SUBSTANTIATION OF TRANSPORT INFRASTRUCTURE INVESTMENTS

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All governmental institutions wish to obtain value for money from investment expenditure into transport infrastructure and need a robust technique to make comparisons between alternative schemes. This enables the technique to be used in the preparation of scheme priority lists. In the preparation of the infrastructure capital expenditure section of the Transport Strategic Development Programme, the limit on expenditure prevents all schemes from starting together; consequently those with the best value for money are given greater priority. The Lithuania Ministry of Transport also uses this priority listing.
Cost/benefit analysis (CBA) compares the costs of road schemes with the benefits derived by infrastructure users and expresses those benefits in monetary terms. The use of CBA involves the same process as financial appraisal, whose main benefit is that it uses behavioural evaluation (i.e. it represents the real choice of consumers). The limitation of financial appraisal is that it does not cover all the costs and benefits of a scheme but is restricted to those financial effects on the producer. The major criticism of CBA is that it is not comprehensive – yet financial appraisal is, if anything, even less so CBA itself is only a partial technique; the type used in Lithuania is restricted to measuring value for money over a limited range of road user benefits and excludes non-user or environmental benefits such as noise, pollution, vibration or community severance.

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1. ECONOMIC EVALUATION OF TRANSPORT INFRASTRUCTURE PROJECTS

Cost/benefit analysis is used to find the best way of investing resources, particularly if those resources are less than the total required. In this way the right projects are selected, but the list of projects must be comprehensive. Some projects may not be included in the list, on the basis that the resources are not available to analyse every scheme. A balance has to be struck between using the resources for project analysis and ensuring that all the available resources are used in the best way.

The cost/benefit analysis (in whatever form) will have applications throughout the scheme preparation process, but it should assist with the following decisions:

(a) the assessment of the need for a particular road or corridor improvement scheme before it is considered for evaluation;
(b) placing each scheme in a priority list based on the evaluation of economic returns and costs, and compared with other schemes in the county, region or country;
(c) the timescale for the scheme and its place in the current or planned construction programme;
(d) the identification of a 'top ten' list of schemes for consideration a public inquiries, by councillors or by ministers;
(e) the detailed design and engineering standards to be used.

2. COSTS AND BENEFITS FORECASTING

Investment requires a consideration of the future, because the expenditure on resources is either current or in the near future (up to three years), while the benefits or returns are spread over a longer term (25 years). A major problem in investment appraisal is to estimate the size of future benefits and to compare a ‘do-nothing’ (or ‘do-minimum’) position with a ‘do-something’ position. Demand estimates for transport facilities are made on the basis of the particular mode used, the particular route and the time of day/week/year in which the journeys are made. In considering the benefits of the IXB transport corridor extension (Southern Vilnius bypass), for example, a general forecast of vehicles per day is inadequate between, say, road Minsk – Vilnius and Vilnius – Kaunas. There is a need to know:

(a) the traffic split in Vilnius streets and roads network;
(b) the modal split of cars, light goods vehicles, heavy goods vehicles, buses, and coaches;
(c) the peak demand periods, how long they last and the sections of the streets network that are involved.

The forecasts then have to take into account:

(a) the types of journey made (work, education, leisure) and the number of trips made under each type;
(b) the modal split of passenger and freight journeys, e.g. passenger journey forecasts by car, bus, etc;
(c) the trips expected to be made along each link of street or corridor;
(d) each part of corridor then has to be linked to form the street network which the Southern Vilnius bypass is expected to affect;
(e) trips currently on the existing streets network reassigned on to the new network (including the Southern Vilnius bypass);
(f) generated traffic (not included in the CBA evaluation).

The data are collected from a range of surveys and computer modelling is used to represent the network and distribute the trips by route and mode.

This last element comprises the trips that were not made at all before the expenditure but which anticipate making as a result of it. Prediction of this traffic is necessary in order to estimate the effects on users, but techniques of prediction are not well advanced. For this reason, the Vilnius Municipality enterprise "Vilniaus Planas" is somewhat reluctant to include the benefits to generated traffic in an evaluation. A procedure could be used, in the absence of reliable predictions, where traffic generation of 10 percent and 25 percent above existing levels is assumed, and the effects of this incorporated into the evaluation to test sensitivity of results. This also demonstrates the need for careful monitoring of different types of project in order to obtain an insight into actual generation rates.

