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A MODEL VALUATION OF ECONOMIC AND SOCIAL EFFECTS – A CASE STUDY OF THE OLSZTYN RING ROAD CONSTRUCTION

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Abstract. This article raises the question of transport infrastructure as a principal component of the social and economic system in any region of the world. Development of transport infrastructure leads to the so-called accumulation of effects obtained through various channels, e.g. upgraded communication and transportation technologies, shorter transit time, lower transport costs, improved safety and better long-term economic output in a given community. This paper presents a model valuation of economic and social effects of an investment made into road transport infrastructure based on a case study of the ring road designed to be constructed around Olsztyn. Analysis of the effects was based on the CBA (cost and benefit analysis) methodology, which is for example employed to evaluate the EU co-financed projects. The method presented herein will ensure more precise valuation of effects generated by planned investment projects and will be a tool supporting the decision-making process.

Key words: transport infrastructure, valuation model, dual prices

INTRODUCTION

Road infrastructure is a major element of the broadly understood technical infrastructure which, by being responsible for spatial transport of people and cargos, is "the blood circulatory system" in any economy. Development of road infrastructure accelerates cargo and passenger flows; it also helps to create new companies and develop the infrastructure in the public sector [Kamińska 1999]. Road transport is the most popular option for transporting people and goods. In Poland, there are 240,000 trucking companies, which make up 7% of all Polish enterprises. The contribution of road transport companies to Poland's GDP equals ca. 10% and their turnover was 64 billion PLN in 2013. In total, Polish road transport companies carried about 1.6 billion tons of goods in 2013. In Poland, like in

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other larger EU countries, nearly 90% of all road cargo transport falls on domestic freight transport. In order to take full advantage of the road transport potential, it is necessary to build new roads and modernize the existing ones. On a global scale, the road transport infrastructure covers 100 million ha, which corresponds to 2/3 of the global land development for transportation [Mazur 1992, Lesiak 2013]. National highways are the roads whose role in economy, defence and tourism encompasses a whole state. They also play a strategic role in the economic development of particular regions of a country by helping to maintain constant contact between capital cities and local economic centres [Wrona, Rek 2001]. An inadequate access to a national and international road network as well as the lack of good road connections with economic and political centres of the European Union are the principal reason why certain regions remain peripheral and experience more difficulties in their economic and social growth. For the authorities of the provinces located in Eastern Poland, development of road transportation is an obvious priority.

MATERIAL AND METHODS

Research methodology

The objective of this paper has been to demonstrate a model for valuation of economic and social effects of investments into road transportation. A ring road around the town of Olsztyn, currently at the stage of being defined and planned, served as the object of the study. Level of horizon of analysis of benefit has been defined Olsztyn for region.

The research methods consisted of:

- A project method – classification of effects generated by road infrastructure projects has been worked out for the purpose of this study. It process effects in foothold about directions of European funds for regional development EFRR and fund of cohesion. Directions (guidelines) are assigned for institution of manager, which (who) commission composition of analysis of cost and benefits, or they compose her (it) independently[1].
- The CBA method (cost and benefit analysis) – a method applied to evaluate economic and social effects which is for example applied to assess projects co-financed from EU funds. Purpose of analysis of cost and it is benefit advisable < indication > and conversion on all money value of possible areas so that determination of cost was possible and benefits of projects; gotten results will be summed benefits net, decision will be taken that on this base for it, if project is wanted and worth realization. Cost and benefits should be evaluated in foothold about principle of increase, through taking into consideration difference between option setting up (bet; found) realization project but without project alternative options [Mischan 1992].

[1] Directions concerning methodology translation analysis cost and benefits. Commission for Affairs Regional Policy. General Board of Management. UE, Brussels 2006.

