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Model for Evaluation of the Economic-Social-Environmental Outcomes of Investments in Road Transport Infrastructure

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**MODEL FOR EVALUATION
OF THE ECONOMIC-SOCIAL-ENVIRONMENTAL
OUTCOMES OF INVESTMENTS IN ROAD TRANSPORT
INFRASTRUCTURE**

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Key words: road infrastructure, benefit-cost analysis, municipality.

Abstract

This paper presents a model for valuation of the economic-social benefits and costs of investments in road transport infrastructure. The analysis of benefits and costs was based on three research areas: economic, social and environmental. Currently, the valuation of benefits and costs resulting from investments in road infrastructure is increasing in importance from the perspective of local development assigning a special role to road investments. Modernisation of road infrastructure has an indirect influence on the economic development of municipalities in the form of so-called economic-social-environmental outcomes that are of both a direct and indirect nature.

**MODEL OCENY EFEKTÓW EKONOMICZNO-SPOŁECZNO-ŚRODOWISKOWYCH
INWESTYCJI W INFRASTRUKTURĘ TRANSPORTU DROGOWEGO**

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Słowa kluczowe: infrastruktura drogowa, analiza korzyści i kosztów, gmina.

Abstrakt

W opracowaniu przedstawiono model wyceny korzyści i kosztów ekonomiczno-społecznych inwestycji w infrastrukturę transportu drogowego. Analizę korzyści i kosztów oparto na trzech obszarach badawczych ekonomicznym, społecznym i środowiskowym. Obecnie wycena korzyści i kosztów wynikających z inwestycji w infrastrukturę drogową z punktu widzenia rozwoju lokalnego nabiera znaczenia, a inwestycjom drogowym przypisuje się szczególną rolę. Modernizacja infrastruktury drogowej ma pośredni wpływ na rozwój gospodarczy gmin, co przejawia się w postaci tzw. efektów ekonomiczno-społeczno-środowiskowych, które mają charakter bezpośredni i pośredni.

Introduction

In economic literature, many definitions of the notion of infrastructure can be found (BRZOZOWSKA 2005 p. 5, KOWALSKI 2006 p. 13, SADOWY 2003 p. 24, PISKOZUB 1998 p. 15, BIEHL 1986 p. 37).

In the majority of these definitions, the physical characteristics of the infrastructure and the qualitative characteristics related to the product or service are identified. The direct and indirect impact on the local development represents an important feature of infrastructure. Infrastructure forms the basis for providing transport services for households and indirectly influences the productivity of businesses on the supply side as a production factor. It also indirectly promotes technological development while having an indirect influence on increasing work productivity.

Thanks to the development of infrastructure, the so-called “accumulation of outcomes” occurs and the consequences of those effects can impact economic development via various channels such as the improvement of transport technologies, decreasing the time and costs of travel, improvement of health and education and, in the long term, improvement of economic results of municipalities. On the demand side, infrastructure facilitates providing services that the people want and need for normal functioning, including water and sanitary facilities, heat and electrical power, telephone lines and improvement of transport access.

It is estimated that almost half of the infrastructural services are consumed at businesses (PRUD'HOMME 2005 pp. 13–15, FAY and MORRISON 2007 p. 35).

Road infrastructure is one of the main areas of widely-understood technical infrastructure responsible for the mobility of people and goods in space, resembling a blood circulation system for every economy.

Road infrastructure development contributes to the rapid movement of goods and passengers, the establishment of new businesses and the development of public sector infrastructure. In the case of passenger and goods transport, road transport is the most frequently chosen option. The number of enterprises providing road transport services is around 240,000 representing ca. 7% of all businesses in Poland. The share of road transport companies in the GDP amounts to ca. 4% while their trade receivables in 2010 amounted to ca. 53 billion PLN. In 2010, Polish transport enterprises transported ca. 1.2 billion tons of freight. In Poland, similar to the larger European Union countries, almost 90% of road transport operations are performed within the country.

The domination of road transport is a consequence of its particular characteristics:

- almost unlimited accessibility,

- high service efficiency,
- high travel flexibility,
- high travel speed is of particular importance in the case of short and medium travel distances,
- timeliness and punctuality of service provision (WOJCIECHOWSKI 2010, pp. 12–15).

