could be a solution to sustainable suburban transport. Mees (2000), on the other hand, argues that sustainable transport systems are run by public organizations. Such cities as Paris and Zurich have been able to understand and exploit network effects and provide high-quality services. According to Mees, it is a lack of knowledge and institutional weakness that hinders provision of effective public transportation.

Taking into account environmental problems, it is rather problematic operate transportation systems based on free market. If market solutions are employed, then strong regulations and control are necessary. Otherwise, there will be heavy pollution. Strong regulation of transportation is absolutely necessary for sustainable urban development.

Adequate funding mechanisms

Efficient financing is essential for cities. Financing is necessary for investment in new infrastructure or for operation and maintenance of existing systems. According to the World Bank (2002), there are three significant complications that distort pricing and funding of urban transportation:

1. infrastructure financing is separated from infrastructure pricing;
2. responsibility for infrastructure is separated from service provision;
3. responsibility for interacting modes of transport is dispersed.

To overcome these complications, urban regions need regional transportation and land use planning organizations which are responsible for financing infrastructure and stable operations of all transport modes.

As well, funding mechanisms should be adequate, efficient, fair, stable, flexible, easy to implement (Reno and Stowers, 1996; Nakagawa and Matsunaka, 1997; Jones, 1998; Clary et al, 2001).

There are two perspectives on transportation funding. The first one is road pricing and traffic congestion. This approach is increasingly concerned with environmental emissions and congestion (Hau 1992; US Department of Transportation, 1992; Link et al, 1999; MsDonald, et al, 1999). The second is that of transportation managers and financiers within government and the private sector.

Kennedy et al. (2005) suggest the next classification of funding mechanisms

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Table 1. Sources of funding for urban transportation systems

	Non-vehicle related	Vehicle related
Non-location-related	General tax base	Fuel taxes
	Local transportation levy	Vehicle license fees
		Vehicle use fees
		Emissions fees
Location-related	Development fees	Road tolls
	Transit impact fees	Congestion pricing
	Right of way fees	Parking fees
		Transit user fees

Source: Kennedy et al. (2005)

First category includes funding mechanisms that are unrelated to vehicle use and location. Funding from the general tax base is practices in such countries as Canada, France, the UK (Nakagawa and Matsunaka, 1997).The advantage of such approach is flexibility it gives to high-level governments to implement national policies such as reduction of greenhouse gas emissions.

The second way of financing transportation systems is through fuel taxes. Such countries as Germany, Japan, and the US tie gasoline taxes to the funding of transportation infrastructure (Nikagawa and Matsunaka, 1997). However, these countries are different in flexibility of spending. Many jurisdictions in the US reserve gasoline taxes for road infrastructure. At the same time, such revenues in Germany can also be spent on non-road infrastructure. In Canada, such cities as Calgary, Montreal, Vancouver receive part of provincial gasoline revenues for urban infrastructure funding. Development of sustainable transportation requires significant reduction of gasoline use. For this reason, gasoline taxes are not appropriate source for long-term infrastructure financing. In addition, the future of oil supplies is associated with uncertainty. Nevertheless, as a short term source of infrastructure funding, gasoline taxes are consistent with sustainable development. As for other vehicle-related, location-independent funding mechanisms, vehicle license fees are common for use.

It should be noted that raising licensing can generate additional revenue and keep auto-rideship in control as experiences of Hong Kong, Malta and Singapore demonstrate (Button, 1998). The other measure that might reduce auto travel in the long run is to impose higher sales taxes on new vehicle sales (Kennedy, et al, 2005). Some other mechanisms that are sensitive to actual vehicle use include fees based on weight, vehicle value, emissions, distance travelled.

Vehicle-related and location-related fees are desirable since they reflect the value the users put on transportation service. Among these mechanisms, there are the most common: parking fees, road tolls, transit user fees. Parking fees are commonly used, but they are usually insufficient. Tolls are used on the main highways in the US, France, and Japan.

