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INVESTMENT RISK MANAGEMENT AND ECONOMIC ASPECTS OF TRANSPORT INFRASTRUCTURE DEVELOPMENT

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The major causes of investment riskiness into transport infrastructure relate to international economy instability, lack of clearly defined and accurate information on the overall processes of international intermodal transportation, absence of objective information due to inconsequent market research as regards interpretation of economic, political and other aspects.

Assessment of objective integrated investments into public transport sector as a very specific branch of economy should necessarily be evaluated as multiple indicators affecting different spheres of community, and the final solution should be drawn when all multi-criteria indicators are well appraised. Economy based grounding of the optimal choice from all possible variants when solving specific tasks of the transport sector, depends on the economic expediency of the constructed subject. The main factors of effective usage of investments become apparent in the process of solving the task of road or railway network development optimisation.

Keywords: transport, infrastructure, investments, efficiency, risk

1. Introduction

Development of countries and welfare created is dependent on their integration into globalisation processes, implementation and application of global technologies, cooperation and interchange of raw materials and production. Integration of logistics centres and transport terminals into the transport system pays the key role in these processes. This proposition is welcomed by [Button, K. J., Langley, J., Coile, J., Gibson J., 2008] and [Kondratowich, L., 2003] who emphasize that reliably functioning European transport system is the premise of for integration, trade and development of economy, competitive ability and equal living conditions in the continent.

Majority of scholars emphasize, that basic elements of transport infrastructure, as constituent of the business, gives to the state an economic and social benefit. Risk management is one of the key issues when planning investments into intermodal transport infrastructure. Investment decision-making requires thorough analysis of the problem both, on the national and international scale, and only then the most rational decision (project) can be made with the view of the effective risk lowering, i.e. seeking the least possible costs.

The attention to methodological reasoning of investments in missing objects of transport infrastructure and to research of positive results for Lithuanian economy is paid, emphasizing their effect in efficiency and stability of economical development in Lithuania [Labanauskas, G., 2010], [Labanauskas, G., Palsaitis, R., 2010], [Palsaitis, R., Labanauskas, G., 2008].

2. Investments Risk into Transport Infrastructure Modelling

One of the most complicated problems among those of risk management when making concept based investments, including investments into transport infrastructure, is commeasuring the efficiency and riskiness of the event or process under analysis, i.e. assessment of the value of stock dividends' increase that would justify acquisition of a more risky stock, or what should be the growth in mean profitability of the investment into a transport infrastructure to encourage taking a variable interest rate loan.

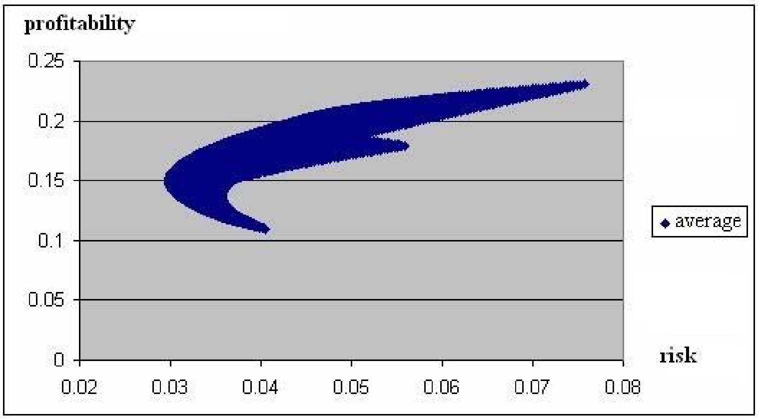
Solution of these problems is more advanced in theory and practice of investment decision-making. The studies of fundamental investment decision-making [see H. Markowitz, 1952, W. F. Sharpe, 1963, J. Tobin, 1965, Ch. Vaughan, 1997] disclose the existence of the efficient line in the mean profitability-risk plane, which is measured by profitability standard deviation. The main characteristics of the efficient line is that its points – investment possibilities, measured against profitability-risk indicators, cannot be improved on account of reducing mean profitability or riskiness if the value of the collateral parameter for evaluation is not changed.

