



## CONCEPTUAL MODELLING OF SUSTAINABLE VILNIUS DEVELOPMENT

Arturas Kaklauskas<sup>1</sup>, Edmundas Kazimieras Zavadskas<sup>2</sup>, Jonas Šaparauskas<sup>3</sup>

<sup>1</sup>*Department of Construction Economics and Property Management,*

<sup>2, 3</sup>*Department of Construction Technology and Management,*

*Vilnius Gediminas Technical University, Saulėtekio al. 11, LT-10223 Vilnius, Lithuania*

*E-mail: <sup>1</sup>arturas.kaklauskas@st.vgtu.lt;*

*<sup>2</sup>edmundas.zavadskas@st.vgtu.lt; <sup>3</sup>jonas.saparauskas@st.vgtu.lt*

*Received 17 September 2008; accepted 23 January 2009*

**Abstract.** This research consists of 5 stages: comparative description of the sustainable urban development in developed countries and in Vilnius; a comparison and contrast of sustainable urban development in developed countries and Vilnius; a development of some of the general recommendations as how to improve the efficiency levels for a sustainable Vilnius; submission of particular recommendations for the city of Vilnius; a multiple criteria analysis of sustainable urban development's components and a selection of the most efficient version of sustainable urban development life cycle. The obtained results have partially confirmed the available data, and interesting trends of the development of established cities have been noted. In order to demonstrate the application of the above research, concrete examples of Vilnius will be considered in this paper.

**Keywords:** sustainable urban development, global development trends, alternatives, Vilnius, conceptual modelling.

**Reference** to this paper should be made as follows: Kaklauskas, A.; Zavadskas, E. K.; Šaparauskas, J. 2009. Conceptual modelling of sustainable Vilnius development, *Technological and Economic Development of Economy* 15(1): 154–177.

### 1. Introduction

Sustainable urban development has various approaches and different priorities in different countries. It is not surprising that there are widely divergent views and interpretations, with marked differences between countries that have a developed market economies, those with transition economies and in developing countries. Not all countries with one of these three development levels understand sustainable urban development in the same way and so have different strategies.

Successful strategies for a sustainable urban development should be more-or-less compatible with political, economic, social, cultural, institutional, technological, environmental, legal/regulatory and educational situations in the country under consideration. A varied spectrum of strategies can be launched, while keeping in mind that the mix of influencing factors and the relative emphasis is on one or other of the factors and overall will depend on local conditions.

Therefore the best sustainable urban development strategy of another country cannot just be copied. Strategies may only be adapted into a real economic, social, political, legislation/regulation and the provisional situation of the existing state. There is no such thing as a single sustainable urban development strategy to suit all societies and that could be applied to all countries.

The model for a rational and sustainable development of Vilnius suggested by this research is based on the presumption that the efficiency of sustainable urban development depends on many micro-, meso- and macro-level variables. The presence of specific variable factors immediately imposes objective limitations for efficient sustainable urban development. Such a development, in the presence of these objective limitations, tries to perform its functions within their bounds with the utmost efficiency. This research aims at producing a model of the rational sustainable Vilnius development by undertaking a complex analysis of micro-, meso- and macro-environment factors affecting it and to present recommendations on increasing its competitive ability.

Vilnius is the capital of Lithuania and one of the country's oldest cities. The honour of founding Vilnius is justly given to Gediminas (a Lithuanian Duke) in the year 1323. The capital is listed in the World Heritage Register of UNESCO. The Old Part of Vilnius is among the most prominent cultural monuments in the world. The population of Vilnius is 600,000 and within a radius of 50 km; 800,000 people live in the Vilnius metropolitan area. A population of 1.6 million people live in the combined counties of Vilnius and Kaunas, which form the main urban axis of Lithuania and the centres of which are separated by only 100 km. At present, the economy of Vilnius is growing much faster than the national economy and is exceeding the national average by 44%. According to the "Standard & Poor's" Agency (Vilnius ... 2008), foreign trading activities in Vilnius are the most active in Lithuania and besides Vilnius is the main receiver of the European Union's support and receives about 60% of foreign investment. The annual ratings announced by London Survey Company "Mercer Human Resource Consulting" (there were 215 cities rated) (Quality ... 2008) prove that Vilnius, according to its quality of life is the third top ranked city in Eastern Europe. Switzerland and Germany dominate the European cities with the best quality of living, each having three cities represented in the top 10. Bern, in Switzerland, ranks 9 following behind Zurich and Geneva. Dusseldorf (6), Munich and Frankfurt (both at 7) represent Germany. Outside the top 10 are Copenhagen (11), Amsterdam (13), Brussels (14), Berlin (16) and Luxembourg (17). Dublin, ranking 25, is followed by Paris (32), Barcelona (42) and Madrid (43). Lisbon is number 44 and is followed by Rome, 55, up from 61 in 2007. Prague (71) is the highest-ranking eastern European city followed by Budapest (74), Vilnius (78), Ljubljana (82) and Warsaw (85). Milan (41), Lisbon (44), Vilnius (78) and Riga (89) have become more attractive destinations, rising markedly in the rankings since 2007 (Quality ... 2008).

The paper is structured as follows. Following this introduction, Section 2 describes the Model for Sustainable Urban Development. In Section 3 we have provided a comparative description of sustainable urban development in developed countries and in Vilnius. A comparison and contrast of sustainable urban development in developed countries and Vilnius is presented in Section 4. Some general and particular recommendations correspondingly are presented in Section 5 and 6. An analysis of the life cycle of individual components and the entire sustainable Vilnius development is described in Section 7. Finally, some concluding remarks are provided in Section 8.

## 2. Model for sustainable urban development

The research's aim was to produce an analytical model of the rational sustainable development of Vilnius (SVD) by undertaking a complex analysis of micro-, meso- and macro-environment factors affecting it and to present recommendations on increasing its competitive ability. The research was performed (Kaklauskas 1998; Kaklauskas *et al.* 2005, 2006, 2007a, b; Zavadskas *et al.* 1994, 2004, 2005, 2007a, b; Zavadskas and Kaklauskas 2005, 2008) by studying the expertise of advanced industrial economies and by adapting it to Vilnius by taking into consideration its specific history, development level, needs and traditions. A simulation was undertaken to provide insight into creating an effective environment for the SVD by choosing rational micro-, meso- and macro-factors.

The level of efficiency and the scope of the activities in the sustainable urban development (SUD) depend on the many micro-, meso- and macro-level variable factors and all these variable factors can be optimized. The main objective of this model is to analyze the best experiences in the field of SUD, to compare it to the present situation in a particular city and consequently to present particular recommendations. In this particular case, the development perspectives of Vilnius were analyzed.

The word 'model' implies 'a system of game rules', which the sustainable Vilnius development could use to its best advantage.

The interested parties of the SUD cannot correct or alter the micro-, meso- and macro-level variables, but they can go into the essence of their effect and take them into consideration in their activities. Interested parties, by knowing the environment affecting their projects, can organize their present and future activities more successfully.

According to report of Competitive European Cities (Competitive ... 2004), cities operate within a set of powerful structural economic social, physical and institutional constraints and global economic changes, national policies and decision-making, history and geography can all place real constraints upon an individual city's capacity to perform well economically. For example, it is clear that cities which are at good strategic locations, have benign climates, attractive natural environments, no legacy of traditional industrial structures attitudes and values, operate in decentralized systems, have access to powerful regional governments, or simply benefited from lucky consequences of post-war relocation of private firms are more likely to be successful than cities which do not have these aspects (Competitive ... 2004).

*This research included the following 5 stages.*

**Stage I.** Comparative description of the sustainable urban development in developed countries and in Vilnius:

- A system of criteria characterizing the efficiency of sustainable urban development was determined by means of using relevant literature and experts methods;
- Based on a system of criteria, a description of the present state of sustainable urban development of developed and transitional countries and Vilnius is given in conceptual (textual, graphical, numerical, etc.) and quantitative forms.

**Stage II.** A comparison and contrast of sustainable urban development in developed countries and Vilnius includes:

- Identifying the global development trends (general regularities) of the sustainable urban development;
- Identifying sustainable urban development differences between developed countries and Vilnius;
- Determining pluses and minuses of these differences for Vilnius;
- Determining the best practice of sustainable urban development for Vilnius as based on the actual conditions.

