



TOWARDS CREATING THE ASSESSMENT METHODOLOGY FOR URBAN ROAD TRANSPORT DEVELOPMENT PROJECTS

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Received 04 December 2011; accepted 09 September 2012

Abstract. The assessment of development on transport infrastructure is a very complicated process using different methods and complexity substantiating their necessity to the State and the society. Accomplished analysis of the assessment of development projects on transport infrastructure used in foreign countries and Lithuania shows that standardized and united methodology does not exist; however many methods and their modifications are used in transport sector. Moreover, there is a problem concerning the assessment of development projects of urban and rural road transport infrastructure in Lithuania. It is obvious that differences between urban and rural road transport infrastructure do exist, but Lithuanian practice shows that common methods are used during the process of preparation and evaluation of development projects, including common assessment aspects, criteria and result indicators.

Keywords: sustainable development, urban and rural automobile road transport infrastructure, social-economic assessment, evaluation indicators and criteria, statistical analysis.

Reference to this paper should be made as follows: Griškevičiūtė-Gečienė, A.; Burinskienė, M. 2012. Towards creating the assessment methodology for urban road transport development projects, *Technological and Economic Development of Economy* 18(4): 651–671.

JEL Classification: D61; D70; H43; R41; R42.

1. Introduction

Sustainable development is recognized as an endeavor to harmonize the growth of urban territories with a social progress by reducing waste of non-renewable natural resources and negative impacts on ecological equilibrium. The cohesion of economic, social and ecologic aspects constitutes the foundation for developing a sustainable city. The quality of transport systems, specifically technical infrastructure and functionality, ensures the existence of

economic and social spheres and is treated as being very important to sustainable urban development. A decade of practice to adapt the principles of sustainable development for urban and rural territories of the Republic of Lithuania shows that this process is very slow, for very little attention was and still is being placed on the development of transport systems: there was and still is a lack of investments for the development of transport infrastructure. Moreover, the process of global integration stimulated the increase of automobilization level which changed the character of territorial consumption, the structure of cities and towns; it also stimulated the process of agglomeration and formed new urban problems (Automobilių kelių investicijų vadovas... 2006; Burinskienė, Rudzkienė 2007; Griškevičius, Griškevičienė 2004; Jakimavičius, Burinskienė 2009; Mačiulis *et al.* 2009).

This issue was started to be solved after the Recovery of Independence of the Republic of Lithuania while implementing a financial support of the European Union (further–EU). The investment projects related to reconstruction of priority urban bypasses, bridges, one level and multimodal crossings, highways together with the anticipated funding commenced to be prepared. The Government applied the procedures of assessing the international projects of rural transport (particularly automobile road transport) in order to validate and evaluate urban transport development projects. It was an easy task to do so as the main aims of the first period of the EU financial support were related to the construction of transport infrastructure, which had to be part of Trans-European transport networks or had to ensure the approach to these networks. The changes that would enable one to evaluate the development projects of urban transport in comparison with rural transport investment projects were not assessed methodologically.

Preparation and selection of investment projects face the problem of assessment which requires: a proper identification and justification of a project according to various aspects, determination of its technical and economic indicators, financial indexes, risk and continuity, a correct choice of alternatives, etc. (Bivainis, Butkevičius 2003; Griškevičius, Griškevičienė 2004; Mačiulis *et al.* 2009). The project assessment allows determining the efficiency of investment alternatives according to particular criteria. In respect of sustainable development, the assessment of development projects of urban and rural transport infrastructure is a very important factor to ensure social, economic and financial activities of separate regions. Seeking to absorb a financial support for the implementation of projects, it is necessary to frame appropriate methodology for a proper assessment of investments that generally differs according to various circumstances.

Moreover, generally applied methodology concerning development, justification, evaluation and ranking of projects could not assess specificity of urban transport systems. Practical investigations of the last decade have allowed professionals to ascertain the need for improvement. In order to improve the approach to the development of Lithuanian urban transport infrastructure, the authors of the present article (further – the Authors) conducted several research works during the years 2008–2012.

The aim of the article is to analyze the essential aspects used in Lithuania and foreign countries for assessing transport development projects in order to form the main methodological steps towards the evaluation of urban road transport development projects implemented in Lithuania.

2. The Assumptions for Developing Urban Transport Infrastructure

Since financing is the most common problem in the realization of transport development policy, investment priorities influencing an adopted transport policy trend are being analyzed. According to urban planning specialists (Burinskienė, Rudzkienė 2007; Juškevičius, Burinskienė 2007), the principles of establishing these priorities concur with the statement: to reach maximum performance of transport system with beneficial results for people and environment by using minimum expenses. In other words, the development of transport systems including social, functional, traffic safety, economical, special and other aspects must assess the opportunity to create (modernize) transport system whose technical parameters and service quality shall correspond to the level of EU countries and integrate into the EU transport system, seeking to create proper conditions for the development of national economy. Paying attention to the use of limited financial sources, to the EU financial support and to the State Investment Program (further – SIP), the selection of projects for priority implementation has to be the main concern for the Decision makers. The practice of the last decade in Lithuania shows that only small part of projects presented to the decisions makers are approved. Besides, these selected projects are major projects concerning the implementation of rural road network. Therefore they have bigger possibility to be supported by the EU financial funds. Other smaller projects usually presenting problems of local urban transport are left for the concern of local authorities.

The selection of urban transport development projects for the priority implementation has to be improved. In order to establish the need for developing transport systems of certain towns it is of overriding importance to firstly ascertain what characterizes urban transport systems and in what way these systems differ from rural ones; this clear identification of distinguished peculiarities would facilitate selection of relevant assessment principles and their application, the use of financial resources, preparation of appropriate investment projects and selection of projects best reflecting the developmental aims that might lead to rectification of the present situation. For these reasons the Authors carried out few analytic investigations during 2008–2012.