Development and modernisation of the road network is necessary to maximize road transport potential. On a global scale, road transport infrastructure occupies 100 million ha representing ca. 2/3 of the global area developed for transport purposes (MAZUR 1992. pp. 8–9).

National roads of general national importance for the economy, defence or tourism which allow continuous connection between provincial cities as well as local economic centres and the capital of the province represent a strategic area from the perspective of the so-called economic development of individual regions.

The aim of the paper is to develop a model for analysis of social-economic-environmental benefits and the costs of investments in road infrastructure.

The section of the National Road No 16 Wójtowo – Barczewo, 9.7 km in length is the **object of the research**. The detailed project data is presented in Table 1.

Table 1
Road investment project data for the section of the National Road No 16 Wójtowo – Barczewo

Section	Section length [km]	Investment outlays [PLN]
Wójtowo – Barczewo	5.5	78,423,120
Barczewo bypass	4.2	35,440,511
Total	9.7	113,863,631

Source: own work.

The studied road section is a part of National Road No 16 which connects the most important economic centres of the province of Warmia-Mazury such as: Olsztyn, Iława, Ełk, Ostróda, Barczewo, Biskupiec, Mrągowo, Mikołajki, and Orzysz. This indicates the immense importance of this road for the transport of the people living in the region. From a national perspective, National Road No 16 connects the Great Masurian Lakelands with the rest of Poland and, consequently, influences access to one of the most attractive tourist regions of the country. From a European perspective, the subject road is a transit connection between Via Hanseatica and Via Baltica.

The subject section is situated within the area of Barczewo municipality and runs mainly through agricultural areas. The major objectives for the investment project in the modernised section are:

- streamlining of transit traffic,
- improvement of road safety,
- improvement of travel comfort,
- socio-economic integration of Poland, Lithuania, Latvia and Estonia within the European Union,
- increasing the attractiveness of investment, development of trade and development of tourism,
- efficient access to the region,
- decreasing negative environmental impact (*Annex to the feasibility study No 4... 2008*).

The basic research methods applied in the study included the project method and the method of analysis and comparisons. The timeframe covers the years 2007–2010.

Model for valuation of the outcomes from investments in road infrastructure

Valuation of the effects in economic, social and environmental aspects represents an important issue in assessment of investment in road infrastructure profitability. Development of a valuation methodology for road infrastructure investment outcomes as an instrument supporting the decision-taking process with particular consideration for social and environmental aspects represents a challenge for practitioners in road investment management. The model presented in the paper assumes analysis of outcomes of an economic, social and environmental character (Fig. 1).

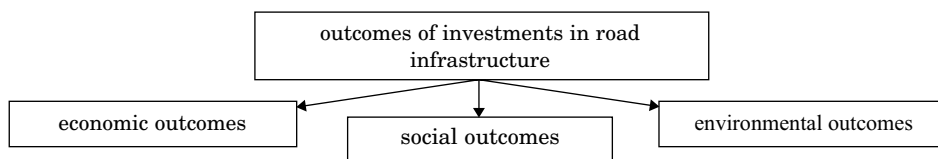


Fig. 1. Types of outcomes obtained through road investment project implementation
Source: own work.

Economic outcomes – savings on time and a decrease in costs of travel represent the basic outcomes obtained through investments in road infrastructure, which induce further outcomes of importance for local development (Fig. 2).

