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Evaluation of Road Investment Project Effectiveness

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Roads in Lithuania are financed only from collected road taxes; however, this funding is not sufficient for road maintenance and improvement. Lithuanian Road Administration under the Ministry of Transport and Communications allocates the funding received from European Regional Development Fund as follows: improvement of pavement of regional roads, implementation of traffic safety and environmental measures, and implementation of Gravel Roads Paving Programme. Since 2004 road projects in Lithuania have been financed from European Union funds. Unfortunately these financial resources are not sufficient for the implementation of all road investment projects in Lithuania.

The problem of selecting the most effective road investment projects is becoming more and more acute. Road investment project alternatives have to be appraised in an integrated manner using mathematical models in addition to economic, social and environmental criteria.

Scientific problem – road investment projects are often appraised from economic, social and environmental viewpoints separately by applying different mathematical models and without using the principle of sustainable development and multi-criteria appraisal methods for integrated analysis of road investments.

The authors propose to select criteria from sustainable environment components, which best reflect economic, social and environmental aspects. It should be noted that these economic, social and environmental aspects are interrelated and complementary, and therefore influence the appraisal of road investment projects.

The article analyses and evaluates the effectiveness of road investment project alternatives by combining economic, social and environmental aspects and processing the data using expert and multi-criteria appraisal methods.

Scientific novelty – an integrated evaluation of economic, social and environmental aspects by using multi-criteria appraisal methods is proposed.

The aim of the research – to present the road investment project appraisal methodology based on the principle of sustainable development and perform the appraisal of the alternative projects by making computations according to expert and TOPSIS (Technique for the Order Preference by Similarity to Ideal Solution) appraisal methods.

The object of the research – road investment projects.

The methods of the research – expert and multi-criteria appraisal method TOPSIS is applied.

Keywords: investment projects, roads, evaluation of effectiveness, sustainable environment, multi-criteria appraisal methods.

Introduction

Transport has become an integral part of human life. It helps to meet the existing needs of a human being and at the same time creates new needs. Unfortunately, the changes and benefits bring about new problems such as traffic jams, time loss, growing levels of noise and pollution (Skrodenis et al, 2009).

Transport intensity increases in our country because Lithuania is a transit country convenient for communication. The condition of roads deteriorates, pavements wear down. New technologies have to be implemented to improve the strength of pavement structures and new methods of building road pavement layers have to be developed; structural performance of road pavements has to be investigated under real conditions (Cygas et al, 2008). Foreign transport companies may bypass our roads due to poor communication infrastructure and that would cause big loss to transport business and the country's economy. Roads and their infrastructure are important for the country's economic development as 60 per cent of cargo in Lithuania is transported by road (Lithuanian Road Administration under the Ministry of Transport and Communications Progress Report, 2009).

Since 2004 road projects in the Republic of Lithuania have been financed from EU funds. These funds are EU structural instruments aimed to stimulate economic development of member states. The main goal of EU funds is to promote the development and structural adjustment of regions whose development is lagging behind. As Lithuania is still lagging behind the EU average, the regional policy is often pointed out as the most vivid benefit of EU membership (Kilijoniene et al, 2010). Road Administration under the Ministry of Transport and Communications of the Republic of Lithuania administers the funds of Road Maintenance and Development Programme designated for national roads (75 per cent in 2008). The programme has the following objectives: to ensure traffic safety, to maintain roads and bridges, to develop road infrastructure, to implement the principles of the National Sustainable Development Strategy in road construction (Lithuanian Road Administration under the Ministry of Transport and Communications Progress Report, 2009).

International practice and tendencies reveal that a growing numbers of vehicles generate higher tax revenue to finance roads. Unfortunately, the central government often uses road financing funds to cover the budget deficit or to finance other programmes. Such practice results in deteriorated condition of roads due to inappropriate management of the Road Fund and insufficient financing of the infrastructure, higher road accident rates, and higher time and vehicle operation costs suffered by consumers. To avoid these problems the most countries in the world seek to modernize road infrastructure.

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Funding of road investment projects in Lithuania and abroad

According to Snieska, Simkunaite (2009), financial support for infrastructure development from the European Union and other financial mechanisms meets one of the major priorities in the development of countries because uniform development of infrastructure creates conditions for the growth of business, social welfare and better quality of life. However, the relation between investment into infrastructure and the country's development is not so widely analyzed in scientific literature in the Baltic States (Lithuania, Estonia and Latvia) as in other European Union states (Snieska, Simkunaite, 2009).

