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A NEW APPROACH TO ASSESSMENT OF INFRASTRUCTURE PROJECTS ON URBAN TRANSPORT SYSTEMS

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The scientific analysis of currently used assessment principles of the development on urban transport systems; subsystems on vehicles, passenger and freight transportations, special public services, pedestrian and bicyclists has been carried out. Each subsystem needs technical infrastructure, the set of informational and traffic control means. Moreover quantitative and qualitative development of transport infrastructure is necessary for appropriate operating of whole communication system. Unfortunately an increase in the level of automobilization, growing transport flows in urban territories and decreasing investment for the development of transport infrastructure are the main barriers for urban development. An uncontrolled increase in automobilization changed the character of the usage of urban territories, urban structure, stimulated the process of agglomeration and formed new problems.

The results of expert evaluation and statistical analysis highlighted the influence of each subsystem on the sustainable development of whole urban transport system by technical, traffic safety, social-economic, environmental and other specific aspects. Objects of technical infrastructure that should be treated as infrastructure of urban road transport system were identified. The results of statistics analysis allowed determine features of separate objects necessary to evaluate; assess and adjust separate stages, key principles and quantitative and qualitative criteria of assessment of the development on urban transport systems infrastructure.

Keywords: sustainable development, urban transport systems, project assessment, statistical analysis, expert survey

1. Introduction

During the process of global integration the number of citizens covering large territories in cities constantly increases. Problems of urban development are becoming relevant. Therefore general urban policy determining main directions for urban development is a complicated and integral part of general policy on state territorial planning and development. Environmental, economic, demographic, planning, technical, managerial and other factors have an influence on complicated, multifunctional processes of urban development. The effect of these factors is usually methodologically assessed in three main aspects: economic, social and environmental. The cohesion of these aspects is the frame for sustainable urban development. Assumptions for sustainable development have to be regularized in planning documents. Local authorities as decision makers have to consider the requirements of territorial planning documents. This principle has to be adopted in the process of strategic planning and implementation of the development of urban transport systems.

One of the most important problems in the whole system of planning is that the connection between strategic planning and territorial planning is rather week. Territorial planning has no official methodology for determination of public infrastructure development trends and opportunities defined. The solutions of valid territorial planning documents partly determine the directions for development of separate cities and other urban territories, and also the necessity of modernization and development of technical infrastructure. Contrary strategic planning uses principles for the definition of evaluation criteria and results in order to determine specific development trends of infrastructure usually without the correspondence to the solutions of territorial planning documentations. In the context of sustainable planning, in order to develop relevant public, and also transport infrastructure, ensuring accessibility and

availability, secure performance, in the same time avoiding negative impact to the environment and society, it is necessary to create a determined and unified model of development on transport systems infrastructure [7, 9].

This article presents the scientific approach for the creation of theoretical model to assess the development of urban transport systems' infrastructure in Lithuania.

2. Current System of Planning

The methodology that is recently put into practice is being developed over the last 12–15 years. After the planned economy period, the rules, standards and regulations of design and construction are newly developed. They relied on the basis of the pre-existing documents and the newly created laws of independent Lithuania. The methodology and procedures of development of programs and preparation of investment projects and assessment of them started to be created anew. Due to extremely difficult economic conditions as the country regained its independence, the state funds and the European Commission's technical/financial assistance have been directed to implementation of major ex-ante studies and investigations of transport communications and preparation of investment projects. The following were the projects of the international significance of reconstruction, modernization and development of separate elements of General Trans-European network in the territory of the Republic of Lithuania: on the highways, rail roads, international airports of Vilnius, Kaunas, Palanga, and the state seaport of Klaipėda. The state has given priority and partial funding to major projects. It is important that together with the reconstruction and modernization of transport arteries of international significance, preparation of their investment project and multidimensional reading at the state level and the European Union (EU), the regulations for the design and construction with their procedures which are applied in the EU have been validated in Lithuania. Technical support that has been accompanying the implementation of these innovations made it possible to absorb these principles quickly and apply them more widely including all planning and design activities of inside objects.

New investments for urban transport infrastructure have not been allocated for a decade. Local authorities of urban territories could only maintain the existing infrastructure and ensure communication of population at the minimum. The problem started to be solved in 1991 while implementing financial support of the EU through the PHARE program. The development and improvements in the level of transport systems on a national scale is inseparable from the level of allocated investments depending on a national policy towards the modernization and development of the transport sector and available possibilities. Having determined the problems of the sector, having formulated the trends and objectives for the development of the whole transport sector and different transport modes, the concrete projects of transport infrastructure are evaluated one by one. The aim of this evaluation is to determine the input of each project to achieve the planned objectives of the sector.

Current trends of development on urban transport infrastructure show, that along with the development of urban areas and decrease in the height of building in the big cities of the country, the integration task arose outside formed population centres. The priority is given to the transport infrastructure projects that meet sustainable development principles and are designed to 1) construct missing streets or roads of bypasses in urban areas and 2) reconstruct the intersections for the free movement 3) modernize the traffic control in the formed part of city ensuring priority passage to public transport and arranging intersections of highways and streets, 4) reconstruct bridges over rivers and viaducts through the railways, 5) modernize and develop urban radial arteries and exit roads from cities 6) assimilate and develop underground space and new buildings for car parking, 7) develop existing and assimilate modern infrastructure for internal communication of the city and communication with the external transport system [2, 10, 15].