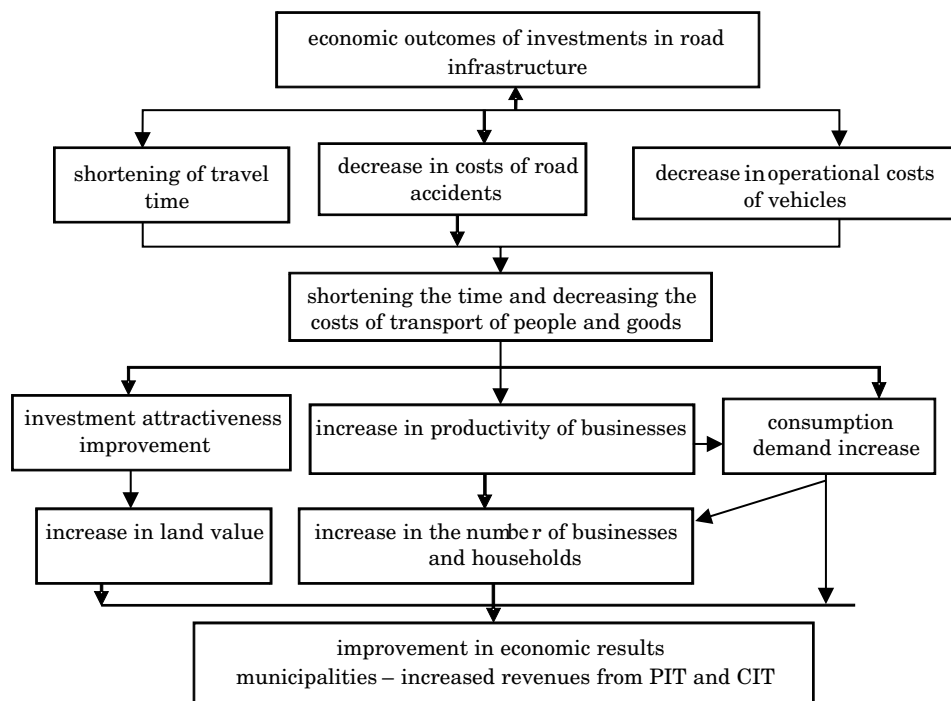


Fig. 2. Economic outcomes of investments in road infrastructure

Source: own work.

Economic outcomes obtained from investments in road infrastructure can be divided into direct and indirect ones. The direct outcomes include¹:

- decreased operational costs of vehicles – lower fuel consumption,
- decreased travel time – faster trips, (indicator: Value Time Transport Saving),
- decreased costs of road accidents.

The indirect effects (deferred in time) include:

- increased investment attractiveness of areas around the road infrastructure,
- increased real estate prices,
- increased number of businesses and households,
- increased revenues for municipalities from the PIT and CIT.

Social effects – the basic outcome of a **social character** induced by road investments is a decrease in unemployment caused, on one hand, by employ-

¹ Direct outcomes related to the decrease in travel time, operational costs and road accidents costs are currently valued according to the formula developed by the Road and Bridge Research Institute in Warsaw (IBDiM 2005).

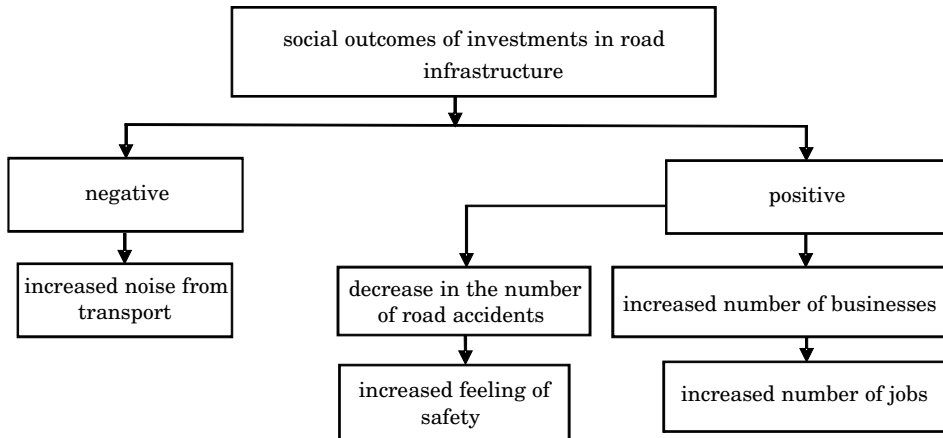


Fig. 3. Social outcomes of road investment projects

Source: own work.