Different road taxes and fees are imposed in foreign countries; entrance to cities or old towns and certain parts of the cities is tolled. Increasing traffic in narrow streets in the Old Town of Vilnius creates environmental, traffic safety, economic and social problems (Grigonis, Pauliulis, 2009). Such a situation has raised discussions to charge entrance fees for driving into Vilnius Old Town. Every city is a complex system, the structure of which is influenced by the needs of inhabitants and developers' ideas, global and local economic conditions (Grigonis, Paliulis, 2007).

Central governments lack funds to finance road projects, therefore Public-Private Partnerships (hereinafter PPP) are formed to this end. The investment and experience of the private sector enable to realize road infrastructure projects. The following major elements of effective PPP management have been distinguished: demand, political, legal and administrative environment, and communication (Skietrys et al, 2008). PPP projects in transport sector are often realized as concession projects. The concessionaire is granted the right to collect fees from the users of the constructed object (road, viaduct, bridge) for a certain period of time. In foreign countries projects used to be appraised in financial terms: the Net Present Value, Internal Rate of Return, Payback Period, the best value for investment (European Investment Bank, 2005; Salman et al, 2007; Abdelrahman et al, 2008; Ye, Liu, 2008; Liou, Huang, 2008; Ye, Tiong, 2008; Ke, Liu, Wang, 2008; Abdel Aziz, 2007; Glenting, 2008; Zavadskas et al, 2004; Brzozowska, 2007). Later, the distribution of risk between public and private sectors was taken into consideration, several risks were distinguished and the risks having the greatest effect on successful implementation of the project were analyzed (Li et al, 2001; Medda, 2006; Mattar, Cheah, 2006; Jin, Doloi 2007); attention was also paid to technical data of the project: project implementation time, complexity, technological solutions etc. (Zhang 2004, 2005a, 2005b) and selection of the private concessionaire (Zhang 2006a, 2006b), which is also important for the success of a road investment project.

According to Antov et al. (2009) and Lama et al. (2006), traffic safety is one of the key problems in many countries, including the Baltic States, irrespective of the progress made in this area in the last years. At present traffic safety on Lithuanian roads is the worst among other EU member states (Ratkeviciute et al, 2007); therefore Lithuania is regarded as a high-risk country from road traffic safety point of view (Zilioniene, Laurinavicius, 2007). Improvement of road traffic safety and halving the number of road accident victims is provided in Road Safety Action Programme 2003-2010 of the European Commission (Macek, Mestanova, 2009). Causes of road traffic accidents are analyzed in other Baltic States too, e.g. in Latvia (Lazda, Smirnovs, 2009). Five major groups of traffic regulation measures are used to remove the causes of road traffic injuries: road lighting, fencing and barriers, vertical road traffic signs, horizontal road traffic signs and traffic lights (Lundkvist, Isacsson, 2008).

Reconstruction of regional roads has started in Lithuania not long ago. Most of these roads have not been reconstructed for 30 years. Although these roads have asphalt paving, they are in poor shape: the roads are just 6 meters wide, paving edges are crumbled, road surface is potholed. The following works are performed for the strengthening of paving and widening of the road: widening of track bed, sub-base construction, laying of asphalt concrete pavement, restoration of water drainage systems, reconstruction of exit roads and public transport stops, posting of traffic signs and traffic bollards, construction of soft shoulders, final rehabilitation of slopes, reconstruction of electric and communication lines and rainwater drainage systems.

Another programme under implementation is asphalt paving of gravel roads. Gravel reconstruction projects are made under the Gravel Road Paving Programme (Gintalas et al, 2007). However the experience of gravel road paving has revealed that road accident rates have increased on

newly paved roads (Gintalas et al, 2008). This shows that project solutions are very important in gravel road reconstruction because inadequately selected solutions may lead to higher numbers of road traffic injuries.

PPP is not employed in road investment projects that are currently implemented in Lithuania. The main reasons are lack of practice, experts and methodology, absence of relevant legislation. The investors from the private sector are ready and willing to implement transport projects based on PPP principle, however, they need assistance and support of the central government. Therefore road projects in Lithuania are realized with the support from EU funds.

Appraisal of road investment project alternatives from sustainable development viewpoint

The authors propose to appraise the planned road projects from sustainable development viewpoint. According to Ciegis, Streimikiene (2005), sustainable development indicators are grouped by major dimensions of sustainable development: economic, social and environmental. These three dimensions are interrelated and complementary. Traditionally the concept of sustainable development comprises three equal components: environment protection, economic development and social development, and three welfare dimensions: economic, environmental and social, as well as their integration and interconnectivity (Ciegis et al, 2009). Combination of these aspects with mathematical methods enables to find the most effective proposal of road investment projects.