Figure 1 shows that the current system of strategic planning consists of three levels. Comparing with other EU countries financial support plays a great role in the process of planning of whole transport sector, but the process of assessment of transport infrastructure development is not so clear. This can be illustrated by the correlation between the stage of strategic planning and the implementation of separate projects. Priority projects are being identified during the stage of strategic planning (ex-ante assessment). Usually these projects are selected after the specific order – to comply the expressions of strategic criteria or preliminary calculated economic and financial criteria without paying more attention to detail expression of social, environmental or other aspects. More detailed evaluation usually is prepared after the selection during the beginning of the implementation stage or sometimes together with technical designing. This principle is not correct because priority projects can describe different type of transport infrastructure, have different objectives and different tasks in the aspect of national level but still have

same importance in the aspect of local level. Moreover the system of strategic planning still does not correspond to the system of territorial planning. Priority investment projects are being selected according to the criteria that meet the requirement of strategic documentations of international and national level. Basic objective for impact assessment on solutions is often ignored as guiding principles of one-day benefit. Besides, practice of 10–15 years shows that General plans determining trends of more or less sustainable development of urban territories started to be prepared quit late comparing with strategic development documentations. Therefore this was a reason to ignore requirement of territorial planning out of the selection and assessment of priority investment projects. Only during the last programming period of 2007–2013 the implementation of territorial planning documentations was included in the financial mechanism of the EU support. Therefore it is widely debated to improve the system of planning, consultation and development in the sphere of new forming solutions of territorial development in the country. However more progressive and developed countries experience these problems as well. Although they have more practice, they similarly form planning objects to strengthen transport sector [2, 5, 9, 10].

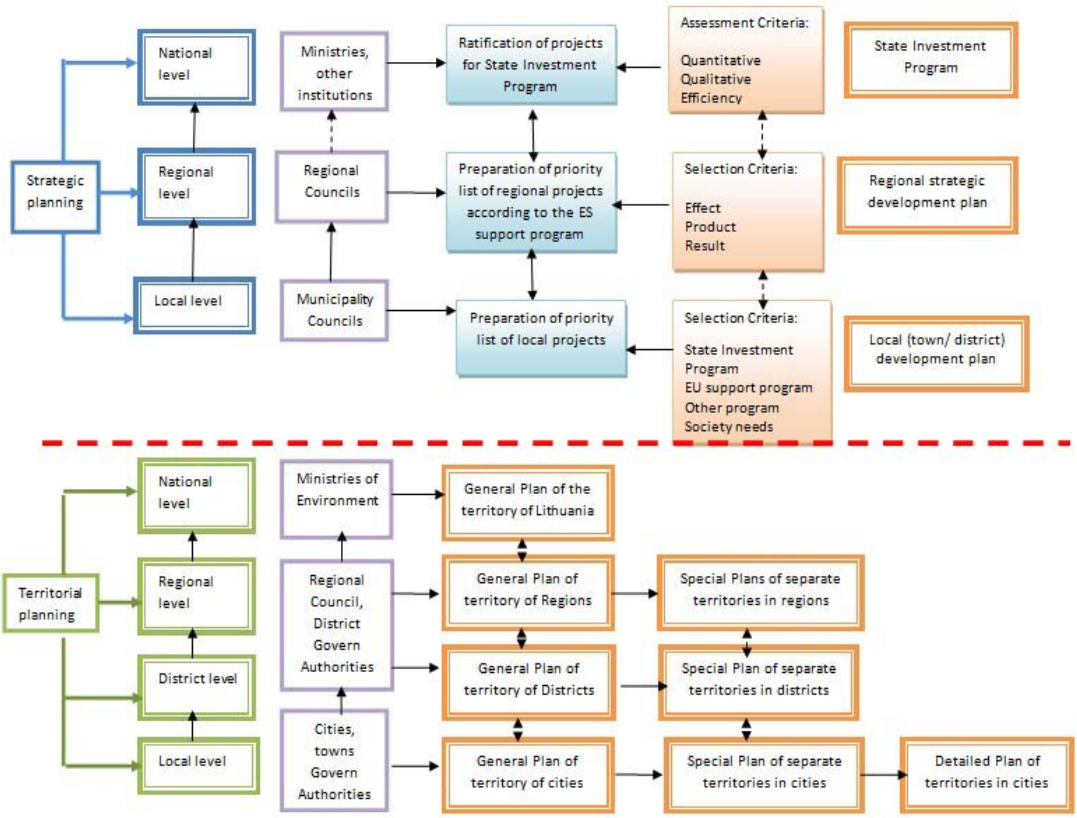


Figure 1. Current system of strategic planning of investment for transport sector in Lithuania

In addition to basic uncertainties of common system of transport development planning, these urban problems can be attributed:

- ✓ ***Urban transport infrastructure systems apply for the definition of public infrastructure***; Transport, social infrastructure and utility networks are often named as components of public infrastructure. However, such a description is not accurate, since the communication system operates in a specific urban area, which is influenced by various factors that may have no impact on other parts of public or social infrastructure. Generally transport system is recognized as an aggregate of pedestrian, passenger and vehicle means and necessary technical infrastructure, information and traffic regulations mean.
- ✓ ***Development of urban and rural road transport systems infrastructure is not separated;*** Generally urban and rural road transport systems are different. Key factors influencing on differences and similarities of urban and road transport systems are as follows: technical infrastructure; transport demand and possibilities; transport modes; occupied area and space for transport needs; environmental, social – economic, financial and other impacts; system administration and management.