Congestion pricing is getting now more attention. Small and Gomez-Ibanez (1998) reviewed thirteen cases of congestion pricing in different cities, starting with Singapore in 1975. Probably, the main barriers to congestion pricing schemes are implementation costs. On the other hand, London experience demonstrates that capital investment would recover within two years as well as social acceptance is holding so far.

The next category of funding mechanism is related to land values. As the value of land increases, some gains in property value might be captured and used for transportation funding.

Public-private partnership

Public-private partnership is well known in transportation sphere. Different forms of public-private partnerships were used in Baron Haussman in 19-century Paris, in the development of New York and Los-Angeles in early 1900s, in the development of Stockholm in 1950s and 1960s (Hall, 1998). Majority of these partnerships involved both infrastructure and land use development. Some of these partnerships were more successful, while others less. Hall writes that the challenge has always been to «gear urban finances so that the public sector triggers private development and in turn is financed by it» (Hall, 1998, p.614).

It is unclear whether it is beneficial to finance transportation infrastructure using public-private partnership. The private sector can bring such benefits as timely completion of projects, high level of expertise, cost-effective service delivery, access to financing in the case of scarcity of public funds, development of innovative service delivery (Giglio, 1998). On the other hand, there are also some disadvantages: increase in lending rates, increase in user costs. Boardman and Vining (1989) studied 500 large industrial firms. They found that mixed private/public firms were generally less efficient and less profitable than private companies. Moreover, they performed worse than state-owned firms.

This summary has lay out some funding mechanism without giving any preference. Local regions themselves should determine what mechanisms are more preferable within their unique environment. According to the World Bank (2002), from the perspective of economic efficiency, fuel price should be determined by its resource cost, road maintenance and congestion should be paid for by differential tolls, and emission costs should be covered by emission charges. At the same time, it should be noted that fuel taxes remain the most common mechanism due to its ease and costs of implementation. In general, if cities adopt new funding mechanisms for transportation, then careful studies should be conducted because of unclearness of wider implications of different schemes.

Investment in infrastructure

If governance and funding mechanisms are well designed, cities would be able to invest in infrastructure that supports sustainable transportation. Investments will be made in both transit and private vehicle-based infrastructure. Here we focus mostly on public transportation infrastructure, but provision and maintenance of infrastructure (ports, rail transfer stations, product terminals, etc.) is absolutely necessary for vitality of cities.

Existing infrastructure can be used more effectively. Such mechanisms as car sharing lanes, car clubs, park-and-ride, intelligent transportation systems have got some success. However, in the long run, such measures at the best hold use of gasoline-fuelled vehicles at current levels (Kennedy, 2005).

New generation of automobiles is absolutely necessary for sustainable development of cities. There are several models of the sustainable automobile of the future which have been introduced through technical innovations and application of industrial ecology. Adaptation to new automobiles would require developing new infrastructure. Transition to alternative fuel would demand investment in production and distribution facilities.

Transit infrastructure

Sustainable transportation implies reduction of auto dependence without compromising mobility and accessibility. Therefore, sustainable transportation system should include well-integrated public transit system, which would be able to provide adequate services for large proportion of urban residents. How transit system should be designed to attract travelers is a key question. North American public transportation rideship has declined since 1990s (Kohn, 2000). No urban area that expanded light rail system in the 1980-1990s achieved an increase in passenger transport's market share (Dunphy, 1995).

Concerning system configuration, the transit systems in such cities as London and Paris can be considered as close to ideal. Such systems have sufficient extent, high levels of accessibility and mobility. On the other hand, if to compare with North American cities, transit systems of North American counterparts are less extensive.

Expanding North American transit system (and, actually, transit systems in other regions of the world) is rather expensive adventure, which can be cost effective in the case of high passenger volumes. This, in turn, requires the development of high density land use at nodes and along corridors. It may be required to supplement it with intermediate class of modes,

specifically semi-rapid transit (ex., light rail transit, bus rapid transit). In general, investment in semi-rapid transit systems can be a key path in developing sustainable urban transportation systems (Kennedy et al., 2005).