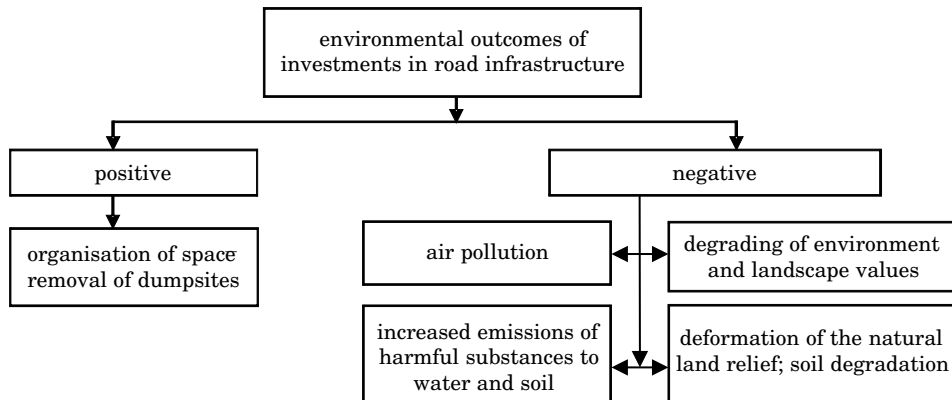


Fig. 4. Environmental outcomes of investment in road infrastructure

Source: own work.

ment for roadworks and as a consequence of the emergence of new businesses resulting from improvement in transport access to a given municipality (Fig. 3).

Social outcomes can be divided into positive and negative outcomes. The positive outcomes may include the improvement of safety and an increase in the number of businesses around the improved road infrastructure. The negative outcomes may include an increase in the level of noise caused by an increase in the number of vehicles using the given infrastructure.

Environmental outcomes resulting from implementation of a given road project can also be divided into positive and negative outcomes. As opposed to the economic and social outcomes, in this case negative, outcomes dominate.

Development of road infrastructure generally has a negative influence on the environment, which leads to conflicts concerning investment projects. As of the end of 2010, 66 road projects were blocked as a consequence of violating the Natura 2000 Act. (GDDKiA 2010).

For this reason, the transport system in Poland should be improved and subject to further streamlining². Nevertheless, valuation of the environmental costs resulting from road infrastructure development or modernisation currently represents one of the major issues of importance from the perspective of allocation of a given project, e.g. the Valley of the Rospuda River.

Analysis of the outcomes obtained from the road project based on the example of the National Road No 16 section Wójtowo – Barczewo

The formulated thesis is that road infrastructure development influences the development of municipalities situated around the infrastructure invested in various analytical areas. The method goes beyond the standard valuation of benefits and costs developed by the IBDiM for implementation of road investment projects. The surveyed outcomes were compared between the year 2007 (W0) and the year 2010 (W1).

Analysis of economic outcomes 2007–2010

The major direct and indirect outcomes that from the application perspective can be subject to valuation and offering the given Municipality the largest economic benefits were considered in the analysis.

The largest part of the savings resulting from the subject investment project was represented by time savings in transport operations by 39%, which, converted into monetary values, gave the amount of PLN 2,300,000. A decrease in the costs of road accidents by 31% was the second largest economic outcome which, converted into money, offered the amount of PLN 5,245,259. The operational costs of vehicles were decreased by 22% as a consequence of increasing the travel speed for the subject road section which, in fiscal terms,

² The detailed partial regulations concerning the EU transport policy are contained in the EU directives: 70/157/EEC; 72/306/EEC; 80/1268/EEC; 80/1269/EEC; 97/27/EC.

Table 2

Analysis of the economic outcomes of the subject project

Benefit / cost name	Verification source	Outcome of benefit / cost 2007(W0) / 2010 (W1) [%]	Year value obtained in PLN
Direct outcomes			
Travel time benefits	Feasibility study	↓ 39	2,300,000
Operational benefits	Feasibility study	↓ 22	4,097,000
Costs of road accidents	Feasibility study, Police statistics	↓ 31	5,245,259
Indirect outcomes			
Benefits from revenues of individuals and corporate entities	Barczewo Municipality budget Resolutions by Barczewo Municipality Council	↑ 20.2	1,474,943
Benefits of increases in prices of industrial real estate per 1 ha	Data from real estate agencies	↑ 54	140,000
Total			13,257,202

Source: own work.

offered the amount of PLN 0.85 per vehicle which, in turn, produced a yearly benefit at the level of PLN 4,097,000. The average traffic density on the subject road section was estimated at 20,000 vehicles per day (General Traffic Survey, GDDKiA 2010).