- ✓ ***Not all projects for assessment of development of transport systems infrastructure in individual cities and towns are prepared*;** the existing experience on this process shows that in most cases the assessment is carried out on those items, the development of which is provided by finance from EU funds, as required by EU legislation. The development of transport infrastructure funded by local government is validated with detailed plan or technical design, where necessity for assessment of object development is not defined.
- ✓ ***There is no uniform system for urban transport systems infrastructure projects' assessment*;** optimal effects can be expected only if basic solutions are adequately motivated. According to the Governments it is authorized to interpret assessing impacts of projects solutions. Since there is no basic definite methodology the effects of interpretations are experienced in various socio-economic, engineer-technical and natural environments inseparable from each other and having additional and continuing connections. Therefore if problem occurred in one sphere (environment), it can cause more negative short-term or long-term effects.
- ✓ ***The organization of common urban transport systems infrastructure development is not regulated**;* throughout legislation system of the Republic of Lithuania, today there is no regulation on public and social and transport infrastructure development in urban areas. The legislature has not adopted the law that complexly regulates the infrastructure of urban areas. The Land Law of the Republic of Lithuania, the Spatial Planning Law of the Republic of Lithuania, and the Construction Law of the Republic of Lithuania governs individual developmental stages of infrastructure in urban areas, but does not define a clear system, entities that organize and participate in the development of urban infrastructure, their rights, duties and responsibilities [1, 2].
- ✓ ***A large shortfall for the development in urban public infrastructure**;* in general the infrastructure development in urban areas is actually being funded by local government budgets and by budgets received and accumulated in funds of municipal urban development, i.e. by budgets of building legal and natural persons in accordance with individual funding agreements with the municipality. Current practice shows that the total of own funds is not sufficient for upgrading and developing urban infrastructure. Due to uncertain use of finances from local, state and private sectors in urban sustainable development, the opportunity to receive the EU financial support is more and more often used.
- ✓ ***Complicated process for taking land for public needs***; current practice shows that property rights are restored in the planning documentation in planned streets and in areas of public infrastructure, aggravating land use for development of infrastructure in residential areas by that, as these areas has to be bought out from private owners or taken for public needs. One of the main reasons is unclear regulation of redeem ability of state-owned land. At present, the territories where transport infrastructure development is planned are not considered as redeemable state-owned land, so after restoration of property rights in these areas, the land must be redeemed or taken for the needs of society, and compensated for the market price. However, in residential areas, especially in large urban areas, a great shortage of vacant state-owned land is already present. Everything is more complex due to the fact that administration of state-owned land is yet not transferred to municipalities [8].

The selection of alternative investment projects of development on transport infrastructure uses number of definite criteria that are common for different types of objects. Usually quantitative criteria as technical parameters, economic or financial indicators are used; therefore selected projects have to be prepared and assessed avoiding qualitative descriptions that cannot be evaluated in monetary value (social, environmental impacts, etc.). Moreover identification of values of separate criteria affect the identification of project's impact factors and targets, prediction on variation, identification and management of project risk types. Therefore different types of criteria cannot be used equally for the assessment of different type of development projects. This can be illustrated by the example of urban and rural road transport infrastructure. The procedures and the requirements used for the international projects of roads were applied to finance, develop, validate and evaluate urban investment projects. The changes, which would determine the assessment of urban transport projects in comparison with rural road investment projects, were not assessed methodologically. Generally applied methodology for development, justification, evaluation and ranking of the projects could not assess the specificity of urban transport systems.

The assessment methodology of urban transport investment projects is more complex in nature because it is related to a series of factors of social, economic, urban development, technology development, financial feasibility, which depend on the macroeconomic and the financial capacity of local authorities, the economic-social needs of urban population and their realized purchasing power, stages of urban development and further planning. A complex set of factors is included in the author's investigations, which have been carried out with the purpose, in accordance with the tendencies of development of infrastructure of present urban transport systems in Lithuania and other countries, to develop the model for assessment of planning and design of infrastructure [6, 7].

3. Methodology for the Assessment Model

The gap of clear methodology used for the assessment of development on urban transport systems infrastructure has been filled with the evaluation methods for investment projects of rural roads and other transport sectors. In order to determine the importance of urban transport systems infrastructure to territorial planning and to form development trends, development necessity must be assessed. For this purpose development projects are being prepared.

In order to create theoretical model for the development of urban transport and communication systems infrastructure the expert survey has been carried out. Delphi method has been used for the survey. This method is a qualitative method of forecasting. Delphi method has a lot of forms and is still being developed. This method is useful when in order to determine common decision or propose other alternatives, a panel of experts communicates. Therefore there are few stages of survey usually carried out. Delphi strategy recommends to survey 10–50 experts. The results of the survey do not depend on the size of panel, rather on experts' competence.

The aim of this questionnaire survey is to determine and to systemize the approach of qualified experts performing in the spheres of territorial planning, planning and designing of transport and communication systems and working in public and private sectors. Two-stage survey has been carried out. The first-stage questionnaire was formed seeking to determine actual principle of the substantiation of urban transport and communication systems. Later on, systemized results were returned to a panel of experts for the assessment of the averages of first stage answers. The results were filled with the experts' comments and notes. In order to ensure equity the anonymity and the confinement of dominant influence was guaranteed.

Performing in the spheres of preparation, evaluation and organization of projects on urban and road transport and communication systems and territorial planning 55 experts were invited to participate in this research. Experts were chosen according to their qualification and practical working experience. 40 of invited experts accepted to participate in this research. Till the end of this survey 25 experts participated. According to the small number of official institutions performing evaluation of investment projects and also to recommendations of Delphi strategy it was concluded that this number of experts was sufficient for this survey to be reliable.

During the first stage, 16 questions about substantiation and evaluation of urban transport and communication infrastructure were presented. First 6 questions included general information about a concept of projects' substantiation, and urban transport and communication infrastructure. Other questions were more specific, concerning assessment of separate aspects and criteria used for theoretical model. For general questions the principle of marking the best answer was used. For specific questions the graduation (weighting) system assessing a priority of answer was used: 1– not important; 2 – low importance; 3 – average importance; 4 – very important; 5 – no opinion about it.

The results of accomplished expert survey were systemized in order to select the priority factors and characterizing criteria of different aspects, which should be used in the assessment of the development on urban transport infrastructure. For this purpose method of statistical analysis – Cluster Analysis – was used. Basic concepts of Cluster analysis are Similarity and Dissimilarity (distance): distance indicates how many objects are distant from one another (different); similarity shows the proximity of objects. Similar objects belong to the same cluster, remote objects – to different clusters. Crucial moment of Cluster analysis is metrics or in other words – the selection of proximity measure. This measure determines the final division of objects into the groups. Since the answers of expert surveys include large database, authors have used K-means method of Cluster analysis. This method requires specifying the desired number of clusters and therefore it is faster than other method of this analysis [10].