**Stage III.** A development of some of the general recommendations as how to improve the efficiency levels for a sustainable Vilnius.

**Stage IV.** Submission of particular recommendations for the city of Vilnius was presented at this stage. Each of the general SUD recommendations proposed in the 5 stage carry several particular alternatives.

**Stage V.** A multiple criteria analysis of sustainable urban development components and a selection of the most efficient version of SUD's life cycle were determined at this stage. After this stage, the received compatible and rational components of a sustainable urban development are joined into the full sustainable urban development process.

### **3. Comparative description of the sustainable urban development in developed countries and in Vilnius**

#### **3.1. A system of criteria characterizing the efficiency of sustainable urban development**

When drawing up the system of criteria that fully describes the life cycle of a sustainable urban development, it is worthwhile taking into account the suggestions of other researchers. This is explained by the fact that the goals pursued by the interested parties and the system of criteria describing the sustainable urban development in a certain sense is rather subjective. Therefore, in order to increase the degree of objectivity, the authors shall rely on the suggestions of specialists working in this field, when drawing up the system of criteria describing the sustainable urban development.

Micro-, meso- and macro-environments have a direct impact on sustainable urban development opportunities. This may facilitate sustainable urban development or, on the contrary,

may create constraints. Until recently, researchers were unable to reach a unanimous conclusion as to the structure of factors of micro-, meso- and macro-environments and therefore several variations can be found in articles and books on this subject.

A study has been made by author of this paper in conceptual form of the under PHARE program (Kaklauskas, 1998) a description of some micro- and macro-level factors (e.g. government intervention, sources of company finance, information technology, labour skills, the transition indicators) relating to the SUD of various countries.

Ng and Hills (2003) made a comparison of global, local, human, social, cultural and environmental development of the largest cities of Asia (Tokyo, Hong Kong, Singapore, Taipei and Shanghai) according to the following indicator system: Global Development (number of foreign government represented, number of international organization participated, exports in million USD, imports in million USD, etc.), Local Development (national internet services provider, expenditure on R&D as % of GDP; cost of living index according to Mercer, etc.), Human Resources (adult literacy rate, population holding post-secondary qualification, etc.); Health (death rate per 100,000 population, suicides, etc.), Environment (wastewater treated in some way, wastewater with secondary treatment, etc.), Transport (proportion of journeys using public transport, number of vehicles per kilometer of road, etc.), Arts and Culture (number of museums (public and private), public expenditure on arts or culture (% of total budget), etc.), Entertainment and Media (number of TV channels: (local and cable/satellite), number of films screened annually, etc.).

The purpose of the Framework 5 project INTEL CITY (Intelcity ... 2003) was the development of a research "roadmap" (one of the authors of this article participated in this project as an expert). This implies that identifying possible future visions and scenarios for the intelligent application of information communication technologies will enable cities to become more sustainable and able to map out research paths that offer the most potential in assisting society to implement them. Visions of the intelligent city see the potential for ICTs in helping to solve many of the current problems in cities, both in terms of the design and redevelopment processes and in terms of their operation and use. The main outcome was 5 alternative visions and scenarios for the city of the future in the knowledge society: e-democracy city (social inclusiveness), virtual city (resource efficiency), cultural city (preservation of culture and diversity), environmental city (ecological protection) and post-catastrophe-city (resilience). On the basis of these possible future perspectives of urban development a large number of other alternative scenarios may be framed and forecasted.

These scenarios were analyzed on the basis of the following criteria groups (Intelcity ... 2003): equity, participation, accessibility, decentralized decision making, safety, education, non-complexity, cultural heritage, population density, age distribution, migration, employment, globalization, distribution equity, allocative efficiency, optimization of use of resources, environment aesthetics, health situation, compact city design, multifunctionality, integration of technologies, degree of innovation, security of data, decision support systems, real time simulation, nD modelling and simulation, ICT domination, accessibility of technologies and information, information richness, technology awareness and societal integration of technologies.

In Framework Project 6 “Intelligent Cities“ (Intelligent Cities ... 2004–2005) these and other scenarios were further analyzed. For example, the modern city aims at being a “knowledge capital” and depends on education. The educated city should be accessible to all its citizens. The strengths of the educated city are: Infrastructure (pre-school provision, quality schools for all, diversity of educational opportunity (e.g. faith schools, specialist colleges), availability of higher education facilities, high penetration of new technologies enabling learning opportunities), People (culture of learning, lifelong learning opportunities, the “creative class”, a skilled workforce), Business (links between education and businesses, good job opportunities), Culture (good public libraries and archives, high number of cultural assets, close proximity of educational facilities to each other and to cultural assets).

The above-mentioned authors and the authors of this paper thoroughly analyzed the city on the basis of human, social, cultural, environmental, technical, technological and other indicators, whereas the authors cited below analyzed the possibilities of urban development according to individual indicator groups (for example, climate changes, air pollution, transport, etc.) with no deeper analysis of the overall urban vision.

Yoon and Lee (2003) created a model for evaluating urban sustainability. They collected indicators showing climatic changes and air pollution in cities. These authors selected 57 towns of South Korea and divided them into 3 categories – large, medium and small. They framed the system’s sustainability indicators as: population, the number of registered vehicles, the number of establishment, energy consumption, CO<sub>2</sub> emissions, SO<sub>2</sub> emissions, CO<sub>2</sub> concentration, SO<sub>2</sub> concentration, changes of land use in built-up areas, green areas, the number of tropical night, temperature of a city and reforestation.

Lithuanian researchers (Viteikienė 2006; Viteikienė and Zavadskas 2007; Zavadskas *et al.* 2007c) created original methodology for urban sustainability evaluation and compared residential districts of particular city.

One of the authors of the article by participating in the project e-City (e-City ... 2003), carried out in Vilnius, established that the choice of public vehicles in most cases is determined by the quality of services rendered by it and this quality can be expressed through the following criteria system:

- Appropriate tariffs-tariff rate, the desirable public services.
- Convenience of travel-time of travel, reliability, frequency, cleanliness, comfort, information, combined tickets, flexibility.
- The accessibility of public transport, system-the needs of people with limited movement ability, construction of a vehicle, station models-convenient change of vehicle near the areas requiring travel to public transport.
- Safety-safety standards, quality of lighting, staff qualification, number of staff on duty/security personnel.
- Effect on environment-emission and release, noise and infrastructure.

While drawing up the criteria system, the experience of transitional countries was also analyzed.

For example, Oradea (Romania) city’s development strategy (Assessment ... 2001), has been analyzed according to a 4 criteria system:

1. Enabling environment for economic development.
2. Living environment and social equity.
3. Strategic urban management practices.
4. Public finance sustainability.

These criteria systems were analyzed even more thoroughly because of their relevance. For example, the criteria system “Enabling environment for economic development” includes the following subsystems: building partnerships for regional development, strategic partnerships with private sector, land management program, urban revitalization, local legal framework for economic development, whereas the criteria system “Living environment and social equity” includes the following subsystems: housing policy, public service improvements, environmental improvements, social inclusion. Further, these subsystems were analyzed even more thoroughly. For example, the criteria subsystem “housing policy” was comprised of the following criteria: social housing, rehabilitation, asset management financing, housing management policies and the improvement of surrounding environments.

Following the above-mentioned and other criteria systems, the generalized criteria system for a thorough description of sustainable development of Vilnius was framed. In order to adapt this criteria system to Vilnius, 28 experts of this field and residents were asked to select the criteria, which correspond in the best way to the development of Vilnius.

Semi-structured and open-ended question interviews were used as the means for questioning a diverse group of experts and respondents who live in Vilnius and to describe their expectations and experiences during their assessment of sustainable urban development of Vilnius. 28 persons took part in face-to-face interviews: 4 interviews with couples and 20 with individuals were completed. To maximize the range of possible experiences and opinions, we included persons of diverse ethnicity, educational levels and age and gender status. After questioning 28 respondents and processing the obtained results by using an expert's method, the concrete system of criteria characterizing the efficiency of sustainable urban development were identified. Some of the established criteria are presented below: GDP per capita, unemployment rate, demographic changes, pollution minimization, globalization processes, efficient urban size, housing, sources of municipal revenue, quality of life, personal safety, living environment and social equity, provision of affordable and qualified housing by low- and moderate-income households, diffusion of urban growth, tourism, changing of inhabitants, attitudes, optimization of electricity use, rationalization of land use, optimization urban, infrastructure, urban regeneration, increasing of education level and skilled workforce.

