

# Technique, principles and features of assessment of economic efficiency of highways construction and reconstruction

Técnica, principios y características de la evaluación de la eficiencia económica de la construcción y reconstrucción de autopistas

Técnica, princípios e características de avaliação da eficiência econômica da construção e reconstrução de rodovias

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## Abstract

Efficiency assessment technique of capital investments in construction and reconstruction of highways is described in this article. Despite the degree of readiness of the methodical device, specialized construction norms of VSN 21-83 focused on implementation of such assessment were not widely adopted in view of the difficulties arising in the course of collecting basic data, their reliability and quality. The present article contains the characteristics of the grouped components and evaluation criteria, in particular, the description of settlement indicators in a section of the intra-transport, extra-transport and social and economic effects resulting from capital investments in linear objects of road infrastructure. On a concrete example the assessment procedure and calculations of summary economic indicators for groups and for the project in general is shown. What shows is a possibility of application of rather difficult technique and its efficiency as scientific tool of complex assessment for the solution of applied tasks in road construction. And use of departmental construction norms in combination with the dynamic methods of assessment based on the analysis of cash flows can increase substantially scientific validity of administrative decisions and quality of investment projects in the field of development of road infrastructure.

## Resumen

En este artículo se describe la técnica de evaluación de la eficiencia de las inversiones de capital en la construcción y reconstrucción de carreteras. A pesar del grado de preparación del dispositivo metódico, las normas de construcción especializadas de VSN 21-83 enfocadas en la implementación de dicha evaluación no se adoptaron ampliamente en vista de las dificultades que surgen en el curso de la recopilación de datos básicos, su confiabilidad y calidad. El presente artículo contiene las características de los componentes agrupados y los criterios de evaluación, en particular, la descripción de los indicadores de asentamiento en una sección del transporte interno, transporte extra y los efectos sociales y económicos resultantes de las inversiones de capital en objetos lineales de infraestructura vial. En un ejemplo concreto se muestra el procedimiento de evaluación y los cálculos de indicadores económicos resumidos para grupos y para el proyecto en general. Lo que muestra es una posibilidad de aplicación de una técnica bastante difícil y su eficiencia como herramienta científica de evaluación compleja para la solución de tareas aplicadas en la construcción de carreteras. Y el uso de normas de construcción departamentales en combinación con los métodos dinámicos de evaluación basados en el análisis de flujos de efectivo puede aumentar sustancialmente la validez científica de las decisiones administrativas

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**Keywords:** construction norms, assessment technique, economic efficiency, capital investments, construction and reconstruction of highways, intra-transport and extra-transport effect.

y la calidad de los proyectos de inversión en el campo del desarrollo de infraestructura vial.

**Palabras claves:** Normas de construcción, técnica de evaluación, eficiencia económica, inversiones de capital, construcción y reconstrucción de carreteras, transporte interno y efecto transporte adicional.

## Resumo

A técnica de avaliação de eficiência de investimentos de capital em construção e reconstrução de rodovias é descrita neste artigo. Apesar do grau de prontidão do dispositivo metódico, normas de construção especializadas do VSN 21-83 voltadas para a implementação de tal avaliação não foram amplamente adotadas em vista das dificuldades surgidas no decorrer da coleta de dados básicos, sua confiabilidade e qualidade. O presente artigo contém as características dos componentes agrupados e critérios de avaliação, em particular, a descrição dos indicadores de liquidação em uma seção dos efeitos intra-transporte, extra-transporte e sociais e econômicos resultantes de investimentos de capital em objetos lineares de infraestrutura rodoviária. Em um exemplo concreto, o procedimento de avaliação e os cálculos de indicadores econômicos resumidos para grupos e para o projeto em geral são mostrados. O que mostra é uma possibilidade de aplicação de técnica bastante difícil e sua eficiência como ferramenta científica de avaliação complexa para a solução de tarefas aplicadas na construção de estradas. E o uso de normas de construção departamental em combinação com os métodos dinâmicos de avaliação com base na análise dos fluxos de caixa pode aumentar substancialmente a validade científica das decisões administrativas e da qualidade dos projetos de investimento no campo do desenvolvimento da infraestrutura rodoviária.

**Palavras-chave:** Normas de construção, técnica de avaliação, eficiência econômica, investimentos de capital, construção e reconstrução de rodovias, efeito intra-transporte e extra-transporte.