CLASSIFICATION OF THE EFFECTS OF CONSTRUCTING A ROAD INFRASTRUCTURE COMPONENT

Each investment into the road transportation infrastructure generates direct and indirect effects. Direct effects are connected with the road's immediate surroundings and occur in relatively short time [Domańska 2006]. Indirect effects appear in further surroundings and in a longer time perspective. The valuation model presented in this paper involves assessment of economic, social and environmental effects. The further in time or space such effects of road network investment projects occur, the more difficult is their quantification or valuation. However, an effort should be taken to achieve possibly the most complete valuation of all direct and indirect effects so as to perform a reliable and truthful analysis of costs and benefits, whose results will prove whether a given investment project is a rational one to implement. Economic effects are closely connected with the achievement of measurable benefits like improved profitability, value, productivity or efficiency demonstrated by users of analyzed infrastructure facilities, resulting from improved accessibility of transport infrastructure.

The basic effects generated by a road investment project are: time savings, lower transit costs, lower costs incurred by traffic accidents, higher prices of real estate etc. (Fig. 1).

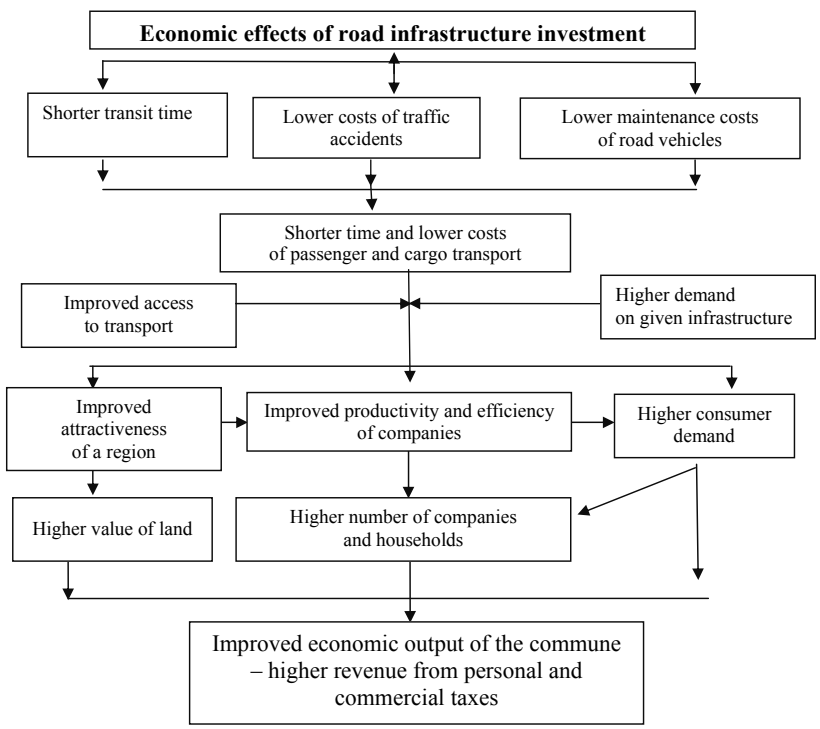

Fig. 1. Economic effects of road transport investment

Source: Own elaboration.

Economic effects generated by road infrastructure investment can be divided into direct and indirect ones.

Direct effects include: lower maintenance costs of road vehicles – lower fuel consumption; shorter transit time (value time transport saving index – VTTS); lower costs of road accidents.

Direct effects induce indirect effects, which appear around modernized infrastructure, with some delay, mainly due to certain administrative procedures and market conditions. Evaluation of indirect effects is certainly a big challenge for researchers. Among major indirect effects (delayed in time) are [Kozłowski 2012]: higher investments on land around the upgraded road infrastructure; higher real estate prices; and higher revenue of communes from fees; personal and commercial taxes in years to come.

Social effects pertain to broadly understood improvement of the quality of life and social welfare. The basic effects created by road infrastructure investments are: increased number of employment opportunities, both in companies involved in the road construction and in new companies which open along a new road; improved road safety, owing to fewer road accidents; and higher mobility of local communities owing to better access to roads and lower costs of transport (Fig. 2).