In practice we pretty often have to face the natural risk management problem when trying to find the optimum (rational) distribution of the capital for the risk management among different risk groups. Solution of this problem is one of the most complete theories of investment portfolios.

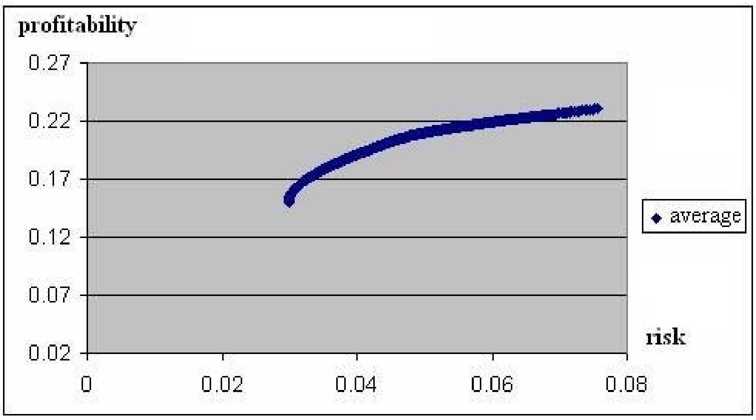
Computer modelling have been used to solve stochastic programming targeting at establishing the optimal proportions of the transport investments risk management among the three risk groups (portfolios). In Fig. 1a, section a we have a set of so called answers or portfolio values measured by internal effect and standard deviation (riskiness); section b presents the so called efficiency line with the mean values of the maximum net effect set on ordinate and the risk set on abscissa.

It clearly shows the investor's net profitability results: R1 (0,1502; 0,0299) – limiting the minimum risk, R2 (0,2066; 0,0478) – maintaining mean risk and R3 (0,2304; 0,0756) – accepting the maximum risk. A specific subject, depending on his interests pursued which are usually expressed by utility function, chooses a certain level of risk, and at the same time a certain coupling of mean profitability and risk.

It is very important that information system development receives a proper concern. In the theory of investment great attention is given to evaluation of the decision possibility (reliability) guarantee. As one of the measures for the information system development and cultivation of the investment criteria adequacy is classification of decision possibilities [see A. Rutkauskas, A. Miečinskienė, V. Stasytytė, 2008], taking into account possibility efficiency and reliability as well as the level of riskiness which depends on the riskiness of the processes under analysis (interest rate, currency exchange rate and alike) and on the ability of a subject – the recipient of the risk consequences to manage it.



a) Portfolio set and profitability

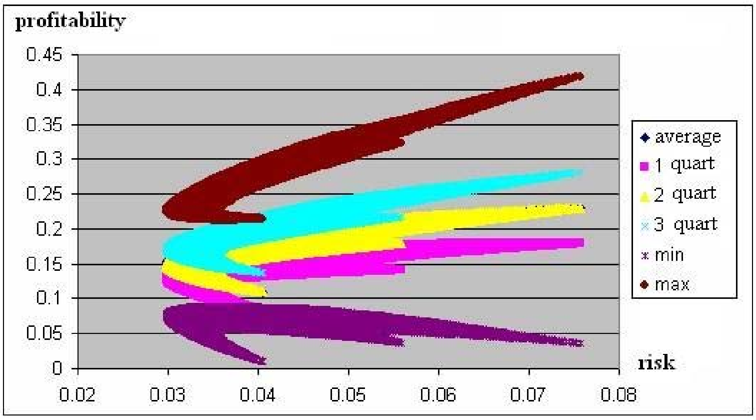


b) Efficiency line

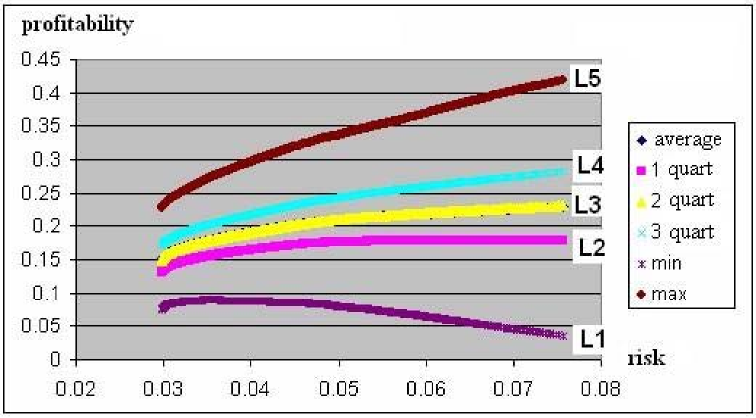
Figure 1. "Standard deviation – mean" portfolio set and efficiency line