Authors have chosen 4 clusters according to the weighting system, which has been chosen in the stage of Delphi method: 1 – very important; 2 – average important; 3 – low important; 4 – those, which are not included/ weighted of separate experts. In order to reach more detailed results cluster analysis are repeated for each type of urban transport systems' infrastructure objects in order to compose clearer priority list of factors, which need to be included into the assessment of urban transport infrastructure investment projects, and also to create clearer distributions of factors, which need to be expressed in monetary values.

Due to a lack of funds, economic aspect plays a great role in the assessment of investment projects and also in the whole stage of alternative selection. The rationale of transport systems infrastructure

development is often associated with the received economic benefit; due to this many of the criteria must be numeric (monetary value). But not all important criteria (e.g. strategic, social and environmental aspects) can be placed in numeric (monetary) form. In order to determine this, tests are performed and in accordance with specific procedures a numerical value for certain criteria is established. Depending on their composition or method for determining the monetary value, the results on project evaluation can be very different. For example, presently, for the economic evaluation of projects prepared for getting financial support from the EU funds Cost-Benefit Analysis (further – CBA) are widely used. This method has a certain level of universality and helps with evaluating factors having no monetary value. CBA deals with a quantitative and (or) qualitative evaluation; social costs are determined, which also take part in justifying project efficiency in terms of traffic safety as well as considering technical and financial aspects. Together with CBA results, the economic values such as Internal Rate of Return, Net Present Value and Benefit/Cost Ratio are determined. Table 1 shows common effects and elements of CBA used in the assessment of transport infrastructure in the EU countries [1, 4, 6, 7].

Table 1. Common effects and elements of CBA used in the assessment of transport infrastructure in the EU countries

Groups of main effects	Elements
Infrastructure costs	Construction costs Costs for object maintenance operation, repair and administration Investigation/ planning designing Land take Residual value
User benefits	Passenger transport time saving, Vehicle operating costs (further-VOC) Benefit to goods traffic
Externalities	Traffic safety, noise, pollution – local/ regional attitudes Climate change Local/regional/global air pollution Water pollution Land use Urban functioning/ renewal
Other	User charges and revenues Disruption from construction

Table 1 confirms that monetary values of such external factors as Travel time, VOC, Traffic safety can be calculated by the help of CBA. Environmental impacts as noise, air pollution, land use, etc. usually have non-monetized values, but these factors usually are quantitatively expressed. Besides economic evaluation, social one is used where the effect of investment projects on the public is determined. Then the results of social evaluation are used for evaluating the project taking into account a strategic aspect, i.e. to describe the need for the project, to justify technical solutions and road safety measures, to calculate the number of created jobs.

The results of economic, social and environmental or other evaluation can be combined in order to get clearer view of alternative projects and choose those projects which solve bigger problems and create higher value-added to society and the country. Therefore authors suggest modifying the CBA method by adding more specific components using the help of Multi-criteria method (further – MCA). The results of expert survey will help to find out, which substantiation aspects can be used for the composite work of CBA and MCA [11, 12].

The next chapters deal with preliminary results of accomplished Expert survey and Statistical Analysis.

4. Main Directions of Investigation

Due to existing problems in the development of urban transport infrastructure, main steps of suggested project assessment model of development on urban transport systems infrastructure are formed and presented for expert evaluation (Fig. 2).

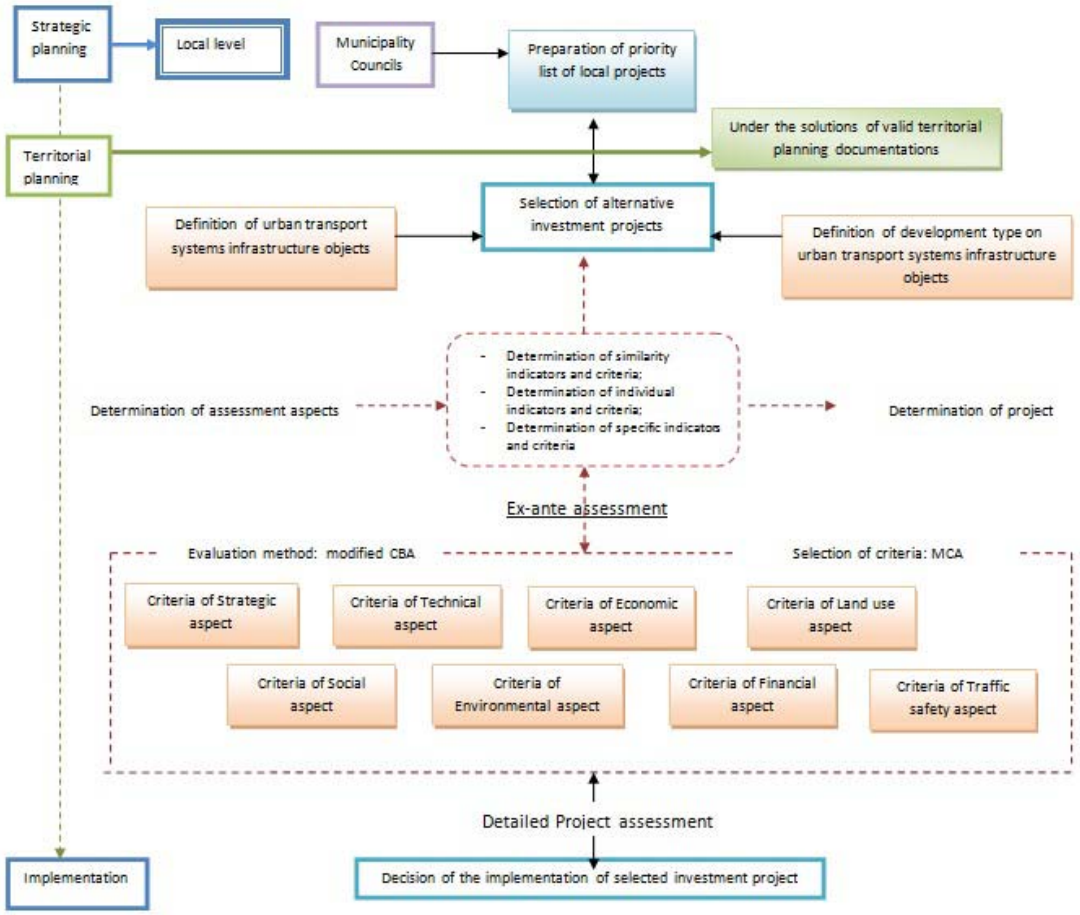


Figure 2. Main steps of suggested project assessment model of development on urban transport systems infrastructure