## Introduction

Evaluation of the economic efficiency of capital investments in road infrastructure objects is carried out using departmental building regulations DCN 21-83 "Instructions for determining the economic efficiency of capital investments in the construction and reconstruction of highways". The existing methodological apparatus, based on these norms, makes it possible to comprehensively take into account the economic consequences of the realization of investments in linear objects and transport infrastructure projects in general (Bogonosov, 2004). What makes the rules an excellent tool for justifying the economic efficiency of large-scale capital-intensive transport infrastructure projects involving government funding, since they allow to take into account all possible measurable effects that occur not only in transport, but also in the economy and public life of the territory as a whole. At the same time, the application of norms is associated with the need to collect and

process a significant array of statistical information, and to conduct a large number of diverse calculations. As a result, for reasons of high labor intensity, substantial cost, which raises the cost of work at the design stage of the facility, as well as the lack of economic agents in the regions that have the competence and information base to conduct large-scale applied scientific research, the use of such an assessment has not been widely adopted. Limitations are also the sufficiency, reliability and quality of the available baseline data (Granberg et al., 2007).

The study area is broad in nature and covers such areas of knowledge as sectoral project management and performance evaluation, transport economics, economic analysis, macroeconomics, regional economics, statistics. The theoretical and methodological basis of the work consisted of the works of domestic and foreign experts in these areas. The basis of the work is the works in the field of economic

efficiency assessment and project management by Vilensky P.L., Kosova V.V., Lipsits I.V., Mazur I.I., Pavlyuchenko V.M., Shapiro V.D., Sheremet V.V., E. Larson. The subject area of research on methodology and performance evaluation in road construction and the economy of transport is contained in the works of Bogonosov M.N., Garmanov E.N., Dinges E.V., Livshits V.N., Polyakova G.A., Tselkovnev D.A.

Among domestic works, the works of such Russian economists in the field of the development of spatial and regional economics, such as Granberg A.G., Egorov E.G., Kugaevsky A.A., Kuleshov V.V., Livshits V.V., Nogovitsyn R.R., Novoselov A.S., Okhlopko N.V., Popov A.A., Suslov V.I., Suspitsyn S.A. Special attention should be paid to the work of the founder of the theory of gravitational stress, (Reilly,1931), which served as the foundation for the development of the economy of cities and the people of resettlement.

Let's consider application of DCN 21-83 on the example of construction of the highway "Nyurbachan – Nyurbachan – Bysyttakh – Chukar – Kirov – Hatyn-Sysy – Zharkhan". The given calculations are made in the prices of 1st quarter, 2008. In the existing conditions, (reference) at the time of assessment, the road had the following characteristics: extent of 177 km, extent of the site of year-round use of 27 km, 150 km in a spring and autumn impassability of roads and also the most part of summer are impassable and can be used only as the winter road.

Note that the presented materials are the results of the work carried out in 2009 and which became a "pilot project" on the applied application of the methodology at the regional level (Novoselov,2011). The concrete example shows the assessment procedure, local and summary calculations of economic indicators by types of efficiency and for the project as a whole. The assessment was carried out in the context of intra-transport, extra-transport and socio-economic effects resulting from capital investments in linear road infrastructure objects (Garmanov,1981).

Thus, the initial goal of testing the methodology at the regional level showed not only the feasibility of its use, but also its universal and complex nature, taking into account the effects that arise and are measurable, which is important for assessing the investment qualities of large-scale infrastructure projects with implicit commercial profitability. The study

demonstrated the possibility of using a rather complicated method and its effectiveness as a scientific tool for integrated assessment for solving applied problems in road construction. And its use in combination with dynamic assessment methods based on cash flow analysis (Larson Eric & Gray Clifford,2013; Sheremet et al.,1998) can significantly increase the scientific validity of management decisions and the quality of investment projects in the field of transport infrastructure development.

## Materials and Methods

Assessment of economic efficiency of construction and reconstruction of highways is carried out with use of static and dynamic methods, depending on completeness and quality of basic data and is characterized by high labor input of settlement process. Basic methodical approaches by determination of economic efficiency of capital investments in road economy contain in departmental construction norms – DCN 21-83 "Instructions by determination of economic efficiency of capital investments in construction and reconstruction of highways". Depending on requirements of the customer and the standing tasks, efficiency assessment can be complemented with performance of dynamic financial model with definition of integrated indicators on the basis of the analysis of the cash flows generated by the project during the accepted settlement period according to provisions of "Methodical recommendations about assessment of efficiency of investment projects and their selection for financing" (the second edition) – VK 477.( Guidelines for the evaluation of investment projects ,2000).