If on Figure 1 instead of the portfolio as a random mean value the values of quartiles are introduced, then we would obtain respectively the sets of portfolio quartiles and the value of risk possibilities (Fig. 2 section a) and, analogically, the efficiency lines (Fig. 2 section b). The distinctive feature of these lines is the case when each point on a certain efficiency line $(l_i \subset L_i)$ corresponds certain levels of guarantee or reliability (here l_i and L_i are guarantees of 95 % and 5 % respectively):

$$P\{\xi \geq l_5\} = 0.05\,,\ P\{\xi \geq l_4\} = 0.25\,,\ P\{\xi \geq l_3\} = 0.5\,,\ P\{\xi \geq l_2\} = 0.75\,,\ P\{\xi \geq l_1\} = 0.95\,.$$



2a) Set of all quartiles – standard deviation portfolios



2b) Efficiency lines

Figure 2. Set of all quartiles – standard deviation portfolios and efficiency lines

3. Economic Aspects of Developing Chains of Transport Infrastructure

Level of the modern scientific-technological advancement requires radical changes in the society's attitude towards efficiency of social-economic measures designed for the development of the specific branches of material production and assessment of their functioning, and transport in particular. Currently, the choice of one possible alternative investment into development of infrastructure is often predetermined by personality and lobbyist practice instead of invoking the comparative theory of economic efficiency. Selection of the European level projects is often based on typical methods applied for the assessment of investments and economic efficiency of modern technology.

Consequently, assessment of objective integrated investments into public transport sector as a very specific branch of economy should necessarily be evaluated as multiple indicators affecting different spheres of community, and the final solution should be drawn when all multi-criteria indicators are well appraised.

Investment projects' efficiency according to the description given in the Automobilių kelių investicijų vadovas – Investment [Guide, 2006] and [Guide to Cost-Benefit Analysis of Investment Projects, 2008], is a category reflecting a project's conformity to the goals and interests set by its participants.

The general scheme of the investment project efficiency consists of the two stages. In case of the transport infrastructure projects at the first stage general indicators of the project efficiency are estimated enabling to make an aggregated economic assessment of possible variants of the projected decision, the so-called commercial efficiency. Evaluation of the commercial efficiency is carried out only in those cases when the project is considered to be of great value to the society. Evaluation of a possible financing scheme, revision of the investors' list as well as assessment of the financial possibility of the project implementation and its efficiency are carried out in the second stage. With the investment projects run by the State it is recommended to apply complex analysis for their evaluation.

Based on the EU methodical recommendations and the Lithuanian Manual for Road Investments the system of criteria indicators for evaluation of road and railway projects' efficiency have been set, comprised of:

1. Integral effect (E integr.) – the total of the discounted (given for a certain period of time) effects for the entire period of the project life cycle;
2. Profitability Index (PI) – ratio of the sum of diverse results and the present costs to the amount of investment;
3. Internal Rate of Return (IRR), i.e. a fixed discount rate over a certain period of time that makes the sum of the diverse results and the present costs are equal to the sum of the given investments;
4. Payback period depending on discounting – a minimum period of time from the start-up of the project implementation beyond the limits of which the integral effect becomes and remains positive;
5. Integral costs (IC) – the sum of the costs over the entire period of the project life cycle.

Solution of the optimised transport tasks with the view to onetime costs of investment into road and railway transport infrastructures for building connections with logistics centres and terminals (reconstruction, major repairs, etc.) as well as cargo flows (by roads and railways) is very important when choosing the most economically rational criterion: "minimum integral costs", meaning:

1. Investments made during the construction period (reconstruction and others) – KI;
2. Investments that are needed for the execution of the planned reconstruction works, to forward or to renew a technical road project (if any) during the accounting period of its operation – KR.;
3. Investments into road or railway transport at the initial stage of the subject operation – KID;
4. Additional annual investments into road or railway transport to meet the yearly increase in the regional transport needs – KP;
5. The scope of community expenditures on redeeming of valuable lands to make implementation of road and railway projects possible – KL;
6. Value of circulating funds which conforms yearly production and consumption on the roads, i.e. in the state of "freeze in" – KF.