The first step. Currently, existing legislation in urban sustainable development areas provides only abstract definitions on urban transport systems infrastructure. However, in order to implement for the principles of sustainable development, it is necessary to accurately identify and define the objects that should be allocated to transport infrastructure. In accordance to the number and types of urban spaces of functional transport systems and subsystems and other features, authors have systemized infrastructure groups of urban transportation systems and proposed them for expert assessment (see Table 2).

Table 2. Objects of infrastructure of surface transport and communication systems [5]

Environmental means (noise isolation systems, mounds, road pavement, accumulation and clearing of surface water, bio-barrage, greening, premise protection from noise, etc.)
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 centres (traffic-lights, traffic control devices, variable electronic signs, pedestrian. cyclist passage switches, pavement signing, etc.), Park and Ride system, informational system with centres (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, etc.

The second step. For determination of necessity to develop urban infrastructure transport systems there is need to define the concept of development and to identify which types or stages of development need substantiation. For that reason, authors have systemized infrastructure types of urban transportation systems and proposed them for expert assessment (see Table 3).

Table 3. Kinds of land transport and communication infrastructure object development [5]

Kinds of surface transport and communication systems infrastructure object development
Maintenance of object
Overhaul of object
New construction of object
Reconstruction of object

The third step. In the scientific literature few specific concepts related to the implementation of development projects are available. Often, definition of project assessment and project substantiation are equated, therefore it is important to find out whether these concepts can be aligned with each other. In addition, it is necessary to establish whether substantiation/assessment of urban transport systems infrastructure development projects must be broken down into separate phases. Table 4 shows conceptions and stages of project substantiation/assessment.

Table 4. Conceptions and stages of Project substantiation/assessment [5]

Conceptions
Project substantiation
Project assessment
Stages of project substantiation/assessment
Only feasibility study
Only investment project
Feasibility study and investment project

The terminology used in Table 4 is officially defined in the legislation of the Republic of Lithuania. The conception of Project Substantiation is defined as the evaluation of expedience of development of the object (repair, construction, reconstruction) in different aspects. The conception of Project Assessment is defined as a systematic and objective determination of suitability, usefulness, efficiency and utility of the project which is planned to implement or has been implemented. Usually project substantiation/ evaluation consist of several separate stages. Feasibility study is a wider concept and is defined as an analysis of alternative object development solutions and substantiation of the most optimal alternative variant in different aspects. An investment project is substantiation of implementation of a certain variant of the object development in the economic and other aspects.

Another important question is to find out what approaches should be included in assessment of development projects on urban transport systems infrastructure. In common structural approach, all projects of communication systems in urban infrastructure development are alike because they share a certain structure, each has a well-defined objective and reachable result, and each project requires certain resources (technique, energy, raw materials and human resources). These resources are always limited so rational use of them is one of the major problems in project implementation. In terms of feasibility, transport systems infrastructure development projects also distinguish in the fact that object's development

(construction, reconstruction, etc.) and object's duration of operation is relatively long, and the implementation of a project requires a significant capital.

In Lithuania, there is no official methodology for the assessment of development on urban transport systems infrastructure, for identification of main dimensions; authors used the experience of foreign countries and current rural road transport infrastructure development reasoning techniques and recommendations. Authors have systemized groups of urban transport systems and separate criteria that influence necessity for object development [2,9]. Table 5 shows main attitudes on Project substantiation.

Table 5. Main attitudes of project substantiation [5]

Main attitudes of project substantiation
Strategic *(describes need and necessity of the development)*
Social *(describes the efficiency of the development to users – publicity)*
Economic (*describes economic benefit/ damage to users – publicity*)
Financial (*describes financial benefit/ damage and input of separate financial sources to total investment*)
Technical (*describes implementation of project according to technical requirements*)
Traffic safety (*describes influence of project on improvement of traffic safety*)
Environmental (*describes negative/positive influence of project on environment*)
Land use (*describes influence of project on sustainable land use*)

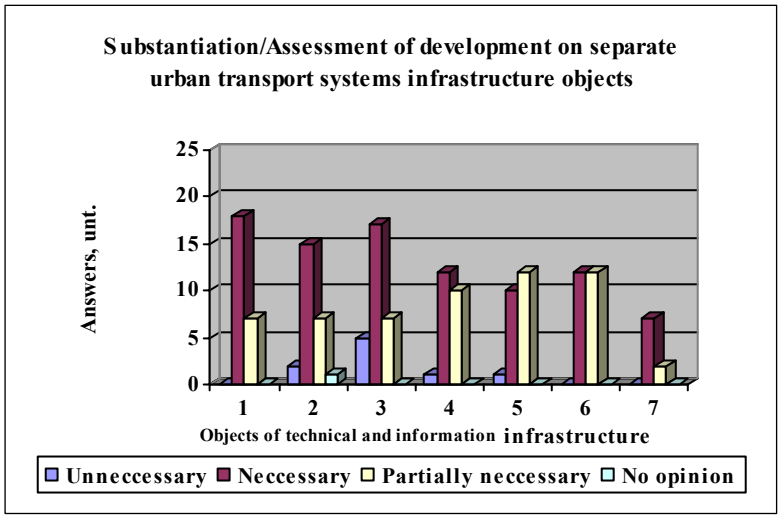
Also in order to determine which urban transport systems need quantitative (financial) or qualitative factor values for infrastructure development, authors have systemized typical criteria of individual grounding aspects and proposed them for expert assessment. In the next chapter expert evaluation of the initial tentative results is provided.