Economic aspects are evaluated by using the methodology developed by Cygas et al. (2006). Cygas et al. (2006) propose economic appraisal of road investment projects by using the following economic indicators:

- Net Present Value (NPV);
- Internal Rate of Return (IRR);
- Payback Period (PP);
- Profitability Index (PI).

These economic indicators show the feasibility of the selected project. If several road projects are compared, the results of economic appraisal can be used to decide which project is the most beneficial.

NPV, IRR, PP and PI are calculated by using cash flow and cost-benefit analysis method. The following benefits are distinguished in the cost-benefit matrix (Cygas et al, 2006):

- object maintenance savings;
- vehicle operating cost savings;
- time savings;
- road accident prevention.

Road maintenance savings are calculated by finding the difference between maintenance costs at market prices of the road in the present condition (without the project) and maintenance costs of the road after an investment project. Gravel road maintenance costs consist of annual grading costs while maintenance costs of damaged asphalt concrete pavement consist of compulsory repair costs. These data are obtained from aggregate construction price indices or from questionnaire survey of road maintenance service contractors and providers.

Vehicle operating cost savings consist of savings on fuel and spare parts. Fuel is saved when vehicles drive at higher speed on better quality roads. The following data is required for the calculation of fuel savings: Annual Average Daily Traffic (AADT) and its distribution by vehicle types; average vehicle fuel consumption, which is determined by the vehicle type and driving territory (town, out of town); road length; change in vehicle speed (before the road project and forecasted after the implementation of the project); fuel economy factor of asphalt paved gravel road selected by vehicle type; average fuel price selected by the vehicle type.

Savings on spare parts due to better ride quality of the pavement can be calculated from the following data: AADT and its distribution by vehicle types; road length; average market prices of new vehicles, determined by their types; current and forecasted values of International Roughness Index (IRI, m/km) selected from the chart showing the correlation of the percentage of a new vehicle's market price with IRI and vehicle type (see. Miskinis, 1999).

Time savings from better ride quality of the road are calculated from the following data: AADT and its distribution by vehicle types; road length; change in vehicle speed (before the road project and forecasted after the implementation of the project); cost of time spent, which depends on vehicle type.

Road accident prevention depends on the influence of different properties of the road and its elements: some elements increase road accident rate, while other elements reduce it. The cost of time spent calculations by vehicle types are presented in the Appendix 1. The financial loss of road accidents are calculated according to the methodology developed by Cygas et al. (2006) and adjusted according to the prices of 2009 (Appendix 2). The feasible rate of road accidents per annum is obtained from the consolidated Road accident data provided by the police for the previous period.

Considering the social aspect in project appraisal, the authors emphasize the need of road projects for public transport: better roads attract the development of new residential districts (public transport stops, schools, kindergartens, shopping centres etc.). Therefore the criterion "the importance of the road for public transport" has been selected for the assessment of the social factor.

Road investment projects are not commercial projects, therefore social and environmental (noise, dust) effectiveness have to be evaluated in addition to economic effectiveness.

According to Griskevicius (2002), negative effect of noise consists of noise duration, frequency and recurrence. Up to now, no generally accepted method for appraising this effect in terms of money has been developed. Most often the following methods are used: *determination of the effect on the market value of the building* (used irrespective of the impact of noise on non-residential buildings; presumption is made that people well understand the impact of noise although it is not true), *evaluation of noise elimination or reduction costs* (this method better than the previous one evaluates the impact of noise, although it is difficult to determine the level of acceptable (normal) noise), *evaluation of damage and remedy costs* (most often

it has a negative effect on health, which is hard to evaluate in terms of money).

Damage caused by noise depends on the level of the country's urbanization and landscape. Research data are very different; therefore, especially in small-scale projects, it is easier to evaluate noise damage by qualitative methods – rates. If the project reduces the level of noise – it is rated by 1, if the project has no influence on noise – it is rated by 0.

Due to the worn-down pavement vehicles move slower, exhaust more pollutants, produce more dust, and create low-frequency noise. These factors negatively affect not only the quality of life and human health but also the environment. Therefore, for the appraisal of road investment projects from environmental viewpoint the authors use the following qualitative criteria: noise reduction with a road project, dust reduction with a road project,

To summarize the integrated project appraisal from sustainable development viewpoint the authors point out that the effectiveness of road investment projects depends on many factors. Road investment project alternatives have to be appraised by selecting such criteria which have the biggest influence on the value of the project (Table 1).