Analyzing differences and similarities of urban and rural transport systems infrastructure the Authors came to the conclusion that only one transport mode can be related to urban territories in Lithuania – automobile road transport. Automobile transport had and still has the highest priority for development. Road and also railway networks cover the whole territory of Lithuania connecting both urban infrastructure of local towns and cities and rural infrastructure of local and international significance. Practice shows that although air transport has a very important share of national economy, the development of air transport is less active than road transport. The main problem is that Lithuania has only four international airports (one of them is used for military purposes). Inland water transport never had a priority for the development, and therefore its infrastructure is very poor and is popular only inside few urban territories of Lithuania. Rail transport infrastructure connects separate cities or industrial objects. Rail transport is usually used for rural travels, because Lithuanian cities and towns have no infrastructure for public rail transport. The development of rail transport is directed to recover rural infrastructure and reconstruction of main railway nodes for bet-

ter rural connections. Therefore, automobile road transport is the main sphere of Author's interests. Transportation problems usually appear at local usage level; thus more attention is paid to the principles of evaluating the development of local transport infrastructure.

According to urban specialists (Juškevičius, Burinskienė 2007) the key factors influencing on differences and similarities of urban and rural road transport systems are the following: *technical infrastructure; transport demand and possibilities; transport modes; occupied area and space for transport needs; system administration.*

Technical infrastructure is mostly a common object of investment projects of transport systems. It consists of linear and other structures (squares, stations, vehicle parking lots, garages, etc.) and equipment (power grid lines, traffic control equipment, and information system). Urban transport system operates for the traffic of pedestrians, passengers and freight transportation inside and outside cities, also for the traffic of special or special purposed transport. The Authors identified different groups of urban transport infrastructure and submitted them to the experts for verification (Table 1).

Rural transport infrastructure serves for the connection between urban territories and main rural centers. According to the technical regulations on road transport (Law on Roads of the Republic of Lithuania (Official Gazette, 1995, No. 44-107; 2008, No. 135-5229), the main differences of urban and rural road transport infrastructure are: size and technical parameters of objects, occupied areas and space for transport, distances between buildings and protected natural territories and the principles of traffic organization. One of the main similarities is that both urban and rural road infrastructure have a hierarchical structure and also require a land plot. This hierarchal structure has a huge impact on grouping of modernized objects, on selection of appropriate technical parameters and thereby on the cost of developmental (installation, reconstruction) works that in turn influences an increase in the value of general development project investments.

Table 1. Selected groups and objects of urban road transport technical infrastructure

| Objects of urban road transport technical infrastructure |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| General communication network (streets, roads, parking lots, paths, territories of transport service, etc.) |
| Main nodes (all level crossings, pedestrian / cyclist passages, squares, etc.) |
| Public Transport infrastructure (route network, rail transport lines, PT traffic lanes, stations, depots, platforms, final nodes, stops, etc.) |
| Traffic regulation and control means (traffic regulation system with centers (traffic-lights, traffic control devices, variable electronic signs, pedestrian, cyclist passage switches, pavement signing, etc.), Park and Ride system, informational system with centers (display panels, external screens, stock tickers, etc.) |
| Traffic safety means (traffic watch systems (traffic flows measurement devices, traffic detection cameras, etc.), safe traffic providing systems (speed limiting devices, prominent pedestrian / cyclist passages, safety islands, boxes, safety mirrors, road reflectors and blinking footprint, etc.), pedestrian, calm traffic zones and etc. |
| Environmental means (noise isolation systems, mounds, road pavement, accumulation and clearing of surface water, bio-barrage, greening, premise protection from noise, etc.) |

Various scientists (Burinskienė, Rudzkienė 2007; Daniel Jonsson 2008; Jakimavičius, Burinskienė 2009; Juškevičius, Burinskienė 2007; Hull 2005) states that *transport demand in urban territories* depends on a city size, on compactness of urban territory, on a type of functional structure, on a social demographical structure and employment of citizens, on a financial basis of a city, its economic activity as well as on the income of residents, whereas *transport demand in rural territories* is mostly influenced by distribution of large cities within the whole State or their significance in the system of local settlements, a type of activities of enterprises, territorial distribution of dwellings and workplaces. This determinant has a great influence on evaluation of social and economic factors in establishing external costs of separate development-related projects.

The need of land for transport depends on road or street significance, traffic intensity and outfits, which could appear in this space. One of the main differences is that urban land is more expensive and needs to be saved. The possibilities of saving are limited. Planning, designing, building and maintenance of transport territories require huge investments. Besides, space for transport needs is not mono-functional within urban territories; its multi-functionality is determined by the significance of space for transport needs in a common structure of the whole city. The prestige of a city and possible investments depend on space quality for transport needs. Meanwhile, rural land is being saved, but priority is given to ensure proper and safe traffic conditions for transit transport. Protected natural territories (reservations, sanctuaries, forestry, water use, etc.), historical-archaeological or cultural heritage sites and also frequent natural obstacles underway create special conditions for the use of areas and space for transport needs within urban and suburban or rural territories. This determinant influences greatly the impact of external factors of separate investment projects of development on the environment, cultural heritage, land use, its designation and assessment of additional costs.