Local design

Investment in public transit systems can be one of the means of achieving sustainability of urban transportation (along with the elaboration of new generation of sustainable automobiles). But investments would hardly work without land use and neighborhood designs, which are supportive to these investments. Houses, jobs and other places should be connected with travel facilities in a convenient way. The design of streets and neighborhoods play a significant role in this deal.

In recent literature, a lot of attention is paid to the design of neo-traditional neighborhoods (Boarnet and Crane, 2001). These designs try to recreate pre-war (WWII) development patterns, with high pedestrian access, mixed land use, narrower streets and other features.

Many codes and guidelines have been produced for practical assistance in designing sustainable neighborhoods (Institute of Transportation Engineers, 1997; Morris, 1997). Geographical information systems are also helpful in studying pedestrian accessibility (Aultman-Hall et al., 1997; Hsiao et al., 1997).

Developing sustainable urban transportation requires more than just creating pedestrian-friendly neighborhoods. Developing urban bicycle networks, a return to the development of boulervards also promote urban sustainability.

Conclusion

All components of sustainable urban transportation considered in this paper have to be established in order for cities to develop in sustainable way. Examples of cities that have achieved success with all components are rather rare. Movement towards more sustainable urban transportation has to be conducted in the next order: governance, financing, infrastructure, neighborhoods. Specific details of these components are likely to differ from city to city since there are different paths to reach similar aims. ■

1. Alberti, M. (1996) Measuring urban sustainability, Environmental Impact Assessment Reviews, 16, pp. 381–424.

2. Anderson, W., Kanaroglou, P. and Miller, E. (1996) Urban form, energy and the environment: a review of issues, evidence and policy, Urban Studies, 33(1), pp. 7–35.

3. Aultman-Hall, L., Roorda, M. and Baetz, B. W. (1997) Using GIS for evaluation of neighbourhood pedestrian accessibility, ASCE Journal of Urban Planning and Development, 123(1), pp. 10–17.

4. Bannister, D. (1998) Barriers to the implementation of urban sustainability, International Journal of Environment and Pollution, 10(1), pp. 65–83.

5. Boardman, A. E. and Vining, A. E. (1989) Ownership and performance in competitive environments: a comparison of the performance of private, mixed and state-owned enterprises, Journal of Law and Economics, 32(1), pp. 1–34.

6. Boarnet, M. and Crane, R. (2001) Travel by Design: The Influence of Urban Form on Travel (Oxford: Oxford University Press).

7. Clary, L., Hand, C., Creamer, R. and Branagan, G. (2001) Alternative transportation revenue sources, in: Transportation Research Board (Ed.) Report of the Committee for the National Conference on Transportation Finance, Scottsdale, Arizona, August 20–23, 2000 (Washington, DC: National Academy Press).

8. Dijst, M. and Schenkel, W. (2002) Urban performance in perspective, in: M. Dijst, W. Schenkel and I. Thomas (Eds) Governing Cities on the Move: Functional and Management Perspectives on Transformations of European Urban Infrastructures, pp. 1–18 (Aldershot: Ashgate).

9. Dunphy, R. T. (1995) Review of Recent American Light Rail Experience (Washington, DC: National Academy Press).

10. European Environment Agency (2001) TERM 2001—Indicators Tracking Transport and Environment Integration in the European Union. Environmental Issue Report No. 23, Catalogue: TH-39-01-295-EN-C (Copenhagen OPOCE).

11. Giglio, J. M. (1998) Financing, in: Proceedings of the Transportation Issues in Large U. S. Cities

12. Conference, Detroit, MI, USA, 28–30 June, pp. 111–125.

13. Gordon, P. and Richardson, H. W. (1989) Gasoline consumption and cities: a reply, Journal of the American Planning Association, 55(3), pp. 342–345.