The first two indicators of onetime costs (KI and KR) that in the investment road and railway projects indicate investments into construction (reconstruction) works are always well considered. The value of these indicators is assessed for each variant of transport tasks in accordance with an estimated value.

The third indicator (KID) – investments into road or railway transport that are necessary for performing cargo carriage at the start-up of the exploitation, and the recommended calculation could be made according to the equation:

$$K_{oa} = \frac{A}{T_a}\left(\frac{Qo}{q_c\beta\gamma}t_{pr} + \sum^{i}\frac{P_{oi}}{vq_c\beta\gamma} \neq t_n\right), \tag{1}$$

where

A – comparative investments into units of transport means and a company's infrastructure for the region's one recorded automobile or van;

T_a – exploitation period of one unit of transport in hours within duration of one year;

t_{pr} – mean duration of outage of a transport unit in hours wasted for its loading in one voyage period;

Q – general size of carriage by roads or railway in tones within one year period;

t_n – loses sustained due to outage at the crossroads, railway crossings, and boarder crossings;
P_{oi} – annual turnover of cargo carriage by road or railway transport within one year period to the road or railway type, t/km;
i – number of road and railway types in a region;
v – technical velocity of a cargo transport on a main infrastructure roads, km/h;
q_c – mean nominal load of one transport unit in tons;
β, γ – run and load coefficients of transport units.

The size of space allotted for warehouses, logistics centres and other premises under construction is estimated according to the amount of loads in inventory:

$$F = \frac{q^1}{k\delta}\left(m^2\right), \tag{2}$$

where
k – coefficient of the useful storage place;
δ – loading rate per one square meter of the useful storage space (in tons per sq. m).

Hence the investments into the construction of warehouses, logistic centres and other premises should be calculated as follows:

$$K_{ts} = S_1 \frac{q^1}{k\delta} + S_2 q_2 , \tag{3}$$

where
S_1 – mean construction costs of one sq. meter of a public warehouse;
S_2 – construction costs of a special-designed warehouse (refrigerated, for storing hazardous goods) per one ton of load.

Amount of the annual loss due to the increased need for circulating asset (K_n), which is conditioned by the need to accumulate load stores in case of seasonal or traffic constraints (road blockades, institutional actions – Latvia, Russia) when some roads are not used, is calculated dependent on the duration of outage defined by equation:

$$K_n = \frac{K_v Q}{12} , \tag{4}$$

where
Q – total amount of the projected annual material resources, in tons;
K_v – costs of one ton of goods in accumulated stocks.

When comparing possible variants for transport – related problem solution it is important to project operating (running) costs that are comprised of:

- costs of yearly repair and maintenance of regional roads or railways ($C_{tg.c}$);
- costs of intermediate road repair, assigned to one year service between the repairs (C_{tgp});
- costs of yearly cargo carriage in each variant under comparison (C_{tper});
- public (external) losses due to traffic accidents (C_{tken});
- public (external) losses due to irregular traffic flows (C_{treg}).

The costs of yearly road or infrastructure connection repairs and maintenance may be determined, irrespective of traffic intensity and volume of carriage (because these costs compared to others are relatively low), by applying calculation normative or on the grounds of perennial statistical data.

Similarly the costs of yearly intermediate road or railway connection repair may be estimated.

The costs of yearly cargo carriage in each possible variant of road or railway connection construction (reconstruction) under comparison may be determined as to their component parts: drivers' salaries and extra-payments (C_{tat}), variable costs (C_{tkin}), fixed costs (C_{tpast}), taxes and charges (C_{tmok}), can be estimated by the equation:

$$C_{tper} = C_{tat} + C_{tper} + C_{tpast} + C_{tmok} \; . \quad (5)$$

However, estimation of one-time investments into labour resources necessary for the maintenance of different category roads or railways and for creating required state transport infrastructure is not enough. Aside from the labour costs that include workers' salaries, it is necessary to estimate additional operating labour costs, related to formation of social funds, improvement of working conditions, etc. Therefore the list of operating costs for separate variants under comparison will not be full without assigning additional operating costs for labour resources ($C_{t\,dr}$).