Feature of economic efficiency assessment of capital investments in construction and reconstruction of highways is application of the state (economic) approach that is accounting of expenses and effects not only in road economy and on the motor transport, but also on other means of transport, as well as in non- transport branches of the national economy (Tselkovnev,2010).

The efficiency is defined by comparison of effects of implementation of capital investments to their size. Economic effect of implementation of capital investments to highways is caused by influence of concrete changes in a condition of a road network, on the level of cost of transportations, both on the motor transport,

and on other means of transport. It's done at the size of expenses out of transport process, at the size of losses in the industry, agricultural industry and construction connected with an insufficient requirements satisfaction in the transportations finally exerting impact on size of the made national income.

A gain of net production of goods, cost cutting or a gain arrived in the organizations of the non-productive sphere at satisfaction of the corresponding public requirements are also a part of economic effect. When determining economic efficiency of capital investments to highways from the total value of effect in these directions, a part which corresponds to a share of the estimated capital investments in the total amount of the capital investments, providing this effect is allocated. Allocation of a part of effect is in proportion to sizes of capital investments.

Main social results, such as, reduction of losses of the national economy and society in general from the road accidents (RA) and reduction of the losses connected with time of stay of passengers in way are added to the total economic effect.

Thus, assessment is carried out on three main components. Components of economic effect are:

- I. Intra-transport economic effect (decrease in the one-time and current costs connected with transportations, requirement for which does not depend on the solution of a question of implementation of capital investments in the considered road). It arises in road maintenance, on the motor transport, at loading and unloading works. It is determined by the difference of expenses in the existing and design specifications, by the profit of the enterprises on performance of additional transportations in design specifications.
- II. Extra-transport economic effect (reduction of losses and expenses of the national economy when performing of the volume established by the plan). Economic effect of this direction is defined

with use of the prices, by prime costs of resources and materials, from the stimulating impact of highways on the sphere of the production of goods which is expressed in a gain of net production.

- III. Economic effect in the social sphere, reduction of losses from the road accidents, reduction of the losses connected with time of passengers' stay in a way at trips; the losses connected with the damage caused by roads to the environment or cost of its prevention. At the same time, it is possible not to consider capital investments in the motor transport and cost of revolving funds, the profit of the self-sustained transport organizations on additional transportations (Ivanova & Polyakova, 1989).

## Results and Discussion

### I. Assessment of intra-transport effect

Due to the change of category, character of the designed highway on year-round and improvement of a paving, that is with achievement of design specifications the intra-transport effect, will arise in the following directions (Dinges & Akulov, 2010; Dinges, 2004; Dinges, 2014):

1. Growth of economic indicators of the road operational enterprises (at simultaneous increase of load of the budgetary system in the form of expenses on financing of works).
2. Growth of volumes of loading and unloading works.
3. Reduction of expenses of the motor transportation enterprises in connection with improvement of a covering of the highway and costs of passengers of journey payment.
4. Increase in income on the cargo motor transport due to growth of volume of transportations (in the real justification, it is referred to the extra-transport effect gained in branches of production of goods after construction of the highway).

## I. Growth of economic indicators of the road operational enterprises.

**Table.1.** Assessment of road operational effect

Statement	Value	
	Current	Project
Extent, total, km	27,3	157,2
Extent, winter roads, km	150	0
Road maintenance norms of expenses:		
- year-round roads, thousand rub/km	96,2	142,8
- winter roads, thousand rub/km	10,1	15,0
Annual revenues of road operational enterprises, thousand rub	4141,26	22448,16
<b>Annual effect, thousand rub</b>		<b>18306,9</b>
prospective period, years		20
<b>Total effect, thousand rub</b>		<b>366138</b>

Revenues of the enterprises of road economy in connection with construction of the new year-round highway in design specifications will reach

22,4 million rubles a year that will give annual effect in the sum of 18306,9 thousand rubles, and for the settlement period – 366,1 million rubles.