Table 1

Criteria selected for the appraisal of road investment project alternatives

Name of criterion	Criterion symbol in calculations
Net Present Value (NPV)	K_1
Internal Rate of Return (IRR)	K_2
Payback Period (PP)	K_3
Profitability Index (PI)	K_4
Noise reduction with a road project	K_5
Dust reduction with a road project	K_6
Importance of the road for public transport	K_7

According to Zavadskas, Liias, Turskis (2008), multi-criteria analysis is often used for solving various economic, management, construction problems. The selection of multi-criteria appraisal method depends on the problem to be solved, therefore Simple Additive Weighting (SAW), Technique for the Order Preference by Similarity to Ideal Solution (TOPSIS), Complex Proportional Assessment (COPRAS) and the newly developed Additive Ratio Assessment (ARAS) method can be used (Tupenaite, 2010). In this paper the alternatives of the road investment projects are ranked by using the TOPSIS method. The calculation algorithm and methodology of this method is presented by Ustinovicius (2001). The method shows the proximity of alternatives under consideration to the positive-ideal solution and to the negative-ideal solution. Under this method a matrix of initial data of alternative solutions is made. In this matrix the investment alternatives are appraised by using the quantitative and qualitative criteria described above. The calculated rate of effectiveness, which composes the effectiveness criteria of all analyzed alternatives, enables to decide which project is the most effective.

Evaluation of the effectiveness of road investment projects

In the analysis part the authors present road (street) reconstruction projects in Garliava, Ringaudai and Uzliedziai villages administered by the local government of Kaunas district and financed from European Union funds and the allocations of Lithuanian Road Administration under the Ministry of Transport and Communications**.** Table 2 contains a short description of these projects.

Calculations of road investment project alternatives were based on the initial data from feasibility studies (UAB EIP Kaunas, 2009a, 2009b, 2009c), enclosed in Appendix 3.

Calculation of cash flows and appraisal criteria are presented in Table 3.

The importance of seven criteria *(K_1, ..., K_7)* defined above and selected by the authors for the appraisal of road investment projects was determined experimentally by questionnaire survey. The aggregate importance weights of these criteria are presented in Table 4.

Table 2

Local road (street) reconstruction projects in Kaunas district

Title:		Reconstruction of the driveway, installation of lightning and rainwater drainage systems, building of sidewalks in *Vasario 16-osios* street in *Garliava* ward (A_1)	Reconstruction of *Berzų* street in *Ringaudai* ward of *Ringaudai* village (A_2)	Reconstruction of the road section from highway A1 (Vilnius-Kaunas-Klaipeda) to the village of *Naujosios Muniskes* in *Uzliedziai* ward (A_3)
Project description:	**Goal:**	Develop transport infrastructure in Kaunas region, build junctions with main and regional roads, create a network of reliable communication infrastructure.	Develop transport infrastructure in Kaunas region by improving traffic conditions in *Ringaudai* ward in Kaunas district.	Develop transport infrastructure in Kaunas region, by improving traffic conditions in the road section from highway A1 to the village of *Naujosios Muniskes.*
	Objective:	Reconstruct 0.6 km section of *Vasario 16-osios* street in *Garliava* (rainwater drainage and lightning systems, sidewalk and driveway)	Reconstruct 0.6 km section of *Berzų* street in *Ringaudai* ward.	Reconstruct 2.0 km road section from highway A1 to the village of *Naujosios Muniskes.*
	Expected results:	Improved traffic conditions, higher traffic safety, reduced negative effect on environment and the quality of life, lower road maintenance and vehicle operating costs, shorter travelling time, better aesthetic view.		
	Implementation time:	2009-2010		
Project value:		1 120 000 LTL	710 000 LTL	820 000 LTL
Financing:		Joint financing from EU funds and national budget of the Republic of Lithuania		

Source: http://www.krs.lt/index.php?576919877 (2010 03 15)