Transport systems operate in certain *administrative territories*. The local authorities are responsible for administering urban transport systems and a road transport network of local significance; they are the main Decision-makers in the process of transport planning; usually, development of urban transport infrastructure is actually being funded by local government budgets and by budgets received and accumulated in funds of municipal urban development, i.e. by those of building legal and natural persons in accordance with individual funding agreements with a municipality. Meanwhile, the road transport sector has one administrator – who is responsible for all the roads of national significance – Lithuanian Road Administration together with a structured administrative institution of separate regions. The activities of the said institutions aim mainly at developing transport systems and infrastructure, at ensuring traffic safety, and specifically at working economically and efficiently when creating adequate traffic conditions. Although the activities of the above-mentioned administrative institutions are based on different principles, the pursuit of sustainable development of transport is the main feature uniting the said institutions. While seeking to implement transport policy at its own level of competence, the possibilities of using EU funding influence the preparation of not only normative but also methodical acts. Such consolidation of powers is of great importance nowadays as EU financial support stimulates the creation of multimodal transport infrastructure and helps to establish closer interconnectedness between urbanized territories

and rural transport systems. The assessment of all these possibilities concerning development is implemented in the process of evaluating and substantiating separate projects of sustainable development. The methods of assessment used for substantiating separate objects of infrastructure with reference to efficacy and feasibility of different possibilities for development are regarded as one of the major issues analyzed by the Authors. A variety of assessment methods used in the EU countries allow systematizing the most appropriate methods realized in the process of substantiating transport infrastructure development and applying or modifying them to ground the development of Lithuanian urban transport infrastructure.

A short analysis of the assessment systems of land road transport infrastructure development used in the EU countries is presented in next section.

3. A General Approach to the Assessment of Automobile Road Transport Development in the EU Countries

During the last decade transport infrastructure has been evolved in Europe. As a result, some implementation of transport development projects of high speed railways, air transport networks and transit transportation systems are implemented. The analysis of realizing the EU financial support shows that the investments to transport infrastructure were mostly orientated to the creation of main connections between urban territories through the development of road, rail, water and air transport. The best example of it – the development of Trans-European transport corridor TEN. The impact on business environment, the growth of economy and employment can be described as positive aspects of such development. Yet, this development created certain problems of sustainable ecology. It required huge investments, the use of land and renewable natural resources. Therefore, more attention started to be paid to transport policy combining the solutions of territorial planning with strategic planning, thus implementing a regional policy (De Brucker *et al.* 2011; Geurs *et al.* 2003; Grant-Muller *et al.* 2001; Mateos *et al.* 2007; Odgaard *et al.* 2005; Rus 2006; Thomopoulos *et al.* 2009).

The analysis of methodology focused on evaluating the development of automobile road transport infrastructure in the EU countries was carried out by the Authors. To allow comparisons of similarities and differences in the assessment systems the analyzed countries have been grouped in five regions confirming the grouping presented in the study by Grant-Muller *et al.* (2001) (Table 2).

The results of the analysis show that as it is mentioned above the assessment methodology is usually common for developing infrastructure of all transport modes. Administrative institutions of different transport sectors were and still are responsible to frame methodology using recommendations of the EU guidelines which highlights the development of infrastructure of European significance. Moreover, analyzing the sector of automobile road transport, it is obvious that differences between urban and rural road transport infrastructure do exist, but methodology mostly highlights justification and assessment of the development of rural road (especially of national significance) transport infrastructure.

Analyzing the practice of the EU countries, the Authors paid more attention to these EU countries that have bigger population than Lithuania where a land is especially preserved and cities are in agglomerations; therefore, oneness of rural roads connecting centers of

Table 2. Analyzed countries* (Grant-Muller *et al.* 2001)

| Region | Selected countries | Standardization of assessment principles for automobile road transport | Assessment principles |
|--------|--------------------|------------------------------------------------------------------------|-----------------------|
| North | Finland | Official requirements, PC software | CBA; QM |
| | Norway | Official recommendations, PC software | CBAs |
| | Sweden | Official recommendations, PC software | CBA |
| East | Czech Republic | Official recommendations, PC software | CBA; MCA |
| | Hungary | Official recommendations | CBA; MCA |
| | Latvia | Official recommendations | CBA |
| | Lithuania | Official recommendations | CBA |
| | Poland | Official recommendations | CBA; MCA |
| | Italy | Official recommendations | CBA |
| South | Greece | Official recommendations, other | CBA; QA |
| | Spain | Official recommendations | CBA; MCA |
| | France | Official recommendations | CBA |
| West | Germany | Official requirements | CBA; QA |
| | Netherlands | Official requirements | CBA; QM |
| | United Kingdom | Official recommendations, PC software | CBA; MCA; QM; QA |

agglomerations or separate settlements disappears. In order to systemize the results of the analysis, the Authors pointed out two approaches: *the assessment of general automobile road transport infrastructure and the assessment of automobile road transport infrastructure within urban territories.*

Analyzing the practice of the EU countries, the Authors systemized the process of assessing the development projects of automobile road transport infrastructure in the EU countries (Fig. 1). The main issues raised were to *identify lifecycles of projects, to determine the structure of the assessment, to systemize the methods used for assessment of social-economic criteria during the decision-making process.*

Usually, the process of decision making plays a great role at the initial states of transport development strategic planning. The decisions are made on a different level of institutional approaches. Despite this structure, a selection of separate projects is quite problematic. The solutions usually have to be represented in 2–4 different alternative ways. The selection of optimal alternative is performed evaluating projects using qualitative and quantitative criteria. The final decision is made after performing a detailed assessment. Elaboration of such assessment depends on a project type and its size. The environmental impact assessment is usually included in the whole process of justification.