## 2. Growth of volumes of loading and unloading works.

**Table.2.** Assessment of loading and unloading works effect

Statement	Value	
	Current	Project
Cargo transportation, thousand tons	593	830
Average price of loading/unloading, rub/ton	300	300
Gross revenue, thousand rub	177900	249000
Correction coefficient on the actual conditions	0,75	0,75
Gross revenue, thousand rub	133425	186750
<b>Annual road construction effect, thousand rub</b>		<b>53325</b>
prospective period, years		20
<b>Total effect, thousand rub</b>		<b>1066500</b>

The total effect will be 53,3 million rubles a year, and total effect for all settlement period – 1066,5 million rubles.

3. Reduction of expenses of the motor transportation enterprises in connection with improvement of a covering of the highway and costs of passengers of journey payment.

The annual volume of transportations on all networks of the existing highway, including winter roads is 48 thousand departures. The heaviest traffic is observed on the route

Nyurbachan – Bysyttakh: 35040 departures a year or 73% of annual volume of passenger traffic. Other parts of transportations are the share of the Bysyttakh – Chukar – Kirov direction.

Reduction of expenses of the motor transportation enterprises in connection with improvement of a covering of the highway and costs of passengers of journey payment, aggregate effect from construction of the road on the specified factors will make for the design period – 616,8 million rubles.

**Table.3.** Assessment of passengers' journey expenses reduction and passenger transportation enterprises revenues increasing

Statement	Value	
	Current	Project
Extent of year-round roads, km	27,3	157,2
Volume of passenger transportation, thousand pass.	1427	2681
Passenger turnover of the enterprises of all kinds of activity, thousand pass. - km	16293	57515
Transported passengers by the buses working at a commercial basis in the suburban routes, thousand pass.	572,6	1076
Passenger turnover by the buses working at a commercial basis in the suburban routes, thousand pass.- km	2000	13265
Coefficient of reduction of fare in the projected conditions (reduction in cost of journey as a result of improvement of roads quality)		0,627
Gross revenue of the enterprises engaged in transportation of passengers by public buses on a commercial basis, thousand rub	7651	31836
Expenses of the enterprises engaged in transportation of passengers by public buses on a commercial basis, thousand rub	7609	19863
Profit of the enterprises engaged in transportation of passengers by public buses on a commercial basis, thousand rub	42	11973
Economy effect of the population on journey expenses, thousand rub		18909
Effect of increase in revenues of the enterprises engaged in transportation of passengers by public buses on a commercial basis, thousand rub		11931
<b>Annual road construction effect, thousand rub</b>		<b>30840</b>
prospective period, years		20
<b>Total effect, thousand rub</b>		<b>616796</b>

**Table.4.** Summary calculation of intra-transport effect for the period

Statement	Effect, thousand rub.
Increase in income in road economy	366138,2
Growth of volumes of loading and unloading works	1066500
Reduction of expenses of the transportation enterprises	616796
<b>Total:</b>	<b>2049434,2</b>

Thus, the total intra-transport effect for the project settlement period will be 2049,4 million rubles.

## II. Assessment of extra-transport effect

Extra-transport economic effect of the designed highway is formed by additional results of increase in the overall performance of motor transport, increase in transported volumes of growing products in a highway zone and also from increase in mobility of the population reduction of time of trips (Granberg et al., 2008; Livshits & Strelnikov, 1983; Reilly, 1931).

Assessment of extra-transport effect is made according to the following sections:

1. Reduction of losses from creation of insurance seasonal stocks.

2. The stimulating impact of the designed highway on development of production of goods, in particular at:

- Diamond mining industry,
- Agriculture,
- Coal mining industry.

1. Reduction of losses from creation of insurance seasonal stocks.

The network of highways created so far has incomplete character and does not provide the year-round motor transport communications both between settlements of the area and with the most economically developed regions of the central and southern Yakutia. Driving through the available highways is arranged, as a rule, only in winter time. In these conditions a special problem is very considerable that is costs of ensuring northern seasonal delivery of freights.

The main economic aspect of a problem of delivery of freights to northern areas is the compelled derivation of considerable appliances

from the reproduction sphere, "freezing" of resources for creation of insurance and seasonal stocks, need of creation and maintenance of warehouse, considerable on the area, and accumulative terminals in basic points and directly in places of consumption, increase in the period of goods turnover.

So, for example, in cross-country conditions of the Republic of Sakha (Yakutia) seasonal stocks are created up to the period of 274 days, and periods of storage of seasonal stocks are made according to official figures by 140-180 days. For Nyurbinsky district the middle period of storage of seasonal stocks is 152 days.