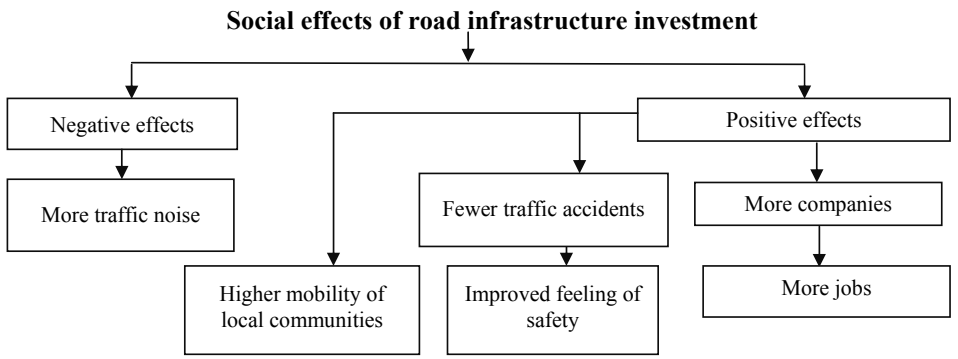

Fig. 2. Social effects of road infrastructure investment

Source: Own elaboration.

Among the negative effects caused by road transport investments is increased noise caused by traffic, which today can be eliminated by raising acoustic barriers [Łaguna 2010].

Valuation of effects of investment into road transport infrastructure

A substantial methodological challenge encountered in both practical and theoretical considerations is the valuation of the economic and social effects in monetary units. Such calculations, however, enable more precise determination of the economic profitability of a given project, thus facilitating right decisions and more effective strategic planning with respect to the distribution of transport corridors. A tool which enables

one to evaluate particular economic, social and environmental effects is the well-known method of analyzing costs and benefits – the CBA [Ray 1990]. It is particularly useful for major public projects because it includes evaluation of non-financial aspects, such as quality of life of residents, new jobs, higher consumer demand, improved safety, superior health care etc. With this method, it is possible to compare financial costs and benefits of completing an investment project with the costs and benefits which are not often expressed in monetary units but whose value is an essential component for analysis of the profitability of a whole project.

The importance of social and economic costs and benefits is appreciated by the EU institutions engaged in financing investment projects, whose application procedures specify such an analysis as one of the prerequisites.

The objective of the cost and benefit analysis is to demonstrate whether a given project will lead to an increase in the welfare of the community occupying the area covered by the analyzed infrastructure investment. The key assumptions are that there are alternative costs, derived from the variable marginal costs curve, and that the variable marginal costs curve assumes an incremental character beyond its climax, which corresponds to the supply curve. The basic measure for valuation of economic and social costs and benefits generated by infrastructural investment projects is the dual prices, understood as an indicator of costs and benefits of a project in terms of the whole national economy [Prud'homme 2005].

The methodology associated with appreciation of dual prices for a given country, region or commune is a rather complex process as it requires accumulation and processing an extremely large amount of data concerning the analyzed phenomenon and the need to express them numerically.

CASE STUDY – CONSTRUCTION OF A RING ROAD AROUND OLSZTYN

Description of the construction project

Olsztyn is the capital city of the Province of Warmia and Mazury. Its area is 88 km^2. The city is cut through by an international road connecting Warsaw and Kaliningrad in Russia. Olsztyn has numerous landscape and environmental assets, for example 11 lakes lying within the urban administrative borders, which altogether make up 9.9% of the town's area. There are also forests which cover 1,200 ha, i.e. 21.2% of the municipality, of which 1,050 ha are used for recreational and relaxation functions. Unfortunately, the street network in the town of Olsztyn is far from being satisfactory, mainly because the existing solutions respond inadequately to today's needs, the technical condition of streets and street engineering facilities is poor and connections with European transport corridors is weak. All major corridors and motorways circumvent Olsztyn and the whole province, except for the Riga – Kaliningrad – Gdańsk route, which runs very close to the province. At present, however, roads which belong to this corridor pass through the town of Olsztyn, including its centre and densely built housing estates. As Olsztyn lacks a ring road, all transit traffic flows through the town's streets, unsuitable for such heavy traffic either in terms of their geometrical characteristics (streets, junctions and crossroads) or with respect to the road surface. This transit traffic raises maintenance costs (road repairs) and causes nuisances exceeding any acceptable norms.