Table 3

Cash flow from road reconstruction projects

Period	Year	Cost, LTL			Benefit, LTL						Total discounted cash flow, LTL
		Direct construction, reconstruction, repair costs, LTL	Road maintenance costs, LTL	Discounted total costs, LTL	Road operation savings (costs without project), LTL	Road accident prevention savings, LTL	Time savings, LTL	Vehicle operating cost savings, LTL		Total discounted benefit, LTL	
								Savings on spare parts, LTL	Fuel economy, LTL		
Cash flow from road reconstruction project in Garliava											
0	2010	1.056.021		1.056.021						0	-1056.021
1	2011			0		40.818	1.550	228.238	197	255.642	255.642
2	2012			0	793.453	40.818	1.612	237.367	204	956.633	956.633
...	...			...		...	...	...	...	...	...
8	2018		171.987	108.479		40.818	2.040	300.345	259	216.634	108.155
9	2019			0		40.818	2.121	312.359	269	211.714	211.714
10	2020			0	171.987	40.818	2.206	324.853	280	303.613	303.613
...	...			...		...	...	...	...	...	...
16	2026		171.987	68.421		40.818	2.792	411.043	354	181.015	112.593
17	2027			0		40.818	2.903	427.485	368	177.103	177.103
18	2028			0	171.987	40.818	3.019	444.584	383	234.273	234.273
...	...			...		...	...	...	...	...	...
21	2031			0		40.818	3.396	500.096	431	162.477	162.477
Cash flow from road reconstruction project in Ringaudai											
0	2010	511.367		511.367	1.012					1.012	-510.355
1	2011				1.012	120.435	800	104.720	25	214.285	214.285
2	2012				1.012	120.435	832	108.909	26	206.052	206.052
...	...				...	...	...	...	...	...	...
8	2018				1.012	120.435	1.053	137.804	33	164.205	164.205
9	2019				1.012	120.435	1.095	143.317	34	158.320	158.320
10	2020				1.012	120.435	1.139	149.049	36	152.705	152.705
...	...				...	...	...	...	...	...	...
16	2026				1.012	120.435	1.441	188.595	45	123.935	123.935
17	2027				1.012	120.435	1.499	196.139	47	119.853	119.853
18	2028				1.012	120.435	1.559	203.984	49	115.947	115.947
...	...				...	...	...	...	...	...	...
21	2031				1.012	120.435	1.753	229.454	55	105.201	105.201
Cash flow from road reconstruction project in Naujieji Uzliedziai											
0	2010	657.249		657.249	2.736					2.736	-654.513
1	2011			0	2.736	0	317	56.320	36	56.084	56.084
2	2012			0	2.736	0	330	58.573	38	54.964	54.964
...	...			...	...	...	...	...	...	...	...
8	2018			0	2.736	0	417	74.113	48	48.765	48.765
9	2019			0	2.736	0	434	77.078	50	47.811	47.811
10	2020			0	2.736	0	451	80.161	52	46.879	46.879
...	...			...	...	...	...	...	...	...	...
16	2026			0	2.736	0	571	101.429	66	41.693	41.693
17	2027			0	2.736	0	594	105.486	68	40.892	40.892
18	2028			0	2.736	0	617	109.706	71	40.109	40.109
...	...			...	...	...	...	...	...	...	...
21	2031			0	2.736	0	694	123.404	80	37.854	37.854

Table 4

The aggregate importance weights of the criteria

	K_1	K_2	K_3	K_4	K_5	K_6	K_7	S_i	q_i	Place of criteria importance
K_1		5	5	5	5	4	5	29	0,28	1
K_2	0		4	3	1	1	2	11	0,10	5-6-7
K_3	0	1		3	3	1	2	10	0,10	5-6-7
K_4	0	2	2		2	3	1	10	0,10	5-6-7
K_5	0	4	2	3		2	3	14	0,13	3
K_6	1	4	4	2	3		4	18	0,17	2
K_7	0	3	3	4	2	1		13	0,12	4

Table 5

Matrix of initial data of road investment projects

Alternatives	Appraisal criteria						
	K_1	K_2	K_3	K_4	K_5	K_6	K_7
A_1 Garliava	3931927	0,35	1,84	4,19	1	0	0
A_2 Ringaudai	2678558	0,38	3,38	6,24	1	1	0
A_3 Uzliedziai	318479	0,04	13,14	1,48	1	1	1
Criteria optimality	max	max	min	max	max	max	max
a^+	3931927	0,38	13,14	6,24	1	1	1
a^-	318479	0,04	1,84	1,48	1	0	0

Based on TOPSIS method a matrix of the initial data of alternative solutions is made where road investment project alternatives are appraised by using the selected quantitative and qualitative criteria *(K_1, ..., K_7)* described above (Table 5).

The essence of TOPSIS method is the modelling of a generalized factor $K_{bit,i}$ based on the deviation of compared variant from the so-called ideal variant consisting of the best criteria of alternatives under consideration (Liaudanskiene et al, 2009). The effectiveness rate computed mathematically shows which one of the three road investment projects is the most effective (Fig. 1).