Construction of the highway will allow increased profitability of the enterprises as a result of reduction of losses from creation of seasonal stocks. Also, what's important, ensuring year-round access of the highway will allow reduction of social and economic tension in the area. By preliminary estimate, the main part of need for food products, freights of material support and separate types of consumer goods can be covered with motor cargo transportations. Creation of uniform network of constant highways will allow to improve significantly economic and social situation in the area, will promote gradual alignment of living conditions of the local population in comparison with the central territories of the republic due to decrease in overall price level on food and consumer goods, will allow to stabilize finally (along with other actions) the general economic situation.

Influence of the designed highway on the social sphere of the area is defined by the factors called above leading to substantial increase of cost of life. The effect of reduction of losses of creation

of seasonal insurance stocks for initial year will be 1 224 million rubles, for the design period – 10 607,4 million rubles (in established prices).

2. Increase in profitability of the enterprises from replacement of air transport on automobile for transportation of workers and cargo delivery.

JSC ALROSA acts as one of the powerful enterprises for development of economic and social situation of the area. For transportation of workers and freights on the territory of the field camp the company uses helicopters. At construction of the road there is an opportunity to use cheaper type of transport – automobile. The effect of replacement of option of transportation of workers and freights will be for initial year 11 million rubles, and for the entire project period – 218 million rubles (in established prices).

3. Influence of road construction on development of agriculture.

Because of low technological level of the existing roads in the area the average movement speed is 20-30 km/h, the length of car life is reduced by 30%, and its productivity falls more than twice that finally leads to increase in transportation cost up to two times. In turn, high transportation costs increase prime cost of agricultural production. Calculation of effect of transportation costs reduction as a part of products cost of agricultural producers is given below.

The effect of expenses reduction in agriculture due to transportation cost reduction as a result of designed road construction will be more than 58 million rubles a year.

Besides, improvement of the transport scheme will eliminate seasonality in delivery of forages and hay, will allow expansion of haying grounds and pastures, will reduce labor input of works by bigger involvement of agricultural machinery,

etc. Agricultural enterprises will be able to take out in due time meat and dairy products for processing to Nyurba and to supply other settlements with fresh products. All this stimulates a growth of the agricultural production at least for 15-20%. Demand for agricultural production is provided with local one on meat less than for 30%, on potatoes and milk – for 70%. Besides, large-scale development of South Yakutia will attract additional inflow of labor from the outside of the republic that will increase demand for food. The neighborhood with the agricultural Nyurbinsky region has to promote sales of local products, increase capacity of local farms to promote increase in a level of living.

The output of agricultural production of the area can increase by 219 million rubles per year. The gain of gross profit of farms will make more than 9 million rubles a year. For the perspective period of the project implementation the effect on the specified indicators will be 2,632 billion rubles and 114 million rubles accordingly.

4. Influence of the road construction on development of the coal industry.

The lack of all the year-round operated road in the area detains development of the coal industry. The main transportation of coal is made only during the winter period. With construction of the designed highway, first, expenses of the enterprises for creation of coal reserves will be cut down. Secondly, construction of the highway will become the instrument of implementation of the regional strategic target program for the conversion of boiler to coal fuel. Along with a coal mining growth the road construction will allow to increase profitability of the coal transportation enterprises.

The effect of reduction of costs of coal transportation is expected in 22 million rubles for initial year, and in 1 995 million rubles for the prospective period of the project.

**Table.5.** Summary calculation of extra-transport effect for the period

Statement	Effect, mil rub.
Reduction of losses from creation of insurance seasonal stocks	10607,4

Effect in diamond mining industry	218,0
Effect in agriculture	114,0
Effect in coal mining industry	1995,0
<b>Total:</b>	<b>12934,4</b>

### III. Assessment of social and economic consequences

Implementation of the project having important social focus will allow to achieve its ultimate goal – to provide needs of the population of the area with passenger traffic with sufficient degree of comfort and speed of the communications in difficult climatic conditions, big sizes of the territory and its discrete planning structure (Yegorov,2006).

Unlike many other branches the main benefits from road construction lie not in commercial area, but public, regional and budgetary effects, i.e. in consequences of road project implementation for economy, social sphere and ecology, for example:

- Growth of production volumes of other (not transport) enterprises as a result of the general reduction of transportation cost and growth of availability;
- Time saving of the population in passenger traffics;
- Impact of road construction on health of the local population (first of all, owing to decrease in road accident).