Hence, comparative economic evaluation of possible variants of investment project according to the criterion "minimum integral costs" should also include estimation of operating costs:

$$C_{tbendr} = C_{tgc} + C_{tgp} + C_{tper} + C_{tmok} + C_{tpapild} + C_{treg} + C_{t\,dr} \; . \quad (6)$$

Economy based grounding of the optimal choice from all possible variants when solving specific tasks of the transport sector, depends on the economic expedience of the constructed subject. The main factors of effective usage of investments become apparent in the process of solving the task of road or railway network development optimisation.

3. Conclusions

Development and implementation of the risk management system for the transport investments modeling will become a tool to attain higher efficiency and stronger security only in the case it is supported by an overall information on the reliability of the decision efficiency and the affect of the risk as compared to the usefulness of the decision.

At present for the evaluation of investments into the national transport infrastructure objects the standard assessment methodology is used. For the evaluation of investments assessment to the transport infrastructure main objects the comparative multiple criteria methodology with reference to state the transport development strategy must be used.

Among the most objective and practically applicable methods the method of "multistage dynamic model approximation" or the method of "several statistical sections" is most commonly used for estimating the total (integral) disposable and operative costs for all transport infrastructure needs of the region (its road, construction and maintenance of stationary buildings, etc.). The most optimal and objective results depend on the precise determination of total cost value parameters at each of their statistical section.

References

1. Automobilių kelių investicijų vadovas. (2006). Kaunas: VĮ „Transporto ir kelių tyrimo institutas".
2. The Cohesion Fund 2000–2006. (1999). Application for Assistance. Environment and Transport. Council regulation (EC) No 1164/94 of 16 May 1994, Council regulation (EC) No 1264/1999 of 21 June 1999 and Council regulation (EC) No 1265/1999 of 21 June. European Commission, Electronic version.
3. Guide to Cost-Benefit Analysis of Investment Projects. (2008). Brussels: European Commission, Directorate General Regional Policy.
4. Kondratowicz, L. (2003). Identification of factors that determine location and functional structure of logistics centres – a comparative study. In *Report for Work Package 1. Networking Logistics Centres in the Baltic Sea Region* (pp. 103-117) Poland: Departament of Scientific Publications of the Maritime Institute in Gdansk.
5. Langley, J., Coile, J., Gibson, J. (2008). *Managing Supply Chain: A Logistics Approach*. Canada: Cerngage Learning.
6. Labanauskas, G. (2010). *Substantiation of investments into development of the prioritized overland transport infrastructure in Lithuania*. Vilnius: Technika.

7. Labanauskas G. (2010). *Substantiation of investments into development of the prioritized overland transport infrastructure in Lithuania.* Vilnius: Technika.
8. Labanauskas, G., Palšaitis, R. (2007) Study of possibilities to establish regional transport terminal in Kaunas. *Transport,* 22(2), 118–121.
9. Markowitz, H. M. (1952). Portfolio selection, *Journal of Finance,* 7(1), 77–91.
10. Palsaitis, R., Labanauskas, G. (2008). Analysis of transport terminals network strategic planning. In Proceedings of the 8th International Conference "Reliability and Statistics in Transport and Communication", 2008 (pp. 216–219). Riga. Latvia: Transport and Telecommunication Institute.
11. Rutkauskas, A. V., Miečinskienė, A., Stasytytė, V. (2008). Investment Decisions Modelling along Sustainable Development Concept on Financial Markets, Technological and Economic Development of Economy. *Baltic Journal on Sustainability,* 14(3), 417–427.
12. Sharpe, W. F. (1963). A simplified model for portfolio analysis. *Management Science*, 9(2), 277-293.
13. Tobin, J. (1965). The theory of portfolio selection. In F. H. Hahn and F. R. P. Brechling (Eds.), *The Theory of Interest Rate* (pp. 3–51). London: Macmillan.
14. Vaughan, E. J. (1997). *Risk Management*. New York: John Willey and Sons, Inc.