These factors will be subsequently analyzed in brief.

### **3.2. Description of the present state of sustainable urban development of developed and transition countries and of Vilnius**

Based on several criteria, a description of the present state of sustainable urban development of developed and transitional countries and of Vilnius was given in conceptual (textual, graphical, numerical, etc.) and quantitative forms.

The current state of sustainable buildings and trends of its development were analyzed from various perspectives. ISO TS 21929 defines that sustainable building brings about the



required performance with the least unfavourable environmental impact, while encouraging economic, social and cultural improvement at a local, regional and global level.

ISO TS 21929 defines a framework for sustainability indicators of buildings. Environmental indicators address environmental aspects in terms of environmental loadings or impacts assessed on the basis of life cycle inventory or assessment. Environmental loadings are the use of resources and the production of waste, odours, noise and harmful emissions to land, water and air. Consequential environmental indicators express environmental impacts in terms of building performance or location either quantitatively or qualitatively.

The principles of sustainable development define the ecological, economic, social and cultural framework for the activities of communities, enterprises and individual citizens. Vision for a Sustainable and Competitive Construction Sector by the European Construction Technology Platform states (ECTP 2006) that “In the year 2030, Europe’s built environment is designed, built and maintained by a successful knowledge and demand driven sector, well known for its ability to satisfy all needs of its clients and society, providing a high quality of life and demonstrating its long-term responsibility to the mankind’s environment. ...In order to meet this vision, objectives and research targets are specified for 2 key aspects of construction: Meeting client requirements and reaching sustainability”.

ISO TS 21929 defines that sustainable building brings about the required performance with the least unfavourable environmental impact, while encouraging economic, social and cultural improvement at a local, regional and global level.

The 3 main types of benefits associated with sustainable construction are environmental, economic and health and community benefits. Environmental benefits include improved air and water quality, reduced energy and water consumption and reduced waste disposal. Economic benefits include reduced operational costs, reduced maintenance costs and increase revenue (sale price or rent). Health and community benefits include enhanced occupant comfort and health, reduced absenteeism and turnover rate, and reduced liabilities (Andrews *et al.* 2006).

Jurevičienė *et al.* (2008) studied home purchase conditions for the youths. Ambrasas and Stankevičius (2007) made analysis on dwelling market of Vilnius town. Raslanas *et al.* (2006) compared prices of flats in London and Vilnius. Yetgin and Lepkova (2007) compared housing policies in Turkey and Lithuania.

One of the examples of conceptual description is provided in Assessment of the Oradea City Development Strategy (Assessment ... 2001). For example, the linkages of criteria system “Living environment and social equity”, describing the development strategy of Oradea (Romania) city with supporting policies is provided in it. Also the graphic information provided is about the sources of municipal revenue in the municipality of Oradea, etc.

Information on the rating of different cities of the world according to the quality of life is provided in the different Web sites (Competitive ... 2004; Swiss ... 2008; Quality ... 2008). European cities dominate the worldwide rankings of locations with the best quality of living, according to Mercer’s 2008 Quality of Living survey. Zurich retains its 2007 title as the highest ranked city, followed jointly by Vienna (2), Geneva (2), then Vancouver (4) and Auckland (5) (Swiss ... 2008).



The present state of sustainable urban development of developed and transitional countries and of Vilnius, in conceptual (textual, graphical, numerical, etc.) and quantitative forms, has been described analogously.

#### **4. A comparison and contrast of the sustainable urban development in developed countries and in Vilnius**

##### **4.1. Identifying global development trends (general regularities) of the sustainable urban development**

The investigation carried out by the authors of this paper under “Intelligent Cities” (Intelligent Cities ... 2004–2005), e-City (e-City ... 2003), INTELCITY (Intelcity ... 2003), Phare program (Kaklauskas 1998), Brita in PuBs (Kaklauskas, Kanapeckienė 2005) and other projects (Kaklauskas *et al.* 2005; Zavadskas *et al.* 2004, 2007a, b, c; Zavadskas and Kaklauskas 2008; Mickaitytė *et al.* 2007, 2008) helped to identify and describe major trends of sustainable urban development in industrialized countries as well as providing recommendations for Vilnius’s development. The comparative quantitative and conceptual analysis of sustainable urban development carried out in developed countries and in Vilnius allowed the authors to identify areas where the situation in Vilnius is comparable, partly comparable with or quite different from the levels attained by the foreign developed cities. The data from this quantitative and conceptual analysis were used in identifying sustainable urban development trends in Western Europe and the USA as well as providing some recommendations for Vilnius.

The analyzed global tendencies of sustainable urban development may be divided into 3 types. Some tendencies, e.g. globalization, interest rates, inflation, the unofficial economy, etc. affecting the urban changes cannot be influenced by city authorities, organizations acting in it or people residing in it. A city in one form or another can influence a large number of other tendencies, e.g. the quality of labour, education and training, the cultural, residential and physical environment, the planning and fiscal regimes, the communication and transportation infrastructure. There are also some effective urban development tendencies that can be influenced by joint actions of city and state authorities. Some of the above-mentioned tendencies stimulating the sustainable urban development are provided in Table 1.

##### **4.2. Identifying sustainable urban developmental differences between developed countries and Vilnius**

According to Competitive European Cities (Competitive ... 2004), cities at the periphery face different economic, social and environmental challenges than those in the centre of Europe and there is not one single model of a European city and the challenges are not the same in every city.

Vilnius varies from the compared cities by economic structure and functions, social, planning and legislative systems, institutions, traditions and cultures, economic performance, institutional arrangements and government policy, immigrant communities, personal safety rankings and other indicators.

**Table 1.** Identification of global development trends (general regularities) of the sustainable urban development and the presentation of some general recommendations as how to improve the efficiency levels for sustainable Vilnius

<p style="text-align: center;"><b>Factors and their trends</b></p>	<p style="text-align: center;"><b>Production of recommendations for the improvement of the efficiency Vilnius sustainable development</b></p>
<p><b>Culture</b>                      Studies of the city traditionally posit a division between a city’s economy and its culture, with culture subordinate in explanatory power to “work.” However, post-industrial and globalizing trends are dramatically elevating the importance of culture. Cultural activities become increasingly crucial to urban economic vitality. Models to explain the growth of cities from the era of industrial manufacturing are outmoded. Some have seen globalization, the wired city, and electronic communication as destroying cities as proximity should decline in importance. This may be correct for some production concerns, but this, in turn, raises questions about consumption versus production decisions affecting urban growth and dynamics. Even in a former industrial power like Chicago, the number one industry has become entertainment, which city officials define to include tourism, conventions, restaurants, hotels, and related economic activities. Citizens in the post-industrial city increasingly make “quality of life” demands, treating their own urban location as if tourists, emphasizing aesthetic concerns. These practices impact considerations about the proper nature of amenities that post-industrial cities can sustain. The city increasingly becomes an Entertainment Machine, leveraging culture to enhance its economic well-being. The entertainment components of cities are actively and strategically produced through political and economic processes (Clark <i>et al.</i> 2003).</p>	<p>To stimulate culture components of Vilnius through political and economic processes</p>
<p><b>Globalization processes</b>                      Globalization process is so influential that almost no major cities remain unaffected, and has in turn given birth to “global cities”, the term recently used to describe the development of large cities in the world in light of global economic restructuring – a process of shifts in the international division of labour and concomitant changes in the production system and social regulation institutions. The recent economic and monetary crises that badly hit Indonesia, however, basically show that the globalization does not only have positive impacts but also can have negative impacts on urban development (Firman 2004).</p>	<p>To maintain close relations with capital cities and other cities in different countries. To make cities venues of various political, cultural, sports events. To improve foreign guest accommodation conditions, carry out energetic tourism business marketing policies and develop the city’s tourist information-technical infrastructure. Encourage international transit transport flows.</p>

Table 1 (continued)