14. Hall, P. (1998) Cities in Civilization (New York: Pantheon).

15. Hau, T. (1992) Economic Fundamentals of Road Pricing. World Bank Policy Research Working Paper Series WPS 1070 (Washington, DC: World Bank).

16. Homer Dixon, T. F. (2001) The Ingenuity Gap (Toronto: Vintage Canada).

17. Hsiao, S., Lu, J., Sterling, J. and Weatherford, M. (1997) Use of geographical information systems foranalysis of transit pedestrian access, Transportation Research Record, 1604, pp. 50–59.

18. Institute of Transportation Engineers (1997) Traditional Neighborhood Design: Street Design Guidelines (Washington, DC: ITE).

19. Jacobs, A. B., MacDonald, E. and Rofé, Y. (2002) The Boulevard Book: History, Evolution, Design of Multiway Boulevards (Cambridge, MA: MIT Press).

20. Jacobs, J. (1961) The Death and Life of Great American Cities (New York: Random House).

21. Jones, P. (1998) Urban road pricing: public acceptability and barriers to implementation, in: K. J.

22. Button and E. T. Verhoef (Eds) Road Pricing, Traffic Congestion and the Environment: Issues of Efficiency and Social Feasibility, pp. 263–284. (Cheltenham: Edward Elgar).

23. Kennedy, C. A. (2002) A comparison of the sustainability of public and private transportation systems: study of the Greater Toronto Area, Transportation, 29, pp. 459–493.

24. Kennedy C., Miller E., Shalaby A., Maclean H., Coleman J. (2005) The Four Pillars of Sustainable Urban Transportation, Transport Reviews, 25:4, 393-414

25. Kenworthy, J. and Laube, F. (2001) The Millennium Cities Database for Sustainable Transport (Brussels: Union Internationale des transports publics (UITP)).

26. Kerzner, H. (2003) Project Management: A Systems Approach to Planning, Scheduling, and Controlling (New York: Wiley).

27. Kohn, H. (2000) Factors affecting urban transit ridership (Ottawa: Statistics Canada). Available at: http://www.statcan.ca/english/IPS/Data/53F0003X1E.htm (accessed 6 June 2000).

28. Link, H., Dodgson, J. S., Maibach, M. and Herry, M. (1999) The Costs of Road Infrastructure and Congestion in Europe (New York: Physica).

29. McDonald, J. F, d'Ouville, E. L. and Liu, L. N. (1999) Economics of Urban Highway Congestion and Pricing (Boston, MA: Kluwer Academic).

30. Mees, P. (2000) A Very Public Solution: Transport in the Dispersed City (Melbourne: Melbourne University Press).

31. Miller, E. J. and Ibrahim, A. (1998) Urban form and vehicular travel: some empirical findings,

32. Transportation Research Record, 1617, pp. 18–27.

33. Miller, J. B. (2002) Case Studies in Infrastructure Delivery (Boston, MA: Kluwer).

34. Monheim, R. (1997) The evolution from pedestrian areas to 'car-free' city centres in Germany, in: R. Tolley (Ed.) The Greening of Urban Transport, 2nd edn, pp. 253–266 (Chichester: Wiley).

35. Morris, M. (1997) Creating Transit Supportive Land-use Regulations (Chicago, IL: American PlanningAssociation).

36. Nakagawa, D. and Matsunaka, R. (1997) Funding Transport Systems: A Comparison Among DevelopednCountries (New York: Elsevier).

37. Newman, P. and Kenworthy, J. (1989) Gasoline consumption and cities: a comparison of US. citieswith a global survey, Journal of the American Planning Association, 55(1), pp. 24–37.

38. Nijkamp, P. and Ursem, T. (1998) Market solutions for sustainable cities, International Journal of Environment and Pollution, 10(1), pp. 46–64.