In several recent studies of new streets and road schemes, the existence of generated traffic has been shown subsequently. There is some traffic generation derived from the improved quality of the journey where the route is now easy and journey times reduced.

Because of transport's essentially derived nature, forecasts of traffic flow also have to consider forecasts of economic growth, household incomes, consumer expenditure, output in manufacturing and commercial activities (and their relative weighting in respect of a particular scheme), changes in land use and the location of activities (e.g. the shift of leisure activities from the central business district to out-of-town shopping and entertainment centres), trends in local population activity and changes in the level of unemployment. These are determined outside the transport industry but have a significant effect on road traffic volume. The forecasting of transport demands and costs and a realistic appraisal of transport projects therefore requires a wide understanding of trends and developments in the whole economy.

The forecasts of growth in vehicle ownership indicate an increase in the extent and severity of environmental impacts associated with roads and traffic in the years to come. While there is certainly scope for reducing these impacts by various policy measures – for example, by transferring some types of traffic to other modes and/or by the introduction of new low pollution vehicles – these measures seem more likely to check the rate of growth of the problem than to reverse the long-term trend.

In more recent years large investment in motorways (***Via Baltica, Vilnius – Klaipeda***), major urban road improvements (***Southern and Western Vilnius bypasses***), and inter-urban motorways, has generated considerable debate on the assessment of benefits derived by the users of the network in relation to the capital expenditure and maintenance costs of the scheme.

3. SOUTHERN VILNIUS BYPASS CBA CASE

The traffic volume forecasts at the Southwestern part of the Vilnius were carried out for the 'with' and 'without' project scenarios using the ***computer model EMME/2***. It is difficult to make long-term forecasts of road accident rates, since these depend not only upon the transport infrastructure but also on other factors such as the culture of road users, the traffic control system, speed limits etc.

The following assumptions were made for making the forecast of road accident rates:

- the ratio of accidents involving personal injury will remain the same;
- if the project is not implemented, i.e. if the Southern and Western bypasses are not constructed, the accident rates in the analysed street network would increase in proportion to the growth of the kilometres travelled;
- if the Southern Bypass is constructed, the accident rate in the existing street network would reduce due to the one-level intersections;
- the traffic in the existing street network will decrease, new traffic safety measures will be introduced, therefore the road accident rates should decrease;

Time savings while taking a shorter route or with higher speed of traffic flows is an important factor for assessing road or street investment projects. The travelling time is treated as a cost since travelling is an indirect expression of demand. The travelling price is expressed in summarised costs that include the travelling time and monetary expenses. The travelling time also represents the cost for the individual since no other activities can be performed during this time.

In order to determine the value of time, the office and out-of-office hours are taken into account as given in ***'Guide to Cost-Benefit Analysis of Investment Projects. EC Edition, 2002'***. The travelling time is estimated in LTL/h/vehicle and the value of the office time amounts to 75 % with out-of-office time accounting for 25 %.

The value of one hour per vehicle is estimated using 1st January 2003 prices in accordance with the value of time computed in the ***Lithuanian Road Investment Guidelines 'Road Investment Manual' Lithuanian Road Administration, Vilnius, 2002'***.

To calculate the annual travelling time it was taken that the traffic volumes at weekends are lower. Using the computer model EMME/2 made the forecast for travelling speeds. The main criterion for the calculation of the vehicle operating costs is the street surface evenness. The road vehicle operating costs are calculated for each traffic flow group and they depend upon the traffic volumes at a specific section of a road or street.

These costs have been calculated by using the ***World Bank HDM–IV computer model (Highway Development Management software)*** for the assessment of investments in the road sector, which is adapted for Lithuanian conditions. This software evaluates the costs of vehicles, fuel, oils, tyres, and other costs related to operating vehicles. These costs are updated in view of all the factors affecting the operating costs. In this economic evaluation, the results obtained by HDM–IV are calculated on the basis of prices at the beginning of 2003.