<p><b>Decentralization of powers and responsibilities to lower levels of government</b></p> <p>In all countries, policy makers are grappling with the need to reduce centralization, improve the performance of national and local governments, de-bureaucratize delivery systems and to create partnership mechanisms and cultures. The balance between national, regional and local responsibilities and powers has been changing in many European countries. In particular, there has been a growing pattern of decentralization of powers and responsibilities to lower levels of government. Traditionally decentralized countries like Germany have continued that process. But even countries more traditionally centralized like Belgium, France, Spain and Italy have been creating or increasing the authority of regional and urban institutions during the past decade (Competitive ... 2004).</p>	<p>Decentralization of powers and responsibilities to lower levels of government and increasing the authority of regional and urban institutions.</p>
<p><b>Efficient urban size</b></p> <p>Among other factors, it is suggested that urban sustainability is also correlated to efficient urban size (Capello and Faggian 2002). Tolley identified and started to measure private and social costs and benefits of increases in city sizes, with a suggestion that in larger cities in the US, it appeared that the social marginal costs exceeded the social marginal benefits, implying that these cities tended to be over-sized. For any city, its optimal size is elusive – highly sensitive to its composition of production, its geographic and regional setting, the quality of governance and administration available to it, and its population composition and demographics (Henderson 2002).</p>	<p>To achieve a balanced and controllable growth of the city's population.</p> <p>To strive for such a size of the city that the conditions for business development and for people to live in that would be the best, while the city's exploitation and development would need minimal expenses.</p>
<p><b>Demographic changes</b></p> <p>Transition-country cities need urgently to find new ways of raising financial resources to meet the huge needs arising from population resettlement (Willoughby 2001).</p>	<p>Urgently need to find new ways of raising financial resources to meet the huge needs arising from population resettlements.</p>
<p><b>Provision of affordable and qualified housing by low and moderate income households</b></p> <p>Public housing programs, sites and services and upgrading have all been attempted as ways of meeting the housing needs of the population with limited success. Yet over time, informal settlements do improve in quality, providing satisfactory living conditions for a large proportion of the urban population (Fekade 2000). The Department of Housing and Urban Development established quantitative Affordable Housing Goals requiring the Government Sponsored Enterprises (GSEs) to increase their purchases of mortgages originated by low- and moderate-income households and for homes located in low-income neighbourhoods. The goals increased the supply of mortgage credit available to low- and moderate-income households, after controlling for other mortgage market factors (Anderson <i>et al.</i> 2003).</p>	<p>To stimulate dwelling house construction, renovation and development of unattractive dwelling city districts. To expand the social housing fund, providing disadvantaged people with housing.</p>

Table 1 (continued)

<p><b>Diffusion of urban growth</b>                  Most governments now recognize that diffusion of urban growth, rather than its control and suppression, is essential for economic development. Policies aimed at creating a “balanced” pattern of urban development in Asian countries over the past 3 decades have largely failed. Programs to slow rural-urban migration and to control the expansion of metropolitan areas fell far short of their goals. Most governments now recognize that diffusion of urban growth, rather than its control and suppression, is essential for economic development (Rondinelli 2006).</p>	<p>Diffusion of urban growth, rather than its control and suppression is essential for economic development</p>
<p><b>Tourism</b>                  Tourism can play an important part in economic development strategies for many older cities by providing jobs, but cities will also have to provide improved quality of life in the form of, e. g. restaurants, shops, activities and entertainment (Hall and Page 2008). Tourism business is not only economically beneficial process. The system of tourism oriented towards a mass development also has some negative influence on the environment (Grundey 2008).</p>	<p>Tourism can play an important part in economic development strategies</p>
<p><b>Changing of inhabitant’s attitudes</b>                  Inhabitants can change their residential behaviour depending on the properties of their neighbourhood, neighbours and the whole city (Benenson 1998). The global village patterns of Tihingan, an village characterized by high kinship differentiation, reveals that the weakening village boundaries and the changing spatial connectivity between house-yards are directly related to the weakening social differentiation between rival kin-groups and between different castes (Sentosa 2001).</p>	<p>To encourage residents to take care of their health and environment and strengthen the social spirit. To take more active steps in the fight against violations of children’s rights, unsocial behaviour and crime among teenagers.</p>
<p><b>Optimization of electricity use</b>                  For electricity use, where there is evidence of dramatic increases in household consumption, the longer-term implications for atmospheric emissions are troubling. Improving technologies of electricity use in the household sector appears to be easily achievable and could be stimulated through market and policy mechanisms that have been used elsewhere. These measures offer the prospect of real environmental and economic gains without sacrificing lifestyle advantages of electrical appliance use in households (Tyler 1996).</p>	<p>Improving technologies of electricity’s use in the household sector by stimulation through market and policy mechanisms</p>
<p><b>Rationalization of land use</b>                  Population growth and redistribution generate urban development in both metropolitan and non-metropolitan counties throughout the USA. Land use policies designed to protect environmental quality in urbanizing landscapes should focus, therefore, on accomplishing at least 3 objectives: (1) minimize further fragmentation of the ecological infrastructure; (2) restore, where practical, severed linkages in the ecological infrastructure; and (3) guide new development to locations near existing urban centres (Lichter <i>et al.</i> 2005).</p>	<p>To implement policies of the coherent development of commercial and industrial territories of the city. To maintain the most valuable parklands by adapting them for tourist and recreational purposes. To meet the demands of new residential</p>

Table 1 (continued)

<p>eThe Valencian Mediterranean Region is one of the most dynamic regions of Spain in terms of industrial-urban development, population growth and agrarian activity. Consequently, land-use conflicts (agrarian uses vs. industrial-urban uses vs. conservation uses) and environmental issues (surface and underground water pollution, soil and air pollution, soil erosion and Stalinization, landscape degradation and deterioration of areas of high conservation value) are emerging increasingly in this region. Comprehensive land-use planning can play a vital role in solving land-use conflicts in the region (Recatala <i>et al.</i> 2000).</p> <p>In the Netherlands, a debate continues to take place on how to allocate the available space among several types of land use. The rural area is under constant pressure from urban developments. Multi-purpose land use is becoming more and more important. Typically, however, the analysis of topological relationships, initiated by biophysical and socio-economic processes, and the spatial configuration of different land uses, is often neglected, especially for agricultural planning. Neglecting the spatial configuration and these relationships can result in spatial fragmentation of land use, thus endangering sustainable land use (Carsjens and van der Knaap 2002). The principle of sustainable development applied in physical planning must ensure governance of rational use of territories and harmony between effective social-economic development and maximal protection of natural resources and landscape (Kavaliauskas 2008).</p>	<p>sustainable urban development, commercial, services and small business investors with regard to the acquisition of land. To give priority to development within the city's borders. To restrict the use of new territories. To carry out the development of the city in areas, where it is possible to utilize in an efficient manner the existing social, engineering infrastructure and to make denser the areas, where the territory was built up in an irrational manner. To improve the quality of the environment and maintain a balance between parklands and built-up areas. To restrict low-rise sustainable urban development to suburbs. To build multistory buildings in the central parts of the city. To preserve as many residential buildings as possible in the old town and other important historic sections of the city.</p>
<p><b>Optimization of urban infrastructure</b></p> <p>Rising energy prices and supply shortfalls have underscored the need to improve the energy efficiency of urban travel. To test the degree to which altering development patterns may affect transport energy savings, relationships between gasoline consumption and urban development characteristics were investigated in 49 U.S. metropolitan areas. The results suggest that cities of medium size with clusters of high residential densities are associated with lower levels of per capita gasoline consumption (WHO ... 2004). Optimization process can be performed using multi-criteria decision aiding methods (Turskis 2008; Zavadskas <i>et al.</i> 2008a, b).</p> <p>An object-oriented model for the integrated planning and management of land resources and utilities-related services facilitates the thorough evaluation of scenarios involving land use, and delivery of utilities such as water, gas, telephone and electricity. It therefore provides a mechanism for generating alternative urban development patterns in search of lower utility costs (Marquez and Salim 2007).</p>	<p>To try to bring the city's social and engineering infrastructure up to the latest requirements. To develop a territorially coherent socio-cultural infrastructure. To optimize social care and health infrastructure. To improve the cultural, sport and entertainment infrastructure. To create planning and management systems for regulating the city's engineering infrastructure development. To renovate old and develop new water supply and the sewage removal systems. To improve the electricity supply system.</p>
<p><b>Pollution minimization</b></p> <p>Building waste recycling as aggregates is a modern approach for preventing environmental pollution through both reducing the stocks of waste and decreasing the use of natural aggregates. The main preliminary conditions for developing the recycling activity are: streams of building waste, experience in recycling, technical and environmental standardization, appropriate technologies, etc.</p>	<p>Continuing social education and engineering of social behaviour and attitudes regarding environmental issues through mass media, campaigns and legal means.</p>