39. OECD (2002) Governance for Sustainable Development: Five OECD Case Studies (Washington, DC: OECD).

40. Reno, A. T. and Stowers, J. R. (1995) Alternatives to Motor Fuel Taxes for Financing Surface Transportation Improvements. TRB NCHRP Report No. 377 (Washington, DC: National Research Council).

41. World Bank (2002) Cities on The Move: A World Bank Urban Transport Strategy Review (Washington, DC: World Bank).

REFERENCES:

Alberti, M. (1996) Measuring urban sustainability, Environmental Impact Assessment Reviews, 16, pp. 381–424.

Anderson, W., Kanaroglou, P. and Miller, E. (1996) Urban form, energy and the environment: a review of issues, evidence and policy, Urban Studies, 33(1), pp. 7–35.

Aultman-Hall, L., Roorda, M. and Baetz, B. W. (1997) Using GIS for evaluation of neighbourhood pedestrian accessibility, ASCE Journal of Urban Planning and Development, 123(1), pp. 10–17.

Bannister, D. (1998) Barriers to the implementation of urban sustainability, International Journal of Environment and Pollution, 10(1), pp. 65–83.

Boardman, A. E. and Vining, A. E. (1989) Ownership and performance in competitive environments: a comparison of the performance of private, mixed and state-owned enterprises, Journal of Law and Economics, 32(1), pp. 1–34.

Boarnet, M. and Crane, R. (2001) Travel by Design: The Influence of Urban Form on Travel (Oxford: Oxford University Press).

Button and E. T. Verhoef (Eds) Road Pricing, Traffic Congestion and the Environment: Issues of Efficiency and Social Feasibility, pp. 263–284. (Cheltenham: Edward Elgar).

Clary, L., Hand, C., Creamer, R. and Branagan, G. (2001) Alternative transportation revenue sources, in: Transportation Research Board (Ed.) Report of the Committee for the National Conference on Transportation Finance, Scottsdale, Arizona, August 20–23, 2000 (Washington, DC: National Academy Press).

Conference, Detroit, MI, USA, 28–30 June, pp. 111–125.

Dijst, M. and Schenkel, W. (2002) Urban performance in perspective, in: M. Dijst, W. Schenkel and I. Thomas (Eds) Governing Cities on the Move: Functional and Management Perspectives on Transformations of European Urban Infrastructures, pp. 1–18 (Aldershot: Ashgate).

Dunphy, R. T. (1995) Review of Recent American Light Rail Experience (Washington, DC: National Academy Press).

European Environment Agency (2001) TERM 2001—Indicators Tracking Transport and Environment Integration in the European Union. Environmental Issue Report No. 23, Catalogue: TH-39-01-295-EN-C (Copenhagen OPOCE).

Giglio, J. M. (1998) Financing, in: Proceedings of the Transportation Issues in Large U. S. Cities

Gordon, P. and Richardson, H. W. (1989) Gasoline consumption and cities: a reply, Journal of the American Planning Association, 55(3), pp. 342–345.

Hall, P. (1998) Cities in Civilization (New York: Pantheon).

Hau, T. (1992) Economic Fundamentals of Road Pricing. World Bank Policy Research Working Paper Series WPS 1070 (Washington, DC: World Bank).

Homer Dixon, T. F. (2001) The Ingenuity Gap (Toronto: Vintage Canada).

Hsiao, S., Lu, J., Sterling, J. and Weatherford, M. (1997) Use of geographical information systems foranalysis of transit pedestrian access, Transportation Research Record, 1604, pp. 50–59.

Institute of Transportation Engineers (1997) Traditional Neighborhood Design: Street Design Guidelines (Washington, DC: ITE).

Jacobs, A. B., MacDonald, E. and Rofé, Y. (2002) The Boulevard Book: History, Evolution, Design of Multiway Boulevards (Cambridge, MA: MIT Press).

Jacobs, J. (1961) The Death and Life of Great American Cities (New York: Random House).

Jones, P. (1998) Urban road pricing: public acceptability and barriers to implementation, in: K. J.