5. The Tentative Results of Investigations

Initial data from expert evaluation showed that the project assessment and project substantiation is usually regarded as terms with equal value (70 percent of experts).

Substantiation/assessment linkage of a development project on urban transport systems infrastructure with the planning stages led to dispersal of experts' answers. 40 percent of experts pointed out that project substantiation/assessment should be associated with each planning stage. Systemization of expert's results showed that only 50 percent of experts associate project substantiation/assessment with technical designing and most – 70 percent of experts – with special territorial planning.

Systemizing results of experts evaluation related to assessment of development project on urban transport infrastructure, it became clear that it is necessary to prepare the substantiation of project development for all general communication network (70 percent of answers) and part of the network (30 percent of answers), for all main nodes infrastructure (60 percent of answers) and their part (30 percent of answers), only 10 percent of experts pointed out that substantiation for development of main nodes is not required (Fig. 3).

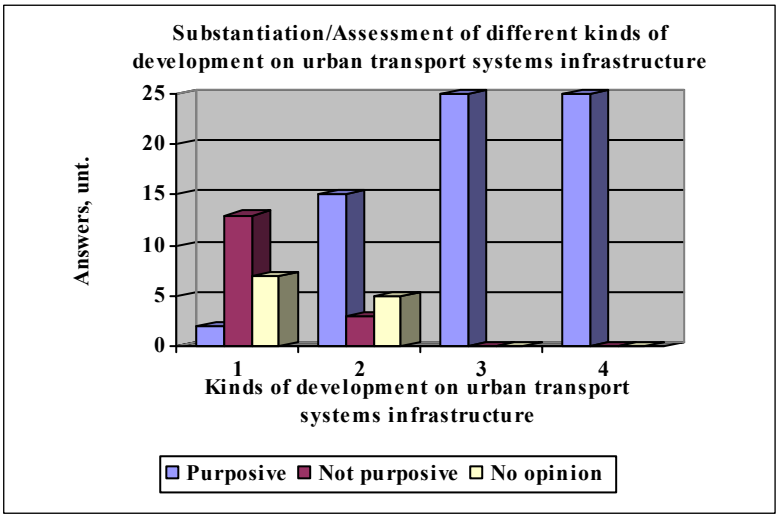


Objects of technical and information infrastructure: 1 – General communication network, 2 – Main nodes, 3 – PT infrastructure, 4 – Traffic regulation and control means, 5 – Traffic safety means, 6 – Environmental means, 7 – other (logistics)

Figure 3. Systemized experts' evaluation results related to substantiation of separate urban transport infrastructure development projects

As Figure 3 shows, for necessity to substantiate public transport (PT) infrastructure development projects 70 percent of experts were in favour, 30 percent of experts needed this for a part of the infrastructure, and 10 percent stated that the substantiation for the development of PT infrastructure is not required. The need of substantiation of traffic regulation and control and traffic safety development projects was presented for 50 percent of experts, 40 percent were in favour of necessity for substantiation of part measures, and 10 percent of experts pointed out that the substantiation for the development of traffic regulation and control means, and traffic safety means are not required. Substantiation for the development of environmental means is necessary, experts divided equally for development substantiation of all and part of measures. 30 percent of experts further noted that the rationale of development of logistics centres infrastructure is also necessary.

In evaluation of types of development on urban transport systems infrastructure, all the experts pointed out that for the reconstruction of facilities and construction of new facilities the substantiation must be carried out. 60 percent of experts noted that the substantiation is appropriate for major repairs of facilities, and only 10 percent of experts noted the appropriateness of the substantiation of the maintenance facilities (Fig. 4).

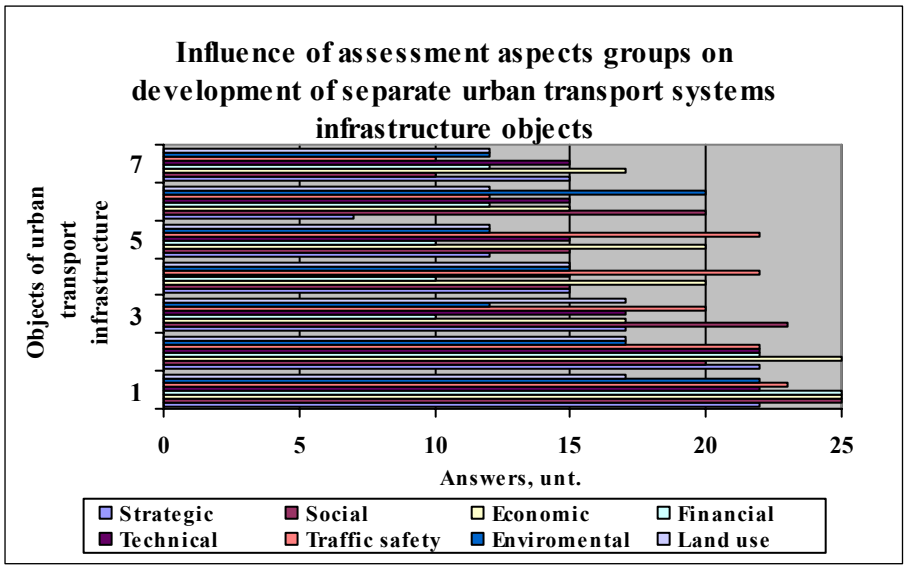


Kinds of development on urban transport systems infrastructure: 1 – Maintenance of object; 2 – Major repairs of object; 3 – New construction of object; 4 – Reconstruction of object

Figure 4. Systemized experts' results related to substantiation/assessment of different kinds of development on urban transport systems infrastructure

Evaluating of stages of development on urban transport systems infrastructure projects, all experts were for preparation of both feasibility studies and investment projects for the development of general communication network and main nodes infrastructure. 60 percent of experts have noted that the feasibility study and investment project should be prepared for the development of PT infrastructure, traffic regulation and traffic control means and traffic safety means, environmental means. 20 percent of experts pointed out that for the development of PT infrastructure, traffic regulation and control, and traffic safety means, environmental means, the preparation of a feasibility study would be sufficient, 10 percent of experts pointed out that for PT infrastructure, traffic regulation and control means, and traffic safety means, environmental means, it would be sufficient to prepare the investment project. One expert further noted that feasibility study and investment project should be developed only for major projects, as for small projects such implementation process is too expensive.