End of Table 1

<p>(Hadjieva-Zaharieva <i>et al.</i> 2003). Cities are complex ecosystems and, all over the world, they are increasingly confronted with environmental problems such as air pollution, acid rain, smog, water shortages and garbage disposal (Savage and Kong 1993). To address, for instance, water shortage problem, information system based on Web services can be used (Dzemydienė <i>et al.</i> 2008a, b).</p>	
<p>...</p>	<p>...</p>
<p><b>Urban regeneration</b>                  It was explored the role of dwelling conditions and neighbourhood characteristics in explaining the frequently observed association between housing tenure and health. The health measures were limiting long-standing illness, self-assessed health, recent symptoms, and anxiety and depression features of the dwelling and its surroundings help to explain observed associations between tenure and health in the UK, and that housing and area problems may be particularly important. Housing improvements and urban regeneration may help reduce the health gap between housing tenures, and more generally to reduce inequalities in health (Macintyre <i>et al.</i> 2003).                  All urban regeneration contributes to sustainable development through the recycling of derelict land and buildings, reducing demand for peripheral development and facilitating the development of more compact cities (Couch and Dennemann 2000).</p>	<p>Housing improvements and urban regeneration will help reduce the health gap between housing tenures, and more generally to reduce health inequalities.                  All urban regeneration contributes to sustainable development through the recycling of derelict land and buildings, reducing the demand for peripheral development and facilitating the development of more compact cities.</p>
<p><b>Increasing education level and skilled workforce</b>                  A skilled workforce is a critical feature of competitive cities. Modern economies increasingly depend upon knowledge intensive sectors, even within manufacturing (Competitive ... 2004). Therefore, forecasting the labour force demand and supply is needed (Dubra and Gulbe 2008). Recent literature documents the important role of education in economic development emphasizing its contribution to economic growth, individual and social development (Tansel 2002). The Human Capital theory predicts a “trickling down” effect of education expansion on earnings equalization. Through education expansion and employment legislation, the state can reduce earnings differentials. By decomposing the determinants of earnings differentials into their “attribute-quantity” and “attribute-price” effects, education expansion for females has reduced gender earnings differentials (Chung 1996).</p>	<p>To create a system for life-long-learning and the acquiring of higher qualification. To broaden the society’s knowledge level in the field of Information Technologies and to strive to make the Internet accessible for everyone. To improve the education and training infrastructure.</p>
<p><b>Modern service industries</b>                  Modern service industries are highly concentrated in the central areas of regional capitals. These are often the major growth industries in advanced economies. Modern high-tech industries such as ICT and the life sciences are also concentrated in the centres of regional capitals. So regional capitals tend to be privileged in the new growth industries or are the places where they would typically like to be located (Competitive ... 2004).</p>	<p>Sponsoring modern high-tech industries in Vilnius will have a disproportionate effect on the competitiveness of the entire region.</p>

As an example, the authors provide a generalized analysis of sustainability indicators of several Western European cities (Intelligent Cities ... 2004–2005; e-City ... 2003; Intelcity ... 2003; Competitive ... 2004; Swiss ... 2008; Quality ... 2008) and Vilnius (Pavilenė 2008; Vilnius ... 2008). This analysis shows how much the sustainability of an “average” Western European city differs from that of Vilnius. The indicator values of an average Western European city are calculated by deriving the means of specific indicators of a group of Western European cities. For example, on average the part of the population employed in production in Western European cities is much smaller than in Vilnius. However, the employment of the population in the service sphere is lower than in Vilnius. More considerable changes in the number of the Vilnius population can negatively affect the urban sustainability, because unemployment can rise and the dwellings may become more expensive, etc.

Also, the security in Western European cities is in average higher (criminal situation, compliance of the citizens to law, internal urban stability) and the quality of life is also higher than in Vilnius. The quality of life is expressed by describing 39 different political, economic, environmental factors, as well as education, health protection and other public services.

Vilnius lands in the 78th position and Riga in 89th position in the Mercer’s annual worldwide quality of living ranking. Zurich scores highest for overall quality of living, while Baghdad – the lowest. Luxembourg ranks highest for personal safety and Baghdad – the lowest. Outside the top 10 are Copenhagen (11), Amsterdam (13), Brussels (14), Berlin (16) and Luxembourg (17). Dublin, ranking 25, is followed by Paris (32), Barcelona (42) and Madrid (43). Lisbon is number 44 and it is followed by Rome, 55, up from 61 in 2007. Prague (71) is the highest-ranking eastern European city followed by Budapest (74), Vilnius (78), Ljubljana (82) and Warsaw (85). The lowest ranking European city is Minsk (183) in Belarus. Minsk scores 49.4 on the index compared with Zurich’s 108. Milan (41), Lisbon (44), Vilnius (78) and Riga (89) have also become more attractive destinations, rising markedly in the rankings since 2007. These data were collected in the 2008 (Pavilenė 2008).

#### **4.3. Determining pluses and minuses of these differences for Vilnius**

After the analysis of Vilnius and comparing cities it was established that Vilnius falls behind them according to a number of quantitative and qualitative indicators. Some of the indicators are provided below.

- GDP, productivity and innovation levels are lower.
- ICT facilities are not well developed; low level of ICT penetration in such sectors as education, health services, lower-tier municipal institutions; narrow scope of e-Government services, a lack of detailed and sound public policy on the matter.
- Despite the size of student numbers, universities do not serve well the needs of the local economy; the educational system is not labour market driven; insufficient funding in per student basis.
- Vilnius is too small to punch its weight in European and global markets: small domestic market.
- A weak and deteriorating physical infrastructure.



- Skills deficit in the labour force (after the accession of Lithuania into the EU a rather large number of employees with high qualification went to work in EU countries, where the salary is much higher, the population is rather old and they have with experiences of a planned economy and deep imprints of a socialistic mentality.
- Low levels of R&D investment and commercialization, R&D policy not adapted to market conditions, feeble and fragmented R&D activities in the private sector; unsteady relations or a lack of relations between research institutes and the business community.
- Prevalence of intense manufacturing, mostly low-technology sectors. Low-skilled intense export sectors; insufficient manufacturing modernization. Insufficient compliance with EU quality manufacturing standards.
- A fairly large informal economy.
- Weak traditions of state institutions' cooperation with the private sector as a partner: widespread belief in ability to solve all problems by administrative measures, disregard to market laws.
- Demographic trends are negative.
- A lack of structural reforms in the social area: health sector is already faced with financial difficulties; pension reform starts from 2004.

However, Vilnius has several advantages in comparison to the analyzed cities:

- Strong GDP growth.
- Strong productivity growth.
- Relatively low intense costs.
- Favourable geographical location between Eastern and Western markets.
- Relatively low profit tax.
- There are comparatively many green areas (trees, parks) in Vilnius.

#### **4.4. Determining the best practice for sustainable urban development for Vilnius as based on the actual conditions**

Information on best practice examples of sustainable urban development can be found in different sources. While implementing projects “Intelligent Cities” (Intelligent Cities ... 2004–2005), e-City (e-City ... 2003), Brita in PuBs (Kaklauskas and Kanapeckienė 2005) other projects (Kaklauskas *et al.* 2005; Zavadskas *et al.* 2004, 2007a, b; Zavadskas and Kaklauskas 2008) and the Phare program (Kaklauskas 1998), the experiences of different cities was analyzed by the authors of this paper and it helped to determine the best practice for sustainable urban development in Vilnius. Hereinafter several examples of the best practices are provided:

- In many cities residents living in social housing are able to access a range of services electronically, including: information about their tenancy such as rent, reporting repairs or booking appointments on-line, on-line benefit calculators, paying rates or local taxes, rubbish removal, streetlight, pavement or road repairs. Even people without direct ac-

cess to computers can use one-stop-shop call centres that are in turn using technology to deliver a range of local services (Campbell *et al.* 2004).