Along numerous sections, the streets of Olsztyn must carry excessive traffic compared to their width, geometry of junctions and throughput of vehicles at traffic lights. The highest flows of vehicles are generated by the southern suburbs of the town, from which about 6,000 cars per hour travel to the centre and to the industrial area. This has stimulated a project of constructing a ring road that would run through several communes around Olsztyn: Gietrzwałd, Stawiguda, Purda, Barczewo and Dywity. The planned length of the ring road is 39 km and its main functions will be:

- to intercept the transit traffic (national and international), which currently runs through the town;
- to improve the access to transport routes from these areas of the town of Olsztyn, which have been zoned for commercial development;
- to make it easier to commute from the suburban residential areas of the town and neighbouring villages to the town's centre.

The ring road of Olsztyn is planned to consist of two sections. The southern section measuring 27 km in length will involve the construction of a new alignment road section from Kudypy (west of Olsztyn) to Wójtowo (east of Olsztyn). The construction project also includes construction or reconstruction of local roads leading to the ring road, which will have in total 95 km in length, and construction of 7 road junctions. The northern part of the ring road will consist of 13 km of a dual carriageway, construction or reconstruction of access roads of the total length of 45 km and construction of 6 junctions. The basic parameters of the ring road construction design are presented in Table 1.

Table 1. Basic investment parameters

Variable	Southern section	Northern section
Length of the section (km)	27	13
Investment outlays (million PLN)	900	250
Duration of the construction	2012–2015	2012–2015
FNPV (million PLN)	–1 280.74	
Number of vehicles daily (pcs)	30 000	25 000

Source: Feasibility study of the Olsztyn Ring Road project. GDDKiA 2009.

The financial analysis shows that the investment project is unprofitable because the expected FNPV value is 1,280.74 million PLN at a discount rate of $k = 5\%$ and operating costs of 7 million PLN annually.

Valuation of the economic and social effects of the project

Evaluation of particular types of effects has been performed according to the dual prices based on available information and analyses of the Olsztyn Ring Road project[2].

[2] Main sources of data for valuation of the effects were the following documents: Feasibility study for the Olsztyn Ring Road project, data provided by GDDKiA in Olsztyn for 2008–2011, local and regional statistics, Strategy for the development of Olsztyn in 2007–2013, Strategy for the development of the Province of Warmia and Mazury in 2010–2020.

Below (Table 2) the valuation of the defined effects of constructing a ring road around Olsztyn is presented in the context of one year, assuming that $n = 30$ years.

Table 2. Forecasted economic effects of the Olsztyn Ring Road

Effect	Description	Evaluation of effects annually
	Direct effects	
Shorter transit time [Spiekermann, Neubauer 2002]	– car velocity raised from 15 to 90 km per hour – valuation formula: number of vehicles × time saving × × hourly rate x number of days a year	↓ 59% = 74 million PLN
Lower maintenance costs	– car velocity raised from 15 to 90 km per hour – valuation formula: number of vehicles × transit time × × average fuel consumption × fuel price	↓ 22% = 45 million PLN
Lower costs of traffic accidents	– levelling cost of treatment of accident casualties – valuation formula: 0.14 PLN[a] per person per km × × number of passengers × distance in km × 0.30% (decrease in number of accidents)	↓ 30% = 8 million PLN
Lower road repair costs	– reduced costs due to road repairs in town – valuation formula: costs by the Municipal Road Maintenance Management on road repairs due to transit of heavy truck and trailers	↓ 28% = 15 million PLN
Total		142 million
	Indirect effects	
Higher revenue of the commune	– higher revenue from personal and commercial taxation – higher revenue from real estate taxation 5 years after the investment project – valuation formula: increased revenue of the commune from personal (39.34%) and commercial taxes (6.71%) with respect to higher employment and higher GDP in the area	↑ 5% = 12 million PLN
Higher real estate prices	– benefits from higher prices of commercial real estates on land adjacent to the ring road – valuation formula: data from the Olsztyn District Office on commercial real estate prices	↑ 50% – price per 1 ha