#### 1. Reduction of trip time for the population.

Time for trip of the population decreases, at the same time saving of time in relation to use of land transport will make, respectively, 10 and 14 minutes during the warm period of year and 13-18 minutes in winter time that will significantly reduce transport "fatigue" of the local population. Cost assessment of reduction of losses of time of passengers in way will make for all design period – 924 million rubles.

#### 2. Improvement of comfort.

Considering big carrying ability of the year-round highway and flexible hours of traffic and also use of motor transport with higher comfort, the comfort of transportation of passengers has to improve.

#### 3. Reduction of accident rate on land transport.

As a result of construction of the designed highway the accident rate has to decrease by 15%, until the end of implementation of the project – for 20-25% with five to four incidents. Cost assessment of economic effect of decrease in accident rate is made proceeding from the maximum sum of insurance compensation according without infliction of harm to the population's health.

#### 4. Other factors of efficiency of the designed road.

Except the factors stated above, unsatisfactory transport availability of a considerable part of the territory and poor quality of highways are the reason of a number of negative social consequences, including:

- excess mortality of the population because of untimely delivery of health care;
- limited education and cultural development in remote areas;
- reduction of free time due to increase in time of stay in a way to the place of work, rest, to the regional center, etc.;
- decrease in mobility of the population and increase in unemployment;
- high mortality in road accident and a large number of the people who are becoming disabled after mutilations or long time of stay on treatment in hospitals;
- decrease in agricultural production efficiency and decline of incomes of the workers occupied in agriculture;
- Rise in crime due to decrease of police mobility.

The negative social and economic consequences arising because of backwardness of a regional road network are one of the reasons of considerable outflow of the population both out

of borders of the region. The danger of thin population of the area is as a result created.

**Table.6.** Summary calculation of social effect for the period

Statement	Effect, mil rub.
Effect of reduction of trip time	924
Comfort ability	increase
Reduction of accident rate	3,2
Reduction of accident rate, %	20-25%

Thus, it is possible to draw a conclusion that insufficient development of road network and unsatisfactory condition of the existing roads

affects practically all parties of social and economic life and is an obstacle for further development of the region.

**Table.7.** Summary calculation of economic effect

Statement	Effect, mil rub.
Intra-transport effect	2049,4
Extra-transport effect	12934,4
Social effect	927,2
Gross effect	15911

The aggregate effect from highway construction for the prospective period will be 15911,0 million rubles. According to DSN 21-83 as the base year accept year of commissioning of an object or its first start-up complex (turn of construction). Therefore, the settlement period in the present feasibility study is accepted in conditional serial years without binding to the calendar.

The indicators of the general (absolute) economic efficiency of capital investments compare to the industry standard. Capital investments recognize as economically effective if the indicators of overall effectiveness received for them are not lower than the standard and the actual indicators for the previous period.

As economic effect of capital investments to highways arises not only on transport, but also in the national economy, the industry standard of the overall (absolute) effectiveness for highways is established according to item 14 of "A standard technique of determination of the economic efficiency of capital investments" approved by the State Planning Committee of the USSR and the State Committee for Construction of the USSR at the level of the standard for the national economy in general, i.e. the  $E_{ci} = 0,14$ .

Summary economic indicators and calculation of efficiency of capital investments are presented in table 8.

**Table.8.** Aggregate economic indicators and calculation of efficiency of capital investments

No	Statement	Unit	Value	
			Current	Project
1	Extent of year round roads, including:	km		157,2
	- year-round roads with hard coating	km	27,3	157,2
	- winter	km	150	
2	Volume of cargo transportation	thousand tons	593	830
3	Volume of passenger transportation	thousand pass	1427	2922
4	Passenger turnover of the enterprises of all kinds of activity	thousand pass.-km	16293	57515
5	Capital investments	mil. rub	-	5247,8
6	Annual costs of roads maintenance	thousand rub	4141,26	22448,16
7	Annual volume of loading and unloading works		133425	186750
8	Annual reduction of expenses of the transport enterprises and costs of trip for passengers in connection with highway pavement improvement	thousand rub	-	30840
9	Losses from creation of seasonal stocks	mil. rub	11604,2	996,9
10	Losses from use of air transport in transportations of people and freights (in diamond mining industry) in a year	mil. rub	11,0	-
11	The losses from off-road terrain in agricultural production eliminated as a result of construction of roads for the period	mil. rub.	114	-
12	Losses from off-road terrain in the coal industry for initial year	mil. rub	22	-
13	Losses from road accident for initial year	thousand rub	800	640
14	Reduction of the losses connected with time of stay in a way of passengers for initial year	mil. rub	-	42
15	Full current expenses and effects considered for the period	thousand rub		15911,0
16	Coefficient of capital investments overall effectiveness			3,03