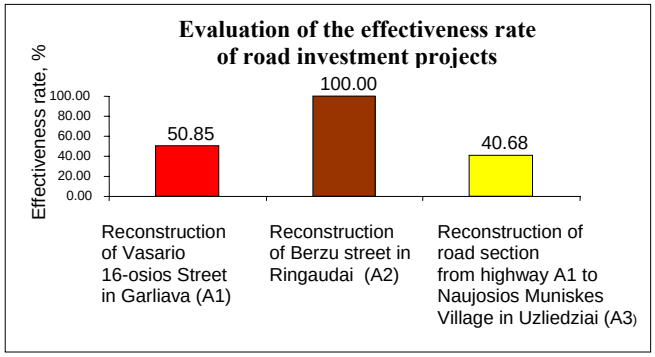

Figure 1. Evaluation of the effectiveness rate

According to the results of TOPSIS, the investment projects were ranked as follows: the highest priority project is reconstruction of Berzu street in Ringaudai (A2), in the second place is reconstruction of Vasario 16-osios street in Garliava (A1) and reconstruction of road section from highway A1 to the village of Naujosios Muniskes in Uzliedziai (A3) represents the lowest priority. Thus, reconstruction of Berzų street in Ringaudai ward of Ringaudai village (A2) is the most effective. This result among the analyzed projects is explained by the following criteria: the lowest NPV, the highest IRR, average PP and the highest PI, as well a reduction of noise and dust with the implementation of the project.

Conclusions

1. Funding of road investment projects in Lithuania is insufficient. Due to this, low standard roads cause a number of road accidents to increase, safety of passengers and pedestrians is undermined, and drivers suffer high time, fuel and vehicle operation costs.
2. The appraisal of road investment project effectiveness needs an integrated approach combining economic, social and environmental aspects. Integrated appraisal by using combined key criteria of the said three aspects gives more valuable information about the provided benefits of the analyzed projects.
3. Private investment in road projects would be an attractive solution for the public sector with the aim to improve the present condition of roads. Investment from the private sector would help to solve the problem of insufficient financing.
4. By applying developed road investment project appraisal methodology the authors determined that reconstruction of the street in Ringaudai is the most effective investment project. This alternative was ranked best by six from seven criteria chosen by the authors (NPV, IRR, PP, PI, noise and dust reduction with the project).

Appendix 1

The cost of time spent by vehicles (data adjusted to the prices of 2009, according to Cygas et al (2006))

Vehicle category	Cost of time, LTL/hour
Cars	22,77
Heavy vehicles (>3,5 t)	42,11
Minivans	76,98
Busses	247,26

Appendix 2

The financial loss of road traffic accidents (data adjusted to the prices of 2009, according to Cygas et al (2006))

The financial loss of road traffic accident if the human died	1.339.974 LTL
The financial loss of road traffic accident if the human was injured	108.343 LTL
The financial loss of road traffic accident if the material losses occurred	5.890 LTL

Appendix 3

Initial data for calculations of road investment project alternatives (Feasibility studies UAB EIP Kaunas, 2009)

Discount rate is equal to 12 months VILIBOR	5.93%,
Life cycle of the road	20 years
Gravel road grading cost per time	~240 Lt/km
Average car fuel consumption	9 l/100 km
Average heavy vehicle fuel consumption	25 l/100 km
Average market prices of new vehicles by categories:	cars – LTL 55000; heavy vehicles – LTL 300000
Fuel economy factor of asphalt paved gravel road selected by vehicle type:	for cars – 0.2 ; for heavy vehicles – 0.27
The assumed rate of traffic growth per annum	4 %
The average car fuel (diesel, petrol, LPG) price	3.17 LTL/l
Paving of asphalt concrete layer on the old pavement	38,39 LTL/m^2
The average heavy vehicle fuel (diesel) price	3,5 LTL/l
Street reconstruction cost	177.11 LTL/m^2

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Investicinių automobilių kelių projektų efektyvumo įvertinimas

Santrauka

Automobilių keliai Lietuvoje finansuojami tik iš surenkamų mokesčių, tačiau šie mokesčiai neužtikrina finansavimo, kuris reikalingas visų kelių būklei palaikyti ir gerinti. Lietuvos automobilių kelių direkcija prie Susisiekimo ministerijos gautą finansavimą iš Europos regioninės plėtros fondų skiria: krašto ir regioninių kelių dangoms stiprinti, eismo saugos ir aplinkosaugos priemonėms diegti, žvyrkelių asfaltavimo programai įgyvendinti. Todėl vis dažniau iškyla problema, kaip atrinkti tuos automobilių kelių investicinius projektus, kurie teiktų didžiausią naudą valstybei bei visuomenei. Analizuojami automobilių kelių investiciniai projektai turi būti vertinami kompleksiniu būdu, apimant ekonominius, socialinius ir aplinkos apsaugos aspektus. Šiame straipsnyje siekiama išanalizuoti ir nustatyti automobilių kelių alternatyvių investicinių projektų efektyvumą, kompleksiškai sujungiant ekonominį, socialinį bei aplinkosauginį aspektus.