[a] Rate 0.14 PLN per person per km was established by the Minister for the Infrastructure to valuate costs of road accidents per 1 km of national roads.

Source: Own elaboration.

The biggest advantage gained from constructing the planned ring road is the time saving, as the transit time will be 59% shorter, which means that 74 million PLN Can be Saved annually at the assumed traffic flow of 30,000 vehicles daily [Generalny pomiar ruchu 2010]. The second most important economic benefit is a 30% decrease in the costs of traffic accidents, which generates 8 million PLN savings a year. The cost of maintaining vehicles will be reduced by 22% owing to a shorter transit time, which will correspond to 45 million PLN saved each year assuming that the traffic flow will equal 30,000 cars a day.

Table 3. Forecasted social effects of constructing a ring road around Olsztyn

Effect	Description	Valuation of effects annually
Higher employment/ /lower unemployment	employment for construction works – 350 jobs, and jobs in companies locating their new premises near the ring road – about 850 jobs (IKEA, DomPlast, PKN Orlen, Lotos)	↓ decreased social aid costs by 8 million PLN valuation formula: number of jobs × cost of maintaining an unemployed person ↑ increased consumer demand by 34 million PLN valuation formula: average pay × number of employees × 12 months
Transfer of companies closer to the ring road	– service companies, e.g. petrol stations, restaurants, hotels – 5 businesses – a hypermarket – 1 – production companies – 3 – other companies – 15	↑ in total – 24 enterprises ↑ estimate formula: the feasibility study for the project, data from the Olsztyn Town Hall
Benefit of increase in population	– areas near the ring road will be more attractive places to settle down	2% of the population estimate formula: average number of residents of Olsztyn per 1 ha
Improved safety	– fewer road accidents – reconstruction and construction of safe crossings for local residents	↓ 80% of the road accidents estimate formula: based on police statistics from comparable ring roads
Improved access to transport	– lower costs of commuting to work or school – higher mobility of local communities – less traffic pressure on the town centre	↓ 15% of commuting costs valuation formula: analysis of costs of commuting from neighbouring communes
Decreased amounts of exhaust fume gases: CO_2, SO_2	– decreased amounts of GHG in the town	↓ 30% = 24 million PLN source of data: data from Sanitary Inspection on costs due to emission of CO_2 and SO_2
Less noise	– less noise in the town – construction of noise barriers along the ring road	↓ down to below 50 LA_{eq} source of data: the feasibility study for the project
Fewer accidents with wild animals involved	– construction of passages for wild animals	↓ 70% = 87 of animals annually source of data; police statistics
Better landscape management – undeveloped areas	– use of undeveloped areas by agriculture and forestry – development of some land under commercial facilities	↓ 30% = 8 million PLN data forecasting: higher prices of unused land, farmland and land for development

Source: Own elaboration.

The major indirect effects include 5% higher revenues for the commune for local taxes and fees, higher prices of industrial real estates located near the planned ring road and an increased number of companies, which will mean higher employment and consumer demand.