- Estonia's cabinet meetings have only computers on their tables. Ministers do not need paper because each can put speaking notes onto the computer and other ministers can make their own comments before the meeting. All ministers and their assistants have access to a ministerial chat room for this purpose. This makes things work faster.
- Parliamentary activities are one of the areas in which technology, and more specifically the Internet, has been used to create and support both geographical and virtual communities. Community portals have proliferated and these are broadly of 2 types: creating a virtual space for 'communities of interest'; on-line access to information and services for residents of specific geographical areas. Whilst the former can exist devoid of any shared physical space and bring together users who are separated by large distances and never likely to meet, the latter is built on the potential for 'real space and real-time' interaction of users. Its aim is to support users as they live in their cities and communities, enabling decision-making, providing another access route to services, and a forum for discussion. For many users, community websites are a comfortable introduction to using technology, and an empowering learning experience. The East Manchester community website – [www.Eastserve.com](http://www.Eastserve.com) – was developed with those objectives and continues to support a lively user community (Campbell *et al.* 2004).

## 5. Development of some general recommendations

It should be noted that the choice of a worldwide trend of development in sustainable Vilnius development is highly dependent on the actual situation. For example, since Lithuania recently became a member of the European Union, it is quite natural that the economic, social and legislative situation in Lithuania and old EU countries are in some cases different. This is particularly obvious when the Western countries tendency towards the reduction of public expenditure on housing is considered. Reduction of public expenditure on housing will be suitable for Lithuania only in the future, when a clearer improvement of housing conditions of most people has been achieved. This is because a substantial majority of the Lithuanian population is facing increasing difficulties in paying for housing. Therefore, while working out an analytical model of sustainable Vilnius development under different projects ("Intelligent Cities", Intelligent Cities ... 2004–2005), e-City (e-City ... 2003), INTELCITY (Intelcity ... 2003), Brita in PuBs (Kaklauskas, Kanapeckienė 2005) and other projects (Kaklauskas *et al.* 2005; Zavadskas *et al.* 2004, 2007a, b, c; Zavadskas and Kaklauskas 2008) major international trends of urban development were considered by taking into account the actual economic, social, legislative, political and technological situation in Vilnius.

The best economic solutions of other countries cannot just be copied. They may only be adopted in a real economic, social, political, legislation/regulation and provision situation of the state. There is no such thing as a single economic solution for all societies. Economic systems depend on the political objectives of government and the interaction of political groupings. Economic systems may be seen to lie on a spectrum of systems ranging from cen-

trally planned (communist) to free market (capitalist). In fact, most countries have adopted economic systems that have elements of both types.

Development of some general recommendations as to how to improve the efficiency levels for sustainable Vilnius development is presented in Table 1.

With regard to the successful experiences of foreign countries, it can be stated that Vilnius has a number of opportunities by using the know-how of investors and EU support, expanding international co-operation, to redesign public administration and to cut bureaucracy using the EU know-how, financial support and spirit of changes; opportunities of the EU support, e.g. exchange programs, structural funds enabling to increase the urban efficiency and sustainability. The threats of the growth of intense costs; direct transmission of EU legislation without regard to local problems, these priorities and traditions can give the opposite results, e.g., the threat to misuse, or actual misuse of, regulatory powers by so-called independent regulators; growth of intense costs due to expanding regulations, bureaucracy and heavy intense taxation; growing pressure on the textile industry; increased “brain drain” of ICT specialists and the reduction of opportunities to reach the average or higher level of EU urban sustainability should be kept in mind.

## **6. Submission of particular recommendations for the city of Vilnius**

A submission of particular recommendations for the city of Vilnius is presented at this stage. Each of the general SVD recommendations proposed in the 5th stage carry several particular alternatives. For example, by implementing the e-City (e-City ... 2003) project a large number of worldwide public transport passenger and operators information systems have been analyzed.

On the basis of the analysis of the best practice, the condition in this sphere of Vilnius, its available resources and acquired experiences and specific requirements for establishing such systems in Vilnius have been proposed. For example, 20 opportunities and requirements were described for the establishment of a public transport passenger information system. Hereinafter some of these requirements are provided in brief:

- Provision of integrated information. The multimodal travel implies the holding simultaneously of transport modes and operators. Thus, the user searches and compares information relating to a single travel (schedule, route, prices) through several operators, thus different sources.
- Provision of a decisional help in order to optimize user’s choice while allowing him/her to take his/her own criteria into account. The limited rationality of the traveller implies that his/her knowledge and means are limited because it is impossible to discover all the possible solutions for a unique problem and to predict all the possible consequences.
- Provisional advice such as the avoidance of the congested area, alternative routes, the avoidance of unsafe area after certain time, etc.
- Provision of real time information about waiting time and vehicle position. Preferably, the real time information is installed at network stops (bus and trolleybus stops) and onboard.

## 7. An analysis of a life cycle of individual components and the entire sustainable development of Vilnius

A multiple criteria analysis of the sustainable development's components of Vilnius (Table 1) and selection of the most efficient versions can be determined at this stage. After this stage, the received compatible and rational components of a sustainable urban development can be joined into the full sustainable urban development process.

In order to efficiently design and implement SVD, it is necessary to investigate as many of the possible alternative solutions for each variable and then to select the most rational one. The selected variables are then combined into one efficient development process. Hence, the efficiency of a development process will depend to a very great extent not only on the selected variables, but also on macro and micro factors affecting them.

The results of this quantitative and conceptual analysis may be widely used for identifying and solving the problems facing sustainable urban development as far as ways and methods of raising its efficiency are concerned.

In order to achieve this goal, multiple criteria decision-making methods developed by authors (Zavadskas *et al.* 1994, Kaklauskas 1998) may be used and are as follows:

- A new method of the complex determination of the weight of the criteria, taking into account their quantitative and qualitative characteristics, was developed. This method allows one to calculate and co-ordinate the weights of the quantitative and qualitative criteria according to the above characteristics.
- A new method of multiple criteria complex proportional evaluation of the SUD projects, that enable the user to obtain a reduced criterion determining the complex (overall) efficiency of the project, was suggested. This generalized criterion is directly proportional to the relative effect of the values and weights of the considered criteria, on the efficiency of the SUD project.
- In order to find what price will make a valued SUD project competitive on the market, a method for determining the utility degree and the market value of projects and based on the complex analysis of all their benefits and drawbacks was suggested. According to this method, the SUD project's utility degree and the market value of a project that is being estimated and are directly proportional to the system of the criteria and adequately describe them, the values and the weights of these criteria.
- A new method of multiple criteria multi-variant design of a SUD project's life cycle, enabling the user to make computer-aided design of up to 100,000 alternative project versions, was developed. Any SUD project's life-cycle variant obtained in this way is based on quantitative and conceptual information. The ideas expressed in this paragraph will be provided more fully in the next article.

## 8. Conclusions

The following aspects were analyzed in this paper, and the conclusions are as follows:

- Cities should be well informed of the micro-, meso- and macro-environment levels in which they operate.

- Cities analyze the micro- meso- and macro-environment levels and distribute their resources to take advantage of the opportunities and to minimize threats to their activities.
- Micro-, meso- and macro-level factors can be optimized.
- Model for sustainable Vilnius development has been developed.
- Some global development trends (general regularities) of the sustainable urban development have been identified.
- Some general and particular recommendations how to improve the efficiency levels for a sustainable Vilnius have been developed.

**Acknowledgement.** The authors of the article are grateful to the front offices of “Intelligent Cities” (Intelligent Cities ... 2004–2005), e-City (e-City ... 2003), INTELCITY (Intelcity ... 2003), Brita in PuBs (Kaklauskas, Kanapeckienė 2005) other projects (Kaklauskas *et al.* 2005; Zavadskas *et al.* 2004, 2007a, b, c; Zavadskas and Kaklauskas 2008) as well as of Phare program (Kaklauskas 1998) for the opportunity to participate in the above research, due to which this article came into existence. We are truly grateful to the citizen of Australia – Nin Bizis for the contribution with English language of the paper.