Mokslinė problema – labai dažnai automobilių kelių investiciniai projektai analizuojami ekonominiu, socialiniu, aplinkosauginiu aspektais atskirai, tačiau nėra kompleksiškai taikoma automobilių kelių investicinių projektų vertinimo metodika darnaus vystymosi principu, taikant daugiakriterinius vertinimo metodus.

Mokslinis naujumas – siūlomas kompleksinis ekonominio, socialinio ir aplinkosauginio aspektų vertinimas, taikant daugiakriterinio vertinimo metodus.

Tikslas – pateikti automobilių kelių investicinių projektų vertinimo metodiką darnaus vystymosi aspektu ir įvertinti šių projektų efektyvumą, taikant ekspertinį ir daugiakriterinio vertinimo TOPSIS metodus.

Objektas – automobilių kelių investiciniai projektai.

Tyrimo metodai – taikomi ekspertinis ir daugiakriterinio vertinimo metodas TOPSIS.

Autoriai siūlo kompleksinę investicinių projektų įvertinimo metodiką, projektams vertinti parenkant darniosios aplinkos sudedamųjų dalių, t. y. ekonominius, socialinius ir aplinkosauginius, kriterijus.

Taikant Čygo ir kt. (2006) sukurtą metodiką, vertinamas ekonominis aspektas, apskaičiuojant šiuos ekonominius rodiklius: grynąją dabartinę vertę (NPV), vidinę grąžos normą (IRR), atsipirkimo laiką (AL), pelningumo indeksą (PI). Pagal šiuos rodiklius galima spręsti apie projekto vykdymo ekonominį tikslingumą. Tuo atveju, kai tarpusavyje lyginami keli investiciniai automobilių kelių projektai, gauti rezultatai parodo, kuris projektas teiktų didžiausią ekonominę naudą. Prieš apskaičiuojant NPV, IRR, AL, PI ekonominius rodiklius, sudaroma naudos ir išlaidų suvestinė (Čygas ir kt. 2006) skiriant keturias naudos grupes: statinio priežiūrai išliestų lėšų ekonomiją, automobilių eksploatacinių išlaidų ekonomiją, laiko vertės nuostolių ekonomiją ir autoavarijų nuostolių ekonomija.

Vertinant socialiniu aspektu, svarbu įvertinti naujų gyvenamųjų kvartalų formavimąsi prie naujų kelių, nes prie jų įsikuria mokyklos, vaikų darželiai, gydymo įstaigos, todėl didžiausias dėmesys turėtų būti skiriamas investicinių automobilių kelių projektų poreikiui viešajam transportui.

Autoriai, analizuodami investicinius automobilių kelių projektus aplinkosauginiu aspektu, atkreipia dėmesį į tai, kad susidėvėjusi kelio danga ne tik mažina automobilių judėjimo greitį, didina taršą, kelio dulkėtumą ir daro neigiamą įtaką žmonių gyvenimo kokybei ir sveikatai, bet taip pat daro neigiamą poveikį aplinkai.

Investicinių automobilių kelių projektų efektyvumui įvertinti darniosios aplinkos aspektu autoriai pasirenka šiuos kriterijus: grynoji dabartinė vertė (NPV) – K_1, vidinė grąžos norma (IRR) – K_2, atsipirkimo laikas (AL) – K_3, pelningumo indeksas (PI) – K_4, triukšmo lygio mažėjimas taikant projektą – K_5, dulkėtumo mažėjimas taikant projektą – K_6, kelio poreikis visuomeniniam transportui – K_7.

Iš taikomų daugiakriterinio vertinimo metodų SAW, TOPSIS, COPRAS, ARAS autoriai pasirinko alternatyvių variantų prioriteto eilei nustatyti taikomą TOPSIS metodą. Šis metodas parodo, kaip analizuojamos alternatyvos yra arčiausiai idealaus teigiamo sprendinio reikšmės ar toliausiai nuo idealaus neigiamo sprendinio reikšmės. Pagal pasirinktas alternatyvas ir kriterijus sudaroma pradinė duomenų matrica ir atlikus matematinius skaičiavimus gaunama prioritetų eilė, kuri parodo analizuojamų projektų efektyvumą.