The other outcomes were of an indirect nature. The increase in own revenues of the municipality from local taxes and charges by 20.2% can be classified as one of the most important indirect outcomes. In 2007, the revenues from taxes from individuals and corporate entities and local charges amounted to PLN 7,286,032 while in 2010 the municipality budget revenues amounted to PLN 8,760,975, which resulted mainly from an increase in the number of businesses and in productivity.

The increase in the value of real estate for investment in the area by 54%, despite the financial market crisis of 2008-2009, represents another indirect outcome.

Analysis of social outcomes 2007-2010

The social benefits and costs were analysed from the perspective of the major problems encountered by Barczewo municipality, which include a high level of unemployment and lack of investments.

Table 3

Analysis of the social outcomes of the subject project

Benefit / cost name	Indicator / Verification source	Outcome benefit / cost 2007(W0) / 2010 (W1) [%]	Measure of the given variable
Benefit of population increase	municipal statistics	↓ 3	472 persons
Benefit of businesses number increase	municipal statistics	↑ 33	298 businesses
Number of the unemployed	provincial Labour Office	↑ 4	43 persons
Benefits related to the increase in the number of jobs	Municipal statistics County Labour Office	↑ 22 of the total number of the unemployed	235 jobs

Source: own work.

An analysis of the social benefits and costs showed that modernisation of the subject road section offering favourable economic outcomes also contributed to improvement of the important social outcomes. The most important outcomes include establishment of a large number of businesses (298) during a period of 4 years, which resulted mainly from improvement of transport access to the municipality. In addition, 235 new jobs were created, although that did not contribute to a decrease in the unemployment rate, which increased by 4% over the period covered. That phenomenon is a consequence of the lack of appropriate human capital in the municipality, which might also offer a starting point for the municipality to implement an effective programme of vocational improvement for the unemployed. This example shows that road infrastructure development should be supported by social infrastructure development, including a general vocational improvement policy targeted particularly at the unemployed.

Analysis of the environmental outcomes 2007–2010

The environment costs for the subject investment project covered the costs related to the emission of toxic components of exhausts generated as a consequence of the increase in the daily traffic density and the costs related to mortality of animals. Among the different taxonomic groups considered in the models describing the road infrastructure influence on the environment, mammals dominate at 55%, followed by birds – 11%, reptiles – 3%, amphibians – 7%, invertebrates – 10% and others – 14% (MIKUSIŃSKI 2010).

Table 3

Analysis of the environmental outcomes of the studied project

Benefit / cost name	Indicator / Verification source	Outcome benefit / cost 2007(W0) / 2010 (W1) [%]	Measure of the given variable
Increase in costs of emissions of toxic exhausts	Road and Bridge Research Institute	↑ 25	345,000 PLN
Costs of mortality of animals	Provincial Administration Office in Olsztyn Town Police Headquarters in Barczewo	↓ 30	70 animals (mammals)

Source: own work.

The costs related to emissions of exhausts increased by 25% during the period covered, which translates into an increase in the monetary costs in the amount of PLN 345,000. The increase in the costs was caused by the increase in demand for the modernised road section expressed by the increase in day traffic density by 45%. The level of accidents fatal for mammals decreased by 70 individuals.

Conclusion

The subject of this paper represents one of the research areas within the general research covering evaluation of the road transport infrastructure role in local development. Direct allocation of the influence of road infrastructure investments on the economic development of a given municipality is very difficult in itself and may cause numerous objections of a methodological and practical nature. That is why each road investment project should be approached individually by focusing on specific outcomes. That would both streamline the decision-making process and eliminate misrepresentations of the effectiveness of a given investment project. This paper presents the material benefits and costs represented in the form of outcomes that can be verified on the basis of reliable sources assuming a study period of 4 years.

This paper presents a model that serves for categorisation and systematisation of economic-social-environmental outcomes which represents the starting point for further analytical work on a comprehensive assessment of road infrastructure projects. It also identifies and defines the direct outcomes, such as savings on travel time, savings on the operation of vehicles, a decrease in the number of road accidents, the assessment of which is not complex. It also

presents the indirect outcomes – the evaluation of which may take place a few years after the project, which undoubtedly represents a methodological challenge for valuation of such outcomes.

On the basis of the conducted studies it can be concluded that modernisation of the subject road infrastructure offers a number of outcomes in the form of benefits and costs, among which the benefits significantly dominate.

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