## References

- Ambrasas, G. and Stankevičius, D. 2007. An analysis of dwelling market in Vilnius, Lithuania, *International Journal of Strategic Property Management* 11(4): 243–262.
- Anderson, L. M.; Charles, J. S.; Fullilove, M. T.; Scrimshaw, S.; Fielding, J. E. and Normand, J. 2003. Providing affordable family housing and reducing residential segregation by income: A systematic review, *American Journal of Preventive Medicine* 24(3): 47–67.
- Andrews, A.; Rankin, J. H. and Lloyd, M. W. 2006. A framework to identify opportunities for ICT support when implementing sustainable design standards, *ITcon* 11: 17–33.
- Assessment of the Oradea City Development Strategy. 2001 [cited 10 09 2008]. Available from Internet: <[http://www.gsd.harvard.edu/research/research\\_centers/cuds/upled/oradea\\_assessment.pdf](http://www.gsd.harvard.edu/research/research_centers/cuds/upled/oradea_assessment.pdf)>.
- Benenson, A. 1998. *Multi-agent simulations of residential dynamics in the city* [cited 10 09 2008]. Available from Internet: <<http://cat.inist.fr/?aModele=afficheN&cpsid=1598143>>.
- Campbell, B.; Slatcher, A.; Birchinall, P.; Stephenson, K. 2004. *Vision of the Regenerated, 'networked' Future City*. Work Package 5. Intelligent Cities project. Framework 6 programme. Contract no.: 507860.
- Capello, R. and Faggian, A. 2002. An economic-ecological model of urban growth and urban externalities: empirical evidence from Italy, *Ecological Economics* 40(2): 181–198.
- Carsjens, G. J.; van der Knaap, W. 2002. Strategic land-use allocation: dealing with spatial relationships and fragmentation of agriculture, *Landscape and Urban Planning* 58(2–4): 171–179.
- Chung, Y. P. 1996. *Gender earnings differentials in Hong Kong: The effect of the state, education, and employment* [cited 10 09 2008]. Available from Internet: <<http://www.ingentaconnect.com/content/els/02727757>>.
- Clark, T. N.; Kenneth, R.; Wong, K.; Jain, P. 2003. Amenities drive urban growth: a new paradigm and policy linkages, *Research in Urban Policy* 9: 291–322.
- Competitive European Cities: Where do the Core Cities Stand? A report to the Office of the Deputy Prime Minister. January 2004 [cited 10 09 2008]. Available from Internet: <[http://www.odpm.gov.uk/stellent/groups/odpm\\_urbanpolicy/documents/downloadable/odpm\\_urbpol\\_027437.pdf](http://www.odpm.gov.uk/stellent/groups/odpm_urbanpolicy/documents/downloadable/odpm_urbpol_027437.pdf)>.

- Couch, C.; Dennemann, A. 2000. Urban regeneration and sustainable development in Britain: The example of the Liverpool Ropewalks Partnership, *Cities* 17(2): 137–147.
- Dubra, E.; Gulbe, M. 2008. Forecasting the labour force demand and supply in Latvia, *Technological and Economic Development of Economy* 14(3): 279–299.
- Dzemydienė, D.; Maskeliūnas, S.; Jacobsen, K. 2008a. Sustainable management of water resources based on web services and distributed data warehouses, *Technological and Economic Development of Economy* 14(1): 38–50.
- Dzemydienė, D.; Maskeliūnas, S.; Dzemyda, I. 2008b. Interoperability of information system components for monitoring of sewage and intelligent analysis of water resources, *Technological and Economic Development of Economy* 14(3): 260–278.
- e-City. 2003. Contract no.: 2003/004.341.08.01.01.0001.
- ECTP 2006. European Construction Technology Platform. Vision for a Sustainable and competitive construction sector. 2006 [cited 10 09 2008]. Available from Internet: <<http://www.hyperion.ie/TP-Construction.htm>>, <<http://www.ectp.org/documentation/ECTP-Vision2030-25Feb2005.pdf>>.
- Fekade, W. 2000. Deficits of formal urban land management and informal responses under rapid urban growth, an international perspective, *Habitat International* 24(2): 127–150.
- Firman, T. 2004. Major issues in Indonesia's urban land development, *Land Use Policy* 21(4):347–355.
- Grundey, D. 2008. Managing sustainable tourism in Lithuania: dream or reality? *Technological and Economic Development of Economy* 14(2): 118–129.
- Hadjieva-Zaharieva, R.; Dimitrova, E. and Buyle-Bodin, F. 2003. Building waste management in Bulgaria: challenges and opportunities, *Waste Management* 23(8): 749–761.
- Hall, C. M. and Page, S. J. 2008. *Progress in tourism management: From the geography of tourism to geographies of tourism – A review, tourism management*, in Press, Corrected Proof, Available online 9 July 2008.
- Henderson, V. 2002. Urban primacy, external costs, and quality of life, *Resource and Energy Economics* 24(1–2): 95–106.
- Intelicity (Intelligent Cities). 2003. 5th Framework Roadmap Project. Framework 5.
- Intelligent Cities project. 2004–2005. Framework 6 programme. Contract No. 507860.
- Jurevičienė, D.; Okunevičiūtė Neverauskienė, L. 2008. The influence of home purchase conditions for the youths' integration in the national labour market, *Business: Theory and Practice* 9(2): 116–124.
- Kaklauskas, A. 1998. *Total life analysis, modelling and forecasting of construction in Lithuania*. Research output, EC Phare-ACE Programme, Vilnius. Project No. P96-6708-F.
- Kaklauskas, A.; Kanapeckienė, L. 2005. Knowledge management and “BRITA in PUBS” project, *Technological and Economic Development of Economy* 11(2): 78–86.
- Kaklauskas, A.; Zavadskas, E. K.; Banaitis, A.; Šatkauskas, G. 2007a. Defining the utility and market value of a real estate: a multiple criteria approach, *International Journal of Strategic Property Management* 11(2): 107–120.
- Kaklauskas, A.; Zavadskas, E. K.; Raslanas, S. 2005. Multivariant design and multiple criteria analysis of building refurbishments, *Energy and Buildings* 37(4): 361–372.
- Kaklauskas, A.; Zavadskas, E. K.; Raslanas, S.; Ginevičius, R.; Komka, A.; Malinauskas, P. 2006. Selection of low – e windows in retrofit of public buildings by applying multiple criteria method COPRAS: A Lithuanian case, *Energy and Buildings* 38(5): 454–462.
- Kaklauskas, A.; Zavadskas, E. K.; Trinkūnas, V. 2007b. A multiple criteria decision support on-line system for construction, *Engineering Applications of Artificial Intelligence* 20(2): 163–175.
- Kavaliauskas, P. A. 2008. Concept of sustainable development for regional land use planning: Lithuanian experience, *Technological and Economic Development of Economy* 14(1): 51–63.



- Lichter, D. T.; Garratt, J.; Marshall, M. L. and Cardella, M. 2005. *Emerging patterns of population redistribution and migration in appalachia* [cited 10 09 2008]. Available from Internet: <[http://www.arc.gov/images/aboutarc/grants/pdf/migration\\_final\\_05.pdf](http://www.arc.gov/images/aboutarc/grants/pdf/migration_final_05.pdf)>.
- Macintyre, S.; Ellaway, A.; Hiscock, R.; Kearns, A.; Der, G. and McKay, L. 2003. What features of the home and the area might help to explain observed relationships between housing tenure and health? Evidence from the west of Scotland, *Health & Place* 9(3): 207–218.
- Marquez, L.; Salim, V. 2007. Assessing impacts of urban freight measures on air toxic emissions in Inner Sydney, *Environmental Modelling & Software* 22(4): 515–525.
- Mickaitytė, A.; Zavadskas, E. K.; Kaklauskas, A. 2007. The knowledge presentation according to the needs of the participants in the public refurbishment sector, *Technological and Economic Development of Economy* 13(1): 47–55.
- Mickaitytė, A.; Zavadskas, E. K.; Kaklauskas, A.; Tupėnaitė, L. 2008. The concept model of sustainable buildings refurbishment, *International Journal of Strategic Property Management* 12(1): 53–68.
- Ng, M. K.; Hills, P. 2003. World cities or great cities? A comparative study of five Asian metropolises, *Cities* 20(3): 151–165.
- Pavilenė D. 2008. *Vilnius and Riga in top-100 in Mercer's Quality of Living survey*. The Baltic Course [cited 10 09 2008]. Available from Internet: <<http://www.baltic-course.com/eng/analytics/?doc=2371>>.
- Quality of Living global city rankings – Mercer survey. 2008 [cited 10 09 2008]. Available from Internet: <<http://www.mercer.com/referencecontent.htm?idContent=1307990>>.
- Raslanas, S.; Tupėnaitė, L.; Šteinbergas, T. 2006. Research on the prices of flats in the south east London and Vilnius, *International Journal of Strategic Property Management* 10(1): 51–63.
- Recatala, J. R. I.; Baird, I. A.; Hamilton, N. and Sanchez, J. 2000. Land-use planning in the Valencian Mediterranean Region: Using LUPIS to generate issue relevant plans, *Journal of Environmental Management* 59(3): 169–184.
- Rondinelli, D. A. 2006. Government Decentralization and Economic Development: The Evolution of Concepts and Practices, *Research in Public Policy Analysis and Management* 15: 433–445.
- Savage, V. R.; Kong, L. 1993. *Urban constraints, political imperatives: environmental design in Singapore* [cited 10 09 2008]. Available from Internet: <<http://www.sciencedirect.com/science/journal/01692046>>.
- Sentosa, L. S. 2001. Genius loci within Balinese dwellings environments: the unlikely scenarios of urban development in Bali, *Habitat International* 25(2): 255–272.
- Swiss and German cities dominate ranking of best cities in the world. Citymayors Environment. 2008 [cited 10 09 2008]. Available from Internet: <[http://www.citymayors.com/features/quality\\_survey.html](http://www.citymayors.com/features/quality_survey.html)>.
- Tansel, A. 2002. Determinants of school attainment of boys and girls in Turkey: individual, household and community factors, *Economics of Education Review* 21(5): 455–470.
- Tyler, S. R. 1996. *Household energy use in Asian cities: responding to development success* [cited 10 09 2008]. Available from Internet: <<http://cat.inist.fr/?aModele=afficheN&cpsidt=2987413>>.
- Turskis, Z. 2008. Multi-attribute contractors ranking method by applying ordering of feasible alternatives of solutions in terms of preferability technique, *Technological and Economic Development of Economy* 14(2): 224–239.
- Turskis, Z.; Zavadskas, E. K.; Peldschus, F. 2009. Multi-criteria optimization system for decision making in construction design and management, *Engineering Economics* 1(61): 7–15.
- Vilnius City Municipality. 2008 [cited 10 09 2008]. Available from Internet: <[http://www.vilnius.lt/new/en/vadovybe.php?open=4&root=2&sub\\_cat1=146&id=118](http://www.vilnius.lt/new/en/vadovybe.php?open=4&root=2&sub_cat1=146&id=118)>.
- Viteikienė M. 2006. Sustainable residential areas evaluation, *Technological and Economic Development of Economy* 12(2): 152–160.