The principal social effects gained from building a ring road around Olsztyn are: higher employment generated by construction works on the ring road (350 persons) and

also in companies that will open afterwards (850 persons), which in turn will lead to the commune expenditure on social aid decreasing by 8 million PLN. More money on the market will stimulate the consumer demand. It is also forecasted that new companies will open along the ring road (24 companies in five years after completing the construction project). Other direct effects include expansion of housing estates, better chances of finding work and starting a family. Improved access to transport routes will decrease costs of commuting to school or work, which will have a positive influence on the mobility of local populations either to gain better qualifications or to search for work (Table 3).

The construction of the planned road infrastructure will cause many indirect, i.e. time--delayed social effects, which generate benefits totalling to 201 million PLN a year, without the economic and social valuation of benefits in dual prices. The final assessment of the profitability of the project can be found in Table 4.

Table 4. Valuation of the profitability of the Olsztyn Ring Road project

Parameter (PLN)	Annually	For the whole period, $n = 30$
Outlays		1.15 billion
CF (cash flow) economic, social and environmental benefits	201 million	3.65 billion
FNPV (financial net present value)		– 1.3 billion
ENPV (economic net present value)		2.5 billion

Source: Own elaboration.

Financial current net value (FNPV = –1.3 billion). Indicator is negative value for researched project FNPV, that enables forestalling about union means. Economic current value defines all benefits from project net (ENPV = 2.5 billion) and it is greater than zero shows that propriety of investment. Based on the performed analyses, it can be concluded that the construction of the Olsztyn ring road is profitable.

CONCLUSIONS

The question raised in this article belongs to a research area which is included in the broadly viewed strategy of road transport development. This article – is a introductory contribution towards improving the methodology applied to investigations on valuation of effects of construction or reconstruction of road transportation corridors, which includes sustainable development, in which social and environmental issues are considered next to economic aspects. The model presented in this article helps to categorize and classify economic and social effects, which is a good starting point for any further analytical work on complex assessment and planning of road transport infrastructure.

Due to the complex character of investments into road transport, each project should be approached individually by defining specific effects, quantifiable in monetary units, which subsequently can be incorporated into a complex profitability study. Valuation of the effects at the stage of planning and designing a project will improve the decision-taking process and rule out any misunderstandings regarding the assessment of the effectiveness of a given project. With the project of building a ring road around Olsztyn

taken as a case study, the author has presented some practical aspects of the valuation of particular types of effects. The financial analysis showed that the expected value was FNPV = –1281 million PLN, but when benefits gained form other effects were taken into consideration the expected economic value ENVP was 2.5 billion PLN.

Based on the performed analyses, it can be concluded that the construction of the Olsztyn ring road is profitable and will generate a series of indirect effects, among which economic benefits are evidently dominant.

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MODEL WYCENY EFEKTÓW EKONOMICZNO-SPOŁECZNYCH NA PRZYKŁADZIE PROJEKTU BUDOWY OBWODNICY OLSZTYNA

Streszczenie. W opracowaniu poruszono tematykę związaną z infrastrukturą transportową będącą jednym z podstawowych elementów układu społeczno-gospodarczo każdego regionu. Rozwój infrastruktury transportowej wywołuje tzw. akumulację efektów uzyskanych

za pośrednictwem różnych kanałów, takich jak: poprawa technologii komunikacyjnych, zmniejszenie czasu i kosztów przejazdu, poprawa bezpieczeństwa, a w długim okresie poprawę wyników ekonomicznych. W artykule przedstawiono model wyceny efektów ekonomiczno-społecznych inwestycji w infrastrukturę transportu drogowego na przykładzie projektu budowy obwodnicy Olsztyna. Analizę efektów oparto na założeniach metodyki CBA (cost and benefit analysis) wykorzystywanej do ewaluacji projektów współfinansowanych z funduszy unijnych. Opracowana metodyka umożliwia bardziej dokładną wycenę uzyskanych efektów z planowanych inwestycji a jednocześnie stanowić może narzędzie usprawniające proces decyzyjny.

Słowa kluczowe: infrastruktura transportowa, model wyceny, ceny dualne

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