Evaluating the influence of transport systems infrastructure development on substantiation of urban transport systems infrastructure, it was noted that it is appropriate to substantiate the development of groups of urban transport systems infrastructure at least in part of aspects groups. In addition it has been noted that no new approaches were provided by the experts. Most attention was brought to substantiation of the general communication network development as follows: 91.25 percent of experts noted that the substantiation should include all assessment aspects. 86.25 percent of experts pointed out that all the groups need to be included in substantiation of the development of the main nodes: in this case the least responses were collected for environmental and land use aspects. The least attention was received for development substantiation of traffic safety means (58.75 percent of experts) and environmental means (57.5 percent of expert): in most of these cases, most answers fell for traffic safety, environmental and technical aspects, least – for strategic and financial aspects. For substantiation of PT infrastructure development most evaluations were collected for social, technical and economic aspects (Fig. 5).



Objects of technical and information infrastructure: 1 – General communication network, 2 – Main nodes, 3 – PT infrastructure, 4– Traffic regulation and control means, 5 – Traffic safety means, 6 – Environmental means, 7 – other (logistics)

Figure 5. Systemized experts' results related to the influence of substantiation/assessment aspects groups on development of separate urban transport systems infrastructure objects

Evaluating the importance of separate aspects, it is noted that any aspect has been associated with the development of urban transport systems infrastructure and it is appropriate to incorporate them into substantiation of separate transport systems infrastructure development. Systemized expert answers show that economic aspect (82.85 percent of answers) and the traffic safety aspect (78.57 percent of answers) were the most popular, least – the land use aspect (57.14 percent of answers). Figure 6 shows systemic percentage distribution of substantiation/assessment aspects groups of urban transport systems infrastructure development projects.

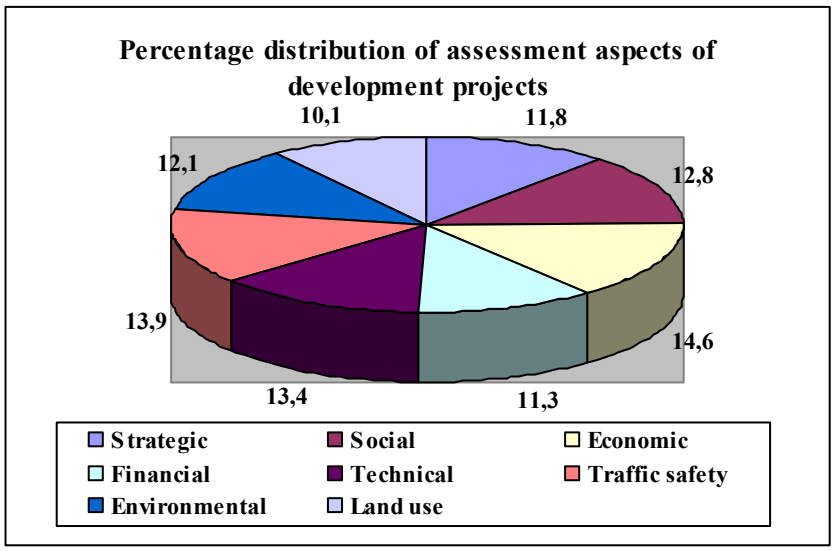


Figure 6. Percentage distribution of assessment aspects of urban transport systems infrastructure development projects

Figure 6 shows that percentage distribution of substantiation/assessment aspects is quite equal in all experts' answers: a significant difference cannot be excluded. This proves that all traditional aspects used in transport infrastructure development substantiation are important and have to be included in general substantiation/ assessment system. The determination of values of separate criteria can have influence on increase or decrease of relevance of one or another aspect.

Systemized initial results of expert survey have proved that criteria of the assessment of development on urban transport systems infrastructure can be separate as follows:

- ✓ Strategic aspect: 90 percent of experts noted that these criteria have most influence on substantiation of general communication network and PT infrastructure development, lower influence on substantiation of main nodes infrastructure development.
- ✓ Social aspect: 90 percent of experts have noted that all presented criteria are equally important for substantiation of general communication network and PT infrastructure development.
- ✓ Economic aspect: 80 percent of experts have noted that these criteria have most influence on substantiation of genera communication network and PT infrastructure development, 40 percent of experts noted that these criteria are important also for substantiation of traffic regulation and control means and traffic safety means development.
- ✓ Financial aspect: 70 percent of experts have noted that these criteria have most influence on substantiation of PT infrastructure development, less influence on substantiation of traffic regulation and control means and traffic safety means development.
- ✓ Traffic safety aspect: all experts noted that these criteria have most influence on substantiation of traffic regulation and control means and traffic safety means development.
- ✓ Technical aspect: 80 percent of experts noted that these criteria have most influence on substantiation of same general communication network, main nodes and PT infrastructure development.
- ✓ Environmental aspect: 80 percent of experts noted that these criteria have most influence on substantiation of environmental means, also general communication network and main nodes development.
- ✓ Land use aspect: all experts noted that land use criteria have influence on substantiation of all group of urban transport systems infrastructure development.