- Viteikienė, M.; Zavadskas, E. K. 2007. Evaluating the sustainability of Vilnius city residential areas, *Journal of Civil Engineering and Management* 13(2): 149–155.
- WHO International Housing and Health Symposium Vilnius, Lithuania. September 29–October 1. 2004 [cited 10 09 2008]. Available from Internet: <[http://www.euro.who.int/Document/E87878\\_pt3.pdf](http://www.euro.who.int/Document/E87878_pt3.pdf)>.
- Willoughby, C. 2001. Singapore's motorization policies 1960–2000, *Transport Policy* 8(2): 125–139.
- Yetgin, F. and Lepkova, N. 2007. A comparative analysis on housing policies in Turkey and Lithuania, *International Journal of Strategic Property Management* 11(1): 47–64.
- Yoon, S. W. and Lee, D. K. 2003. The development of the evaluation model of climate changes and air pollution for sustainability of cities in Korea, *Landscape and Urban Planning* 63(3): 145–160.
- Zavadskas, E. K.; Ginevičius, R.; Kaklauskas, A.; Banaitis, A. 2005. Analysis and modeling of the Lithuanian real estate sector, *Journal of Business Economics and Management* 6(3): 135–143.
- Zavadskas, E. K.; Kaklauskas, A. 2005. Working out a rational model of Lithuanian construction industry development, *Journal of Business Economics and Management* 6(2): 71–80.
- Zavadskas, E. K.; Kaklauskas, A. 2008. Model for Lithuanian construction industry development, *Transformations in Business & Economics* 7(1): 152–168.
- Zavadskas, E. K.; Kaklauskas, A.; Banaitis, A.; Kvederytė, N. 2004. Housing credit access model: the case for Lithuania, *European Journal of Operational Research* 155(2): 335–352.
- Zavadskas, E. K.; Kaklauskas, A.; Kaklauskienė, J. 2007a. Modelling and forecasting of a rational and sustainable development of Vilnius: emphasis on pollution, *International Journal of Environment and Pollution* 30(3-4): 485–500.
- Zavadskas, E. K.; Kaklauskas, A.; Šaparauskas, J.; Kalibatas, D. 2007b. Vilnius urban sustainability assessment with an emphasis on pollution, *Ekologija* 53(Supplement): 64–72.
- Zavadskas, E. K.; Peldschus, F.; Kaklauskas, A. 1994. *Multiple criteria evaluation of projects in construction*. Vilnius: Technika.
- Zavadskas, E. K.; Viteikienė, M.; Šaparauskas, J. 2007c. Sustainable development assessment of cities and their residential districts, *Ekologija* 53(Supplement): 49–54.
- Zavadskas, E. K.; Turskis, Z.; Tamošaitienė, J.; Marina, V. 2008a. Multicriteria selection of project managers by applying grey criteria, *Technological and Economic Development of Economy* 14(4): 462–477.

## VILNIAUS DARNAUS VYSTYMO KONCEPTUALUS MODELIAVIMAS

A. Kaklauskas, E. K. Zavadskas, J. Šaparauskas

Santrauka

Šis tyrimas apima penkias pakopas: išsivysčiusių šalių miestų ir Vilniaus darnaus vystymosi lyginamasis aprašymas; išsivysčiusių šalių miestų ir Vilniaus darnaus vystymosi skirtumų nustatymas; bendrų pasiūlymų, kaip pagerinti Vilniaus darnos lygį, kūrimas; konkrečių pasiūlymų pateikimas Vilniaus miestui; miestų darnaus vystymosi komponentų daugiakriterinė analizė ir efektyviausio miesto darnaus vystymosi gyvavimo ciklo varianto parinkimas. Tyrimų rezultatus iš dalies patvirtina turimi duomenys, aprašytos kai kurios žinomų miestų vystymosi tendencijos. Tyrimas iliustruojamas Vilniaus pavyzdžiu.

**Reikšminiai žodžiai:** darnus miestų vystymasis, globalinės vystymosi tendencijos, alternatyvos, Vilnius, konceptualus modeliavimas.

**Artūras KAKLAUSKAS.** Prof PhD DrSc. Chair in Construction Economics and Real Estate Management Department and Vice-director of the Institute of Internet and Intelligent Technologies at the Vilnius Gediminas Technical University. Lithuanian Science Prize Laureate, Expert member of Lithuanian Academy of Sciences, Leader of the CIB Study group SG1 “The Application of Internet Technologies in Building Economics” and past Advisor of the e-Business W@tch Web for ICT and Electronic Business in the Construction Industry. Editor of “International Journal of Strategic Property Management”, “Journal of Civil Engineering and Management” and editor of “Facilities” for Central and Eastern Europe. He participated in 9 Framework 5 and 6 projects and author of 221 research publications and 7 monographs.

**Edmundas Kazimieras ZAVADSKAS** is a principal vice-rector of Vilnius Gediminas Technical University and head of the Dept. of Construction Technology and Management at Vilnius Gediminas Technical University, Vilnius, Lithuania. He has a PhD in building structures (1973) and Dr Sc (1987) in building technology and management. He is a member of Lithuanian and several foreign Academies of Sciences and Doctor honoris causa at Poznan, Saint-Petersburg, and Kiev Universities. He is also a member of international organisations and was a member of steering and programme committees at many international conferences. E. K. Zavadskas is a member of editorial boards of several research journals as well as the author and co-author of more than 300 papers and a number of monographs in Lithuanian, English, German and Russian. Research interests: building technology and management, decision-making theory, automated design and decision support systems.

**Jonas ŠAPARAUSKAS.** Doctor, Associate Professor. Department of Construction Technology and Management. Vilnius Gediminas Technical University. First degree in civil engineering, Vilnius Gediminas Technical University (1997). Master of Science (1999). Doctor (2004). Research visits to Leipzig Higher School of Technology, Economics and Culture (Germany, 2000 and 2001) and Eindhoven University of Technology (The Netherlands, 2002). Researcher in International Project “Intelligent cities” (2004), Member of the EWG-MCDA Working Group within EURO since 2002. Author of about 15 scientific articles. Research interests: construction technology and organisation, project management, multiple criteria decision making and sustainable urban development.