Analyzing the differences between EU countries in terms of *the first approach*, there is a wide range of purposes for using assessment. For example, the assessment of automobile road transport infrastructure in Germany is performed to facilitate a choice of priority projects for the Transport Investment Plan. The assessment conducted in the Czech Republic is used to select an alternative project and project priorities within transport modes. In France, the assessment of transport infrastructure is used first to decide whether to proceed with a

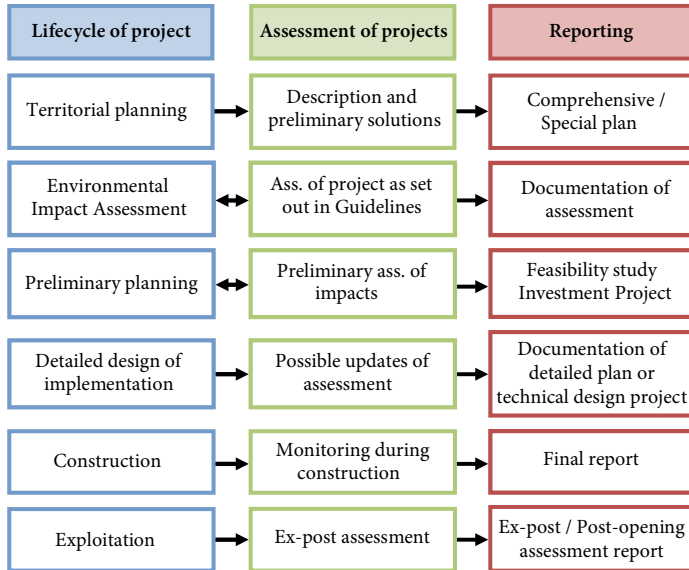


Fig. 1. A general approach to the justification process of development projects on transport infrastructure in the EU countries (systemized results of the EU practice)

project and then select an optimal alternative project including what and when to build. In Sweden, the assessment of transport infrastructure is used to select projects that should be included in the 10-year plan which is updated every 4 years. This type of assessment is also used to choose an optimal solution of all alternatives at the level of project feasibilities. Various scientists (Beria *et al.* 2010; Bekefi *et al.* 2003; Eliasson, Lundberg 2011; Gitelman *et al.* 2008; Joumand, Nicolas 2010; Parkhurst, Richardson 2002; Rus 2006) confirm that social-economic assessment is the most common way to make final decisions. Usually this assessment consists of three main stages: Social Justification, Financial and Economic Evaluation.

Cost-Benefit Analysis (further-CBA) or Multi-Criteria Analysis (further-MCA) methods are most commonly used for social-economic assessment (Table 2). Analyzing the use of most common CBA and MCA, there are usually opinions (Brambilla, Erba 2004; Brauers, Zavadskas 2011; Beukers *et al.* 2012; Eliasson, Lundberg 2011; Beria *et al.* 2010; De Brucker *et al.* 2011; Macharis *et al.* 2009; Schetke, Haase 2007; Saporauskas *et al.* 2011; Kildiene *et al.* 2011; Antucheviciene *et al.* 2011) that CBA can be adapted more widely since this analysis incorporates two important stages – the impact analysis and monetary assessment. Also, a modern approach to assessment assures that there are many intrinsic shortcomings and limitations concerning accuracy of information, distributional equity, compensatory payments, discount rate and lifetime of a project. Thus, information uncertainty and conflict management are critical issues. Many conflicting views may emerge evaluating alternative projects. Moreover, nowadays the concept of sustainable development is used for assessing non-monetary and qualitative effects. Therefore, next to a monetary CBA based approach it is necessary to apply other approaches such as decision-making and institutionally-based approaches. Especially modern approaches like MCA can help in this position. MCA can

be helpful in taking into account such conflicting issues by considering priority schemes or weights as an element in an evaluation analysis of development projects. A modern approach to using MCA confirms that this type of method is more flexible in the assessment of transport investment projects. However, social-economic assessment is usually applied to a wider evaluation of various impacts, and therefore new modified and combined CBA and MCA methods are being used. Table 3 shows summarized groups of impacts used for the assessment of automobile road transport infrastructure in the EU countries.

Table 3. Summarized impacts used in the assessment of automobile road transport infrastructure

| Impacts used in CBA and MCA | | | | | | |
|-----------------------------|---------|-----------------------------------------|------------------------------|-----------------------------------------------------------------------------|---------------------------|--|
| Direct | Costs | Investment | | | | |
| | | Capital | | Administration | | |
| | | Investigation / planning / designing | | Compensation for ecological effects and replacement of environmental assets | | |
| | | Land take | | Mitigation of environmental impacts | | |
| | | System Operating | | Maintenance | | |
| | | Residual value | | | | |
| | | Benefit | Travel time | | Accessibility | |
| | | | Vehicle Operating Cost (VOC) | | Reliability | |
| | | | Safety-Accident | | Service Quality - Comfort | |
| | | | | | Sustainability | |
| Environmental | Benefit | Noise | Dust nuisance | Landscape – Visual impacts | Severance | |
| | | Vibration | Water Pollution | Land Take | Ecological impact | |
| | | Local / Regional / Global Air Pollution | | Land Amenity | Agriculture impact | |
| | | CO2 emissions | Electromagnetic radiation | Special Sites | | |
| Indirect Social | Benefit | Output | Urban functioning | Strategic Mobility | Barrier and risks | |
| | | Employment | Urban renewal | Defense | Equity | |
| | | Land Use | | Revenues/ User charges | Other Policy Synergy | |

Three main economic impacts – Travel time, VOC and Accident – have monetized values. Environmental impacts as shown in table 3 (vibration, emissions etc.) usually have non-monetised values, except for Noise, Air pollution, Dust nuisance which can be monetised. Indirect social–economic impacts as output, urban functioning land use etc. usually have non-monetised values. Costs usually include investment, planning and implementation, and system operating together with maintenance costs. Other types of costs are more specific and used more rarely. Further a short analysis of assessment methods and evaluated impacts used in few selected countries are presented.

France (Grant-Muller *et al.* 2001; Macharis *et al.* 2009; Margail, Auzanet 1996) uses CBA for monetary valued effects plus MCA to take into account accessibility, direct and indirect employment, included economic effects, compliance with local strategies and other effects that can influence selection.