Efektyvumo įvertinimo skaičiavimams atlikti autoriai pasirinko tris alternatyvius investicinius automobilių kelių projektus: gatvės važiuojamosios dalies rekonstrukcija, apšvietimo, šaligatvio ir lietaus nuotekų tinklų įrengimas Vasario 16-osios gatvėje, Garliavos seniūnijoje (alternatyva A_1); Beržų gatvės rekonstrukcija Ringaudų kaime, Ringaudų seniūnijoje (alternatyva A_2); rekonstrukcija kelio ruožo nuo automagistralės A1 (Vilnius–Kaunas–Klaipėda) iki Naujųjų Muniškių kaimo Užliedžių seniūnijoje (alternatyva A_3). Šių alternatyvių investicinių automobilių kelių projektų ir efektyvumo įvertinimo skaičiavimas buvo atliktas remiantis pradiniais parengtų galimybių studijų duomenimis (UAB EIP Kaunas, 2009).

Atlikus naudos ir išlaidų suvestinius skaičiavimus ir įvertinus socialinius bei aplinkosauginius aspektus, gautos atitinkamos analizuojamų kriterijų reikšmės. Įvertinus alternatyvas A_1, A_2, A_3, pagal kriterijus K_1, ..., K_7 sudaryta alternatyvių sprendimų pradinių duomenų matrica:

1. Alternatyva A_1 : K_1= 3 931 927 LTL, K_2= 0,35, K_3= 1,84 m., K_4= 4,19 %, K_5= 1, K_6= 0, K_7= 0;
2. Alternatyva A_2 : K_1= 2 678 558 LTL, K_2= 0,38, K_3= 3,38 m., K_4= 6,24 %, K_5= 1, K_6= 1, K_7= 0;
3. Alternatyva A_3 : K_1= 318 479 LTL, K_2= 0,04, K_3= 13,14 m., K_4= 1,48 %, K_5= 1, K_6= 1, K_7= 1.

Autorių apibūdinti ir parinkti automobilių kelių investiciniams projektams vertinti septyni kriterijai (K_1, ... K_7), kurie buvo įvertinti ekspertiniu būdu, nustatytas šių kriterijų reikšmingumas. Atlikus skaičiavimus TOPSIS metodu, gauta tokia investicinių projektų prioritetų eilė:

1. Beržų gatvės rekonstrukcija Ringaudų kaime, Ringaudų seniūnijoje (alternatyva A_2), efektyvumo rodiklis – 100 %,
2. Gatvės važiuojamosios dalies rekonstrukcija, apšvietimo, šaligatvio ir lietaus nuotekų tinklų įrengimas Vasario 16-osios gatvėje, Garliavos seniūnijoje (alternatyva A_1) – 50,85 %,
3. Rekonstrukcija kelio ruožo nuo automagistralės A1 (Vilnius–Kaunas–Klaipėda) iki Naujųjų Muniškių kaimo Užliedžių seniūnijoje (alternatyva A_3) – 40,68 %.

Išvados:

1. Automobilių kelių investicinių projektų finansavimas Lietuvoje yra nepakankamas. Dėl to daugėja nelaimingų atsitikimų keliuose, neužtikrinamas keleivių ir pėsčiųjų saugumas, vairuotojai kelyje patiria didžiulius laiko, kuro ir automobilių eksploatacijos nuostolius.
2. Būtinas kompleksinis automobilių kelių investicinių projektų efektyvumo įvertinimas, kompleksiškai sujungiant ekonominį, socialinį ir aplinkosauginį aspektus. Svarbiausių kriterijų sujungimas vertinant kompleksiškai teikia daugiau informacijos apie analizuojamų projektų teikiamą naudą visuomenei.
3. Privataus sektoriaus investicijų pritraukimas į transporto projektus būtų patrauklus sprendimo būdas viešojo sektoriaus atstovams, siekiant pagerinti esamą kelių būklę. Privataus sektoriaus investicijomis būtų išspręsta nepakankamo kelių finansavimo problema.
4. Taikant autorių pasiūlytą automobilių kelių investicinių projektų įvertinimo metodiką, buvo nustatyta, jog efektyviausias projektas iš analizuojamų alternatyvų yra alternatyva A_2 – gatvės rekonstrukcija Ringauduose. Ši rezultatą lėmė šeši iš septynių autorių parinktų kriterijų (NPV, IRR, AL, PI bei triukšmo ir dulkėtumo sumažėjimai įgyvendinus projektą).

Raktažodžiai: *investiciniai projektai, automobilių keliai, efektyvumo vertinimas, darnioji aplinka, daugiakriteriniai vertinimo metodai.*

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