Kennedy C., Miller E., Shalaby A., Maclean H., Coleman J. (2005) The Four Pillars of Sustainable

Urban Transportation, Transport Reviews, 25:4, 393-414

Kennedy, C. A. (2002) A comparison of the sustainability of public and private transportation systems: study of the Greater Toronto Area, Transportation, 29, pp. 459–493.

Kenworthy, J. and Laube, F. (2001) The Millennium Cities Database for Sustainable Transport (Brussels: Union Internationale des transports publics (UITP)).

Kerzner, H. (2003) Project Management: A Systems Approach to Planning, Scheduling, and Controlling (New York: Wiley).

Kohn, H. (2000) Factors affecting urban transit ridership (Ottawa: Statistics Canada). Available at: http://www.statcan.ca/english/IPS/Data/53F0003X1E.htm (accessed 6 June 2000).

Link, H., Dodgson, J. S., Maibach, M. and Herry, M. (1999) The Costs of Road Infrastructure and Congestion in Europe (New York: Physica).

McDonald, J. F, d'Ouville, E. L. and Liu, L. N. (1999) Economics of Urban Highway Congestion and Pricing (Boston, MA: Kluwer Academic).

Mees, P. (2000) A Very Public Solution: Transport in the Dispersed City (Melbourne: Melbourne University Press).

Miller, E. J. and Ibrahim, A. (1998) Urban form and vehicular travel: some empirical findings,

Miller, J. B. (2002) Case Studies in Infrastructure Delivery (Boston, MA: Kluwer).

Monheim, R. (1997) The evolution from pedestrian areas to 'car-free' city centres in Germany, in: R. Tolley (Ed.) The Greening of Urban Transport, 2nd edn, pp. 253–266 (Chichester: Wiley).

Morris, M. (1997) Creating Transit Supportive Land-use Regulations (Chicago, IL: American PlanningAssociation).

Nakagawa, D. and Matsunaka, R. (1997) Funding Transport Systems: A Comparison Among DevelopednCountries (New York: Elsevier).

Newman, P. and Kenworthy, J. (1989) Gasoline consumption and cities: a comparison of US. citieswith a global survey, Journal of the American Planning Association, 55(1), pp. 24–37.

Nijkamp, P. and Ursem, T. (1998) Market solutions for sustainable cities, International Journal of Environment and Pollution, 10(1), pp. 46–64.

OECD (2002) Governance for Sustainable Development: Five OECD Case Studies (Washington, DC: OECD).

Reno, A. T. and Stowers, J. R. (1995) Alternatives to Motor Fuel Taxes for Financing Surface Transportation Improvements. TRB NCHRP Report No. 377 (Washington, DC: National Research Council).

Transportation Research Record, 1617, pp. 18–27.

World Bank (2002) Cities on The Move: A World Bank Urban Transport Strategy Review (Washington, DC: World Bank).

Устойчивость городского транспорта: основные компоненты

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Развитие устойчивой транспортной системы является очень важной для городских территорий. В развивающихся странах численность городского населения приближается к 50 % от общей численности населения, а в развитых странах уже 75 % населения живет в городах. В такой ситуации планирование устойчивой транспортной системы является одной из важнейших задач, которую должны решать современные города. Быстрое расползание городов, развитие пригородов с низкой плотностью населения, где общины в основном используют автомобили, представляют собой особый интерес. Выбросы загрязняющих атмосферу газов, пробки, авто-зависимость снижают качество городской жизни. Такие вопросы, как какие городские формы являются более устойчивыми (в зависимости от использования земли и транспортной системы) обсуждаются учеными и практиками в течение длительного времени. Действительно, некоторые городские формы являются более «эффективными» в отношении использования автомобилей, использования энергии, загрязнения воздуха, использования земли, затрат. Эта статья посвящена анализу основных компонентов устойчивой городской транспортной системы.

Ключевые слова: устойчивость, транспортная система, использование автомобиля, город