Germany (Odgaard *et al.* 2005; Schetke, Haase 2007; Thomopoulos *et al.* 2009) uses CBA plus non-monetary assessment of special effects and non-monetary ecological risk analysis, including impacts as ecologic risk, spatial development and connectivity, urban improvement. The weighting on a 1 to 5 scale is used for each parameter.

The Netherlands (Haugen 2004; Odgaard *et al.* 2005) for a primary assessment uses a special method which helps to list the characteristics of alternatives against determined criteria. These characteristics can be both measured and described. Therefore, sometimes, MCA is used and CBA is used for major projects. Non-monetised impacts include noise, vibration, air quality, safety, security, landscape.

In *Norway* (Kjerkreit *et al.* 2008; Odgaard *et al.* 2005; Thomopoulos *et al.* 2009), methodology created in 2006 is often used assessing road transport projects. It allows evaluating the results of an opened project by using CBA. The biggest attention is paid to the forecast of transport volumes which is prepared for a period of 25 years, because post opening (or ex-post) assessments usually are performed only five years after the projects were opened. In the post opening assessment, the changes of effects having non-monetary values are determined. For such calculations a computer program with standard CBA software package EFEKT was created. This program helps to retrieve and compare ex-ante evaluations with ex-post assessments.

The United Kingdom (Hull 2005; Parkhurst, Richardson 2002) has made significant changes over the last 15 years in the methodology used to assess transport infrastructure. MCA is used in conjunction with CBA. Impacts do not have explicit weights. Decision makers judge whether proposals offer good value for money. Such effects as distribution and equity, affordability and financial sustainability, practicality and public acceptability are usually assessed. Townscape, heritage, water, journey ambience, biodiversity, transport interchange are rated on a seven point scale plus a qualitative comment. Landscape is rated on an eight point scale, access to transport – on a seven point scale with a comment. Noise impact is assessed as a reduction in the number of people annoyed.

The practice of *Greece* represents great connections between a national regional policy and recommendations of EU (Polyzos 2010; Thomopoulos *et al.* 2009). The Strategic Guidelines form the basis for identifying investment priorities, which are then to be elaborated in National Strategic Reference Frameworks at the Member State level. In addition to these strategic guidelines, a number of other factors shape a final establishment of transport investment priorities. Other factors include: Cost-effectiveness of projects; Availability of other sources of funding; Appropriateness of transport policy; Administrative capacity to adequately absorb and manage funds. CBA can be used to phase a foreseen transport investment in time or to seek alternatives with similar functionality that offer a higher value for money. The main groups of impacts - economic competitiveness, territorial cohesion, environmental sustainability and additionally the accessibility problem index – are used. The impacts are assessed with the support of the SASI model. This model is a recursive-dynamic simulation model of social-economic development and is common in 130 regions of Europe. It is used to assess social-economic and spatial impacts of transport infrastructure of European significance. Figure 2 shows the structure of the SASI model. This model

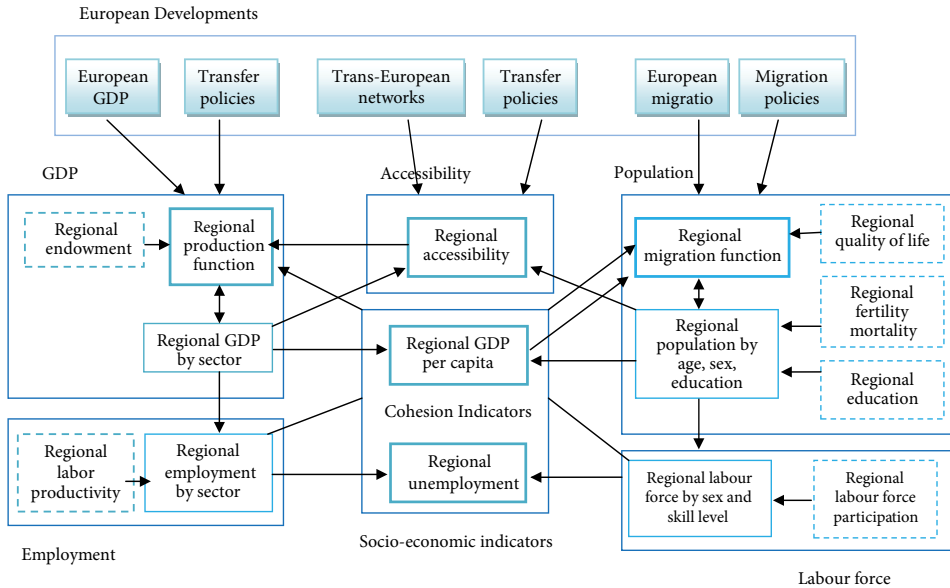


Fig. 2. The structure of the SASI model* (Polyzos 2010; Thomopoulos *et al.* 2009)

helps to model the impacts of transport on regional development by modeling production and population. The model allows to dived forecast time into short periods, the impacts can also be taken into account.

Analyzing the practice of the EU countries in terms of *the second approach*, the Authors paid more attention to the implementation of sustainable development policy within urban territories. In order to solve current urban transport problems, the concept of interaction between transport planning and land use was started to be used. Various scientists (Beria *et al.* 2010; Burinskienė, Rudzkienė 2007; Eliasson, Lundberg 2011; Daniel Jonsson 2008; Mateos *et al.* 2007; Parkhurst, Richardson 2002) define this as an aim to reduce demand for unnecessary travel (land use policy) and to offset the necessary traffic (transport planning policy). Transport policy is more clear and effective than regulation of land use when the main aim of policy is a sustainable transport system. Yet, the means of land use is valid at all stages of transport planning and are often efficient for a long-term perspective. Therefore, an integrated and effective interaction between transport planning and land use is often validated through the procedures of territorial planning. During the last decade integrated planning models dedicated to forecast the impact of urban or regional transport to the expansion were started to be used. The main principles of these models are connected to the main attitudes of sustainable development – environmental, social and economic. But the analysis of existing models shows that still not all of these models determine intermodal connections or have no model for freight transport. Further few examples of qualitative interaction between transport planning and land use used in selected EU countries are presented.