$$E_{ci} = 15911/5247,8 = 3,03$$

The calculated value of an indicator of overall effectiveness demonstrates positive efficiency of capital investments in construction of the highway.

### Conclusion

This paper contains the results of a study on the applied application of «Instructions by determination of economic efficiency of capital investments in construction and reconstruction of highways» A concrete example presents the assessment procedure, local and summary calculations of economic indicators by types of efficiency and for the project as a whole. The assessment was carried out in the context of intra-transport, extra-transport and socio-economic effects resulting from capital investments in a linear road infrastructure in the area of the existing road section. The results showed the feasibility of applying the guidelines, their universal and complex nature, taking into account the effects that arise and are evaluable, which is important for evaluating the investment qualities of large-scale infrastructure projects with implicit commercial profitability. The study demonstrated the possibility of using a rather complicated method and its effectiveness as a scientific tool for integrated assessment for solving applied problems in road construction. And its use in combination with dynamic valuation methods based on cash flow analysis can greatly enhance the scientific soundness of management decisions and the quality of investment projects in the field of road infrastructure development.

### References

- Bogonosov, M.N. (2004). A systematic approach to the calculation of indicators of economic efficiency in road projects. *Vestnik MADI*. 3. Pp. 93-98.
- Dinges, E.V. (2004). Methods for evaluating the effectiveness of leasing transactions in the road sector, *INFORM-AVTODOR*. 1.
- Dinges, E.V. (2014). Economics of construction, repair and maintenance of roads: studies. for stud. institution higher arr. Publishing Center "Academy".
- Dinges, E.V., Akulov, A.I. (2010). Analysis of methods for the feasibility study of the reproduction of transport infrastructure (for example, road bridges). M.: Informavtodor, 1. p.84.
- Garmanov, E.N., Polyakova, G.A. (1981). The non-transport effect of the development of the road network.
- Granberg, A.G., Suslov, V.I., Suspitsyn, S.A. (2007). Multi-regional systems: economic and mathematical research. Novosibirsk: Siberian Scientific Publishing House, 371 p.
- Granberg, A.G., Suslov, V.I., Suspitsyn, S.A. (2008). Economic and mathematical studies of multi-regional systems. Region: Economics and Sociology. Novosibirsk: IEEPP SB RAS, 2. pp. 120-150.
- Guidelines for the evaluation of investment projects (second edition). (2000). Ministry of Economy, Ministry of Finance of the Russian Federation, the Civil Code for construction, architecture and housing policy. M.: Economy, 421 p.
- Larson Eric, U., Gray Clifford, F. (2013). Project Management: Per. from English fifth, full. reclaiming ed. [trans. V.V. Dedyukhin] - M. Publishing House "Business and Service", 784 p.
- Livshits, V.V., Strelnikov, A.I. (1983). Calibration and verification of the gravitational statistical model of labor correspondences. Automation of urban planning processes. Collection. M.: TsNIIP urban planning, p.79-101.
- Novoselov, A.C. (2011). Region: Theory and Practice of Economic Management .468 p.
- Polyakova, G.A., Ivanova, E.N. (1989). Features of determining the socio-economic efficiency of capital investments in the tasks of the technical and economic design of highways. 33 p.
- Reilly, W.J. (1931). The law of retail gravitation. - New York.
- Sheremet, V.V., Pavlyuchenko, V.M., Shapiro, V.D. and others. (1998). Investment management: in 2 tons. - M.: Higher school, 512 p.
- Tselkovnev, D.A. (2010). Algorithm for evaluating the effectiveness of innovative projects for the creation of toll roads // FES: Finance. Economy.10. P.35-38. URL: <https://elibrary.ru/item.asp?id=15289604>.
- Yegorov, E.G. (2006). North of Russia: economics, politics, science, 560 p.