Systemizing initial results of Cluster analysis the list of priority criteria was formed. In order to ease the process of project selection 2–3 the most important criteria common for each type of grouped transport infrastructure objects were chosen for the description of each assessment aspect (see Table 6).

Table 6. List of priority criteria of main aspects of projects assessment

Main aspects of project assessment	Selected criteria	Expression	Description
Strategic	Compliance with strategic goals of regional development raised by local level institutions	Qualitative + quantitative	Distance, km; Part in whole network, km, rate;
	International/ state/ local level demand for development of object	Qualitative + quantitative	Distance, km; Plots of land, m^2, ha; Part in whole network, km, rate;
Social	Impact on inhabitants employment	Quantitative	New workplaces, number; Added value of one workplace, Lt
	Impact to inhabitants mobility	Quantitative	Distance, km; Added value of one trip, Lt
	Impact on accessibility of public social services	Qualitative + quantitative	Distance, km; Average value of service price, Lt
Economic	Economic benefit	Quantitative	Economy of Vehicle operating costs, Lt Economy of Travel time costs, Lt Economy of environmental costs, Lt; Economy of social costs, Lt; Economy of traffic safety costs, Lt Economy of land use costs, Lt
	Project payback time	Quantitative	Time, year
	Project risk	Qualitative+ Quantitative	Social, environmental, technical risk, etc. Overhead costs, Lt
Financial	Project investment	Quantitative	Budget sums, Lt
	Project income/ expenses	Quantitative	Sums, Lt
	Project effectiveness	Quantitative	Rate of return; Net present value of project, etc.
Technical	Complexity of technical solutions	Quantitative	Technical parameters; Price of construction works, Lt
	Type of solutions	Qualitative + quantitative	Amount of project activities; Amount of construction works; Price of construction works, Lt; Salary for project staff, Lt;
	Structure and volumes of traffic	Quantitative	Type of traffic participators; Average volumes, aut./h; ped./h; bcl./h
Traffic safety	Accident rate	Quantitative	Costs, Lt Economy of accident costs, Lt
	Impact on decrease of accident number	Quantitative	Number of Accidents per km; m^2;
	Impact on the selection of technical solutions	Quantitative	Amount of construction works; Price of construction works, Lt
Environmental	Impact on human health	Quantitative + qualitative	Economy of environmental costs (noise, air pollution, dusts), Lt
	Impact on aesthetic view of landscape	Quantitative + qualitative	Reduced plots in urban territories, ha; Average price of plots in urban territories, Lt;
	Impact on natural surroundings	Quantitative + qualitative	Reduced plots in surroundings, ha; Average price of plots in natural territories, Lt;

The continuation of Table 6

Main aspects of project assessment	Selected criteria	Expression	Description
Land use	Compliance with requirements of regulation on land use	Quantitative + qualitative	Total area, ha; Built up area, ha; Area for infrastructure, ha
	Impact on neighbouring land	Quantitative + qualitative	Occupied territories, ha; Occupied build up territories, ha; Occupied natural territories, h
	Necessity of land taking for public purposes	Quantitative + qualitative	Average price of plots in urban territories, Lt; Average price of real estate, Lt Average price of plots in undeveloped territories, Lt. land, Lt

Table 6 shows that selected specific criteria still can be described by quantitative or qualitative expression. In order to modify CBA method, these criteria have to be express by monetary values. In this case method of MCA can play a great role choosing the right criteria for monetary expressions.

This primary analysis also proved that specific criteria of social and land use aspects together with criteria of environmental aspects have to be included into the economic evaluation. Main indicators of social-economic development of separate urban territories can be used for the calculation of monetary values. This stage of analysis will be presented more detailed in the next article.

6. Conclusions

During the process of global integration the number of citizens covering large territories in cities constantly increases. Problems of urban development are becoming relevant. Therefore general urban policy determining main directions for urban development is a complicated and integral part of general policy on state territorial planning and development. There is an important methodological problem in the design of urban planning and development for assessment, comparison and selection of development programs and plans and the investment projects. This gap has been filled with the evaluation methods of investment projects on rural roads and transport of other sectors.

In order to create theoretical model for the development of urban transport systems infrastructure the expert survey has been carried out. The aim of this questionnaire survey was to determine and to systemize the approach of qualified experts performing in the spheres of territorial planning, strategic planning and designing of transport and communication systems and working in public and private sectors. The questionnaire presented in this article was formed seeking to determine actual principle of the assessment. Due to existing problems in the development of urban infrastructure, main steps of assessment model were formed and presented for expert evaluation: definition of urban transport systems infrastructure objects; definition of development type on urban transport systems infrastructure objects; determination of key aspects and criteria for project substantiation. The results of accomplished expert survey were systemized in order to select the priority factors and characterizing criteria of different aspects which should be used in the assessment of the development on urban transport infrastructure. For this purpose method of statistical analysis – Cluster Analysis – was used.

The results of initial analysis have showed that all traditional aspects of assessment of development on transport infrastructure are important and have to be included in general system of project substantiation. The determination of values of separate criteria can have influence on increase or decrease of relevance of one or another aspect. When comparing the alternative projects and identifying the level of project's implementation need, social, environmental and other aspects that define the qualitative value of the project, also play important roles in the need for assessment. Identification of values of the separate criteria affect the identification of project's impact factors and targets, prediction on variation, identification and management of project risk types. For this detailed statistics the researches have to be carried out.

Since the rationale of transport systems infrastructure development is often associated with the received economic benefit; due to this many of the criteria must be numeric (monetary value). But not all important criteria (e.g. strategic, social and environmental aspects) can be placed in numeric (monetary) form. The suggested model of the assessment helps to mark necessary criteria of assessment

aspects and modify CBA method in order to evaluate and describe more detailed social benefit of investment project on development of urban transport infrastructure. MCA method plays a great role choosing the right criteria for monetary expressions. This stage of analysis more detailed will be described in the next article.

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