Based on the acknowledgement of the existence of a strong link between the performance of transport modes and the characteristics of areas they were using, the methodology was developed to evaluate social and economic effectiveness of Park-and-Ride (further-PR) schemes in France (Margail, Auzanet 1996). The aim of this methodology was to locate geographic zones in city, where the total cost of travelling by public and private transport would become equal. In other words, to create a system of routes attractive to people living in city. This model was applied to private cars and regional express train network (RER) in the Paris area and placed an optimal location at 20 km from the center of Paris. The method consists of the following procedures: reference situation, investment, direct and indirect costs of using transport modes and the benefits derived by economic agents. Description of current situation includes estimation of total costs, determination of project investors and important users. Key economic indexes treated as a basis for the pricing of PR schemes are determined in economic evaluation using CBA.

A similar policy was implemented in the United Kingdom cities. It was seeking to forbid traffic in the center areas in seeking to expand pedestrian zones with bicycle paths, a new system of reorganized public transport and car parking places (Hull 2005; Parkhurst, Richardson 2002). Table 4 shows the key elements of costs, investments and gained benefit (Margail, Auzanet 1996; Parkhurst, Richardson 2002).

Table 4. The major elements of cost, benefit and investment on PR schemes of Paris area

| Costs elements | Investment elements | Benefit elements |
|-------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| Costs of car usage | Expense of creating the PR facility | Time savings |
| Environmental costs (noise, pollution) | Release of space around the station | Reduction in car use |
| Relieving congestion on the highway or savings inland space | Savings in spending on parking in the centre following modal transfer | Variation in PT use |
| Highway maintenance | Savings in surface public transport as a result of a possible reduction in the size of the bus fleet following the opening of the car park | Savings in parking provision |
| Externalities | | Savings for buses in the suburbs |

Systemizing the results of analytic investigation of assessment systems used in foreign countries the Authors confirm that complicated and modified methods are used for the assessment of urban road infrastructure development. These methods integrate more detailed evaluation of various factors according to objects territory, type of built-up area, general structure of certain town, structure of traffic flows and volumes, population and other social, environmental, traffic safety, technical and other aspects. Systemized aspects of assessment can be grouped as follows: Social-Economic aspects, Environmental- land use aspects, Traffic related aspects.

Next section will present a short analysis of the current assessment system of automobile road transport infrastructure development in Lithuania.

4. Lithuanian Practice in Assessing Investment Projects of Transport Systems Infrastructure

Various scientists (Bivainis, Butkevičius 2003; Griškevičius, Griškevičienė 2004; Mačiulis *et al.* 2009) maintain that the practice of preparation of investment projects of transport infrastructure in Lithuania is not sustained. The current practice shows that the total of own funds is not sufficient for upgrading and developing urban transport infrastructure. Due to uncertain use of finances from local, state and private sectors in sustainable development, Project Financing is becoming one of the most important stages of project implementation. In order to select priority project more efficiently, it is necessary to create assessment model allowing more deeply characterize the need of project implementation. Therefore it is necessary to improve connection between all stages of project lifetime, determine principle guidelines of implementation and also minuteness of justification. In order to reach these aims the Authors suggested the Assessment model for the development of urban transport infrastructure. The main steps of suggested assessment model are shown in Figure 3.

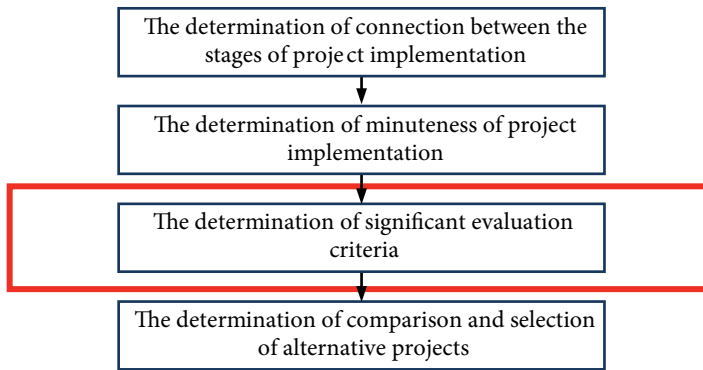


Fig. 3. Main steps of the suggested Assessment model
(Source: Systemized results of expert survey, 2011)

Figure 3 shows that the Authors suggested 4 main steps for the formation of the Assessment model. The main step concerns the determination of specific criteria used for the assessment of urban transport infrastructure development. Integrated structure of specific criteria allows comparing different indicators of alternative projects and also creating priority queue for their implementation.

In order to verify the working of suggested model the Authors carried out few analytic investigations of the current assessment system. *The first analysis* was carried out during the years 2008–2010. Ten projects of local urban road transport infrastructure and five projects of rural road transport infrastructure prepared for the EU financial support were selected. The objects of selected urban transport infrastructure projects met the requirements of description mentioned in Table 1. The projects of rural road transport infrastructure included separate elements (bridges, junctions, roundabouts, bicycle paths) of local roads and regional roads of national significance having links with European Transport corridors. These mentioned

projects were compared in order to verify the first and the second main steps of suggested assessment model: *to systemize the existing differences in approving the development of urban and rural road transport infrastructure: a structure of the whole process, the principles of assessment and lifetime of project were identified*. The systemized results of the first analysis showed that:

- Assessment of the development of automobile road transport infrastructure was and still is used for these projects which meet the requirements of the EU and the State transport policy. The development of transport infrastructure funded by local authorities is validated with the implementation of the detailed plan or a technical design project, and the necessity for approving development is not defined and is usually not required.
- Moreover, there is no uniform system of the assessment of urban road transport infrastructure. According to the Government, it is authorized to interpret assessing impacts on project solutions. The effects of interpretations are usually experienced in various social-economic, engineer-technical and natural environments inseparable from each other and having additional and continuing connections. Therefore, if a problem occurred in one sphere (environment), it can cause more negative short-term or long-term effects.
- Moreover, the methodology of assessment of rural road transport infrastructure which was approved by the Lithuanian Road Administration (after EU official recommendations) is commonly used for the assessment of urban road transport infrastructure (Automobilių kelių investicijų vadovas...2006; Guide to Cost Benefit Analysis...2008; Laurinavičius *et al.* 2012). Referring to the EU recommendations, the Lithuanian Guidelines defined the main steps towards implementing road infrastructure projects and the main aspects used for assessment.
- The justification has to be tightly connected to separate stages of territorial planning and environmental impact assessment in order to prepare a financial program and allocate financing for the final stages of project implementation. However, the results of the accomplished analysis carried out by the Authors confirmed that usually both stages of territorial planning and environmental impact assessment or the stage of justification are missed or performed after the stages of technical design creating problems of non-correspondence to forecasted indexes and illustrating the problems mentioned above.
- Determinations or calculations of separate assessment elements are similar for both urban road and rural road infrastructure. Total costs of separate projects are assessed by the same methods, considering costs for Planning, Designing, Construction and Maintenance. Moreover, the same variation rate is applied for the CBA calculations. Indexes used in these calculations are confirmed and recalculated every few year by the Lithuanian Road Administration. The same variation rate is applied to forecast transport indexes. Software is used for foreseeing distribution of transport flows.
- The main criteria used in the CBA have numeric (monetary) expressions and are similar as used abroad: Costs of Constructions and Costs of Road Maintenance; Savings in Travel Time, Savings in VOC, Traffic Accident Savings. Ecologic Savings are assessed in different ways: expressing qualitatively or in monetary value. The calculations of Dust, Air pollutant and Noise criteria are expressed in monetary terms, but a qualitative expression of Ecologic aspects is more common.

- The MCA is still rarely used for the assessment of automobile road transport infrastructure development implemented in cooperation with international institutions. (However, investment projects implemented in cooperation with the State are assessed by using the MCA. The result of this method is the evaluation of efficiency of alternative investment projects according to the selected evaluation criteria that shall reflect both the investment project of implementing a subject as well as the interests of the State). Moreover, the results of the first analysis confirmed that the MCA is used for selecting alternative concepts prepared for the same object to reach better results of a separate development project. Alternative concepts are compared using specific criteria. The type of criteria used is qualitative (maximizing) or quantitative (minimizing). The total score of criteria shows the better alternative to select. However, this MCA method used is explicit. It uses only few criteria of technical, economic and social aspects: for example, the total amount of investment, the effectiveness of costs of accidents, the effectiveness of ecologic costs, the effectiveness of VOC, the ratio of social-economic benefit and costs. Therefore, the results of selecting an alternative concept can be evident beforehand.

Systemized results of the first analysis confirmed that current assessment system is similar to the ones used abroad and can be used to assess the development of urban transport infrastructure. Therefore the Authors concentrated their analysis on the determination of specific criteria influencing the development of urban transport infrastructure. Moreover Authors maintain that the usage of combined CBA and MCA methods could help to systemize results of alternative projects comparing one integrated indicator. The findings of the second analysis concerning this topic are presented in another part.

5. The Implication of a New Approach

The second analysis was carried out during the years 2010–2011 in order to systemize the main principles used: evaluation aspects and criteria used in the assessment of development of road transport infrastructure and to determine general significant criteria. The expert survey was carried out. 55 experts, performing in the spheres of preparation, evaluation and organization of development projects of urban and rural road transport systems and territorial planning, were invited to participate in this research. Only 18 experts finished the survey. Delphi method was used to systemize the results of this survey. 16 questions concerning the assessment system used in Lithuania were presented. The first 6 questions included general information about a concept of justification and description of urban transport infrastructure. Other questions were more specific, concerning the system of assessment: separate evaluation aspects and criteria were presented. All questions were divided into separate groups of urban transport infrastructure objects (6 groups according to Table 1), seeking to establish the impact of analysis-related criteria on the development of separate groups. The results of the expert survey were systematized by applying methods of statistical analysis.

The results of statistical analysis showed that general questions were related and approved by statistical indicators. The results confirmed that question No. 6 presenting the relevance of separate evaluation aspects was the most important for the experts. (Table 5).

Table 5. The results of statistical analysis of question No. 6

| No. | Main evaluation aspects | N | Mean | Median | Standard deviation |
|-----|-------------------------|----|--------|--------|--------------------|
| 1 | Strategic aspect | 18 | 0.9444 | 1 | 0.2357 |
| 2 | Social aspect | 18 | 1.0 | 1 | 0.0 |
| 3 | Economic aspect | 18 | 1.0 | 1 | 0.0 |
| 4 | Financial aspect | 18 | 0.8889 | 1 | 0.3234 |
| 5 | Technical aspect | 18 | 0.9444 | 1 | 0.2357 |
| 6 | Traffic safety aspect | 18 | 0.8889 | 1 | 0.3234 |
| 7 | Environmental aspect | 18 | 0.8889 | 1 | 0.3234 |
| 8 | Land use aspect | 18 | 0.7222 | 1 | 0.4609 |

Source: Systemized results of expert survey, 2011

Table 5 shows that experts were unanimous for the usage of Social and Economic aspects, also Strategic and Technical aspects. The usage of Land use aspect was negotiable and depended on more detailed statistical analysis of received results. According to the recurrence frequency of expert answers, the results were systemized by the method of clustering analysis (90 answers for 6 groups of urban transport infrastructure). In order to select and combine evaluation criteria common for all suggested groups of urban transport infrastructure the *method of k-mean* was applied. After 4 steps of iteration the expert answers were combined into 3 clusters. The first cluster combined criteria having minimal influence (11 criteria – Environmental and Land use aspects), the second cluster – having average influence (8 criteria – mostly Economic, Social, Strategic aspects), the third cluster – having the greatest influence (10 criteria – mostly Traffic Safety and Technical aspects) on the assessment process. The priority queue of criteria inside each cluster was formed showing their importance. Criteria of financial aspects were not included in these clusters and can be treated as spare criteria used for specific cases.

In order to simplify the process of comparison of alternative project general significant criteria have to be determined. Since development projects usually integrate few groups of urban transport infrastructure, criteria of the first cluster were also included. Three criteria of each cluster were selected after the EU guidelines to determine criteria characterizing relevance, utility and efficiency of separate projects. These criteria selected independently of their priority queue, because of possibility to be expressed by more than one different indicator with quantitative or qualitative expression and also seeking to simplify the determination of integrated indicator. This proves the opinion of scientists (Burinskienė, Rudzkiene 2007; Yazdani *et al.* 2011) that indicators having influence on sustainable development, have to be known for the publicity, comprehensible and measurable. Table 6 shows general criteria selected.

Table 6 shows that clustering analysis allows systemizing criteria necessary to be included in the assessment of urban transport infrastructure. These criteria has common feature – they can be expressed in numeric terms, but also can be describe qualitatively. Particular attention is focused on Traffic Safety. The criterion of priority Technical aspect embraces the results of the research on road; thus it indicates the need to determine the scope and structure of indispensable research. As the impact of these two major aspects of development is described from the financial point of view and is determined on the basis of economic calculations, the obtained results of the analysis once more prove the importance of the said aspects

Table 6. The selection of general criteria

| Priority | Aspect | Criterion | Expression | Final aim |
|----------------------------------------------------|----------------|-------------------------------------------------------|------------|-----------|
| II cluster – criteria having significant influence | | | | |
| 2 | Technical | Traffic volume and structure, variation | numeric | minimize |
| 3 | Traffic Safety | Number of traffic accident | numeric | minimize |
| 5 | Traffic Safety | Speed variation | numeric | minimize |
| III cluster – criteria having average influence | | | | |
| 1 | Economic | Received economic benefit | numeric | maximize |
| 2 | Social | Influence on resident mobility | numeric | maximize |
| 9 | Social | Influence on employment | numeric | maximize |
| I cluster – criteria having minimal influence | | | | |
| 2 | Environmental | Influence on noise level variation | numeric | minimize |
| 5 | Environmental | Influence on air quality | numeric | minimize |
| 11 | Land Use | The necessity of land take for the needs of publicity | numeric | minimize |

Source: Systemized results of expert survey, 2011

and stringent investigations into substantiation of urban infrastructure development. The economic aspect determining the benefits is represented as a mean value for substantiating the development of urban transport infrastructure. However, according to the present EU regional policy of development and the documents regulating a financial support provided for the EU developing countries, economic assessment has to remain as an essential comparative tool for alternative projects of urban transport infrastructure development. The impact on resident mobility has been selected as the most significant criterion of social aspects which, in its importance, has surpassed such valuable social criteria as the impact on employment or on their social development. The issue concerning resident mobility is one of the newest trends in the EU regional policy. Mobility platforms are being created which unite different cities of the world that seek sustainable mobility. Thus involving this social criterion into substantiation of urban transport infrastructure development projects would be an innovative approach in Lithuanian practice. Environmental impacts are necessary to be included independently of the complexity of objects and necessary implementation stage of environmental impact assessment.

Next step – the determination of integrated indicator – involves both identification of indicators and determination of their importance. The Authors used the simplest method of indicators ranking. Actual values of indicators received from alternative projects are compared with standard expressions determined after the results of cluster analysis. Corrected expressions are valued by the help of indirect ranking. The weight ratios of separate indicators are determined by the help of pairwise comparison method. Since evaluated indicators characterize assessment aspects with the different importance to each other additionally weight multipliers are determined for separate clusters. The values of multipliers are calculated after the correspondence to the recommendations of the White paper (European Commission... 2011): the highest value - for criteria of Traffic safety aspect, the smallest value – to criteria of Environmental and Land use aspects. The results of calculations of integrated indicators and testing of assessment model will be published in Authors' other articles.

6. Conclusions

There is no uniform system for the assessment of development projects of urban road transport infrastructure in Lithuania. According to the Governments, it is authorized to interpret assessing impacts of project solutions. Since there is no basic definite methodology, the effects of interpretations are experienced in various socio-economic, technical and natural environments inseparable from each other and having additional and continuing connections. This gap is filled with methods used for the assessment of development projects of rural road transport infrastructure in spite of the fact that technical infrastructure of road transport partly differs in urban and rural territories. Moreover, methodologies of project justification used in the EU countries mainly highlight the assessment of development of rural road transport infrastructure. Assessing the projects of urban transport infrastructure, streets and roads close to build up areas are unified with common principles. Paying attention to the use of limited financial sources, to the EU financial support and to the State Investment Program, the selection of projects for priority implementation has to be the main concern for the Decision makers.

In order to systemize the existent problems related to the process of assessing the development of road transport infrastructure and to create assessment model specified for urban transport infrastructure, few analyses were carried out during the years 2008–2011. The results of analytic investigation confirmed that current assessment system is similar to ones used abroad and can be used to assess the development of urban transport infrastructure. Therefore the Authors concentrated their analysis on the determination of specific criteria influencing the development of urban transport infrastructure. Moreover Authors maintain that the usage of combined CBA and MCA methods could help to simplify the comparison of alternative projects comparing one integrated indicator and also the formation priority queue for implementation.

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