The road surface evenness in the existing street network has not been measured; therefore the calculations are for average road roughness on the analysed street sections that is 3 m/km and according to the international IRI standard.

The total vehicle operating costs on City streets was based on the fuel consumption increasing by 10 %.

In view of the forecasts for road traffic, the total vehicle operating costs were calculated with vehicles using only the existing streets. The calculations took into account also those vehicles that are going to use the new Southern Bypass. They did not include vehicles that would only use the existing street network whether the bypass is built or not. If the traffic flows were also taken into account, the benefits of constructing of the bypass would be even larger since the vehicle operating costs would certainly increase if it were not.

In the analysis, the road accident, travelling time, and vehicle operating cost savings were taken into consideration. However, the operating costs were the same since both the distance and the route are the same. The IRR, NPV, cost and benefit ratio and the payback period of the project were calculated.

For the purpose of economic evaluation, all the costs and benefits were expressed at actual prices, i.e. the present or future value of time.

Project benefits include:

- savings in vehicle operating costs;
- savings of travelling time;
- savings in accident losses.

Project costs include:

- the costs of constructing;
- the maintenance costs.

The project benefits are long term. The project is considered acceptable if the IRR is more than 5 % and as given in the '***Road Investment Manual. Lithuanian Road Administration, Vilnius***, 2002'.

The savings (project benefits) are expressed as the difference between the costs in the 'without' and 'with' project scenario and as also required in the Road Investment Manual.

The key project evaluation indices in the economic analysis include:

- IRR, the discount rate at which the NPV of the project cash flow is zero;
- NPV – the total amount of all discounted project cash flows that represent the effect of the rehabilitation of the Southern Bypass with respect to the time factor (within the project life). Where the NPV>0, the project is viable;
- cost-benefit ratio C/B. Where C/B>1, the project is viable, and it can be implemented.

Economic evaluation of the average scenario

The following key parameters were chosen for the economic evaluation of the Southern Bypass:

- nominal (average) costs of the construction for both alternatives;
- 5 % discount rate;
- nominal (average) traffic volume increase scenario;
- nominal (average) costs of bypass maintenance.

The savings in vehicle operating costs and travelling time are the difference between the costs incurred when the vehicles take the existing streets and the costs when they use the bypass.

The savings of the travelling time per year equal the saved time (hours) per day multiplied by the value of one hour of the vehicle and the number of days per year. The cost-benefit analysis is calculated in accordance with the forecasts of the traffic volume increases.

Savings related to the reduction of the accident rate losses equal the difference between the accident costs in the 'without' and 'with' project scenarios. The forecasted accident costs after the bypass is built are subtracted from the total accident costs incurred per year on the analysed section.

Table 1. Main benefits identified in the CBA

Project number	Benefit 1: VOT savings		Benefit 2: Accident savings		Benefit 3: VOC savings		TOTAL	
	Present Value (thousand Euro)	%	Present Value (thousand Euro)	%	Present Value (thousand Euro)	%	Present value (thousand Euro)	%
1	97 995	62	9 984	6	49 608	32	157 587	100

Table 2. Main results of the CBA in thousand Euros

Project number	Economic Life	Net Present Value of Costs	Net Present Value of Benefits	Net Present Value	Internal Rate of Return	Benefit/Cost Ratio
1	25	34 937	157 587	122 650	22.7 %	4.5

The above results of the CBA are obtained due to the following reasons:

- existing traffic goes through the congested street network which are unable to cope with high traffic volumes;
- the new bypass will be shorter than the present routes and will allow higher speeds and increased traffic volumes.

The largest project benefits are generated by the savings of time. Given nominal traffic volumes, realistic/average scenario, and 5 % discount rate, the time savings account for approximately 62 % of the relative benefits.

Given nominal traffic volumes, a realistic/average scenario, and 5 % discount rate, the VOC savings account for approximately 31 % of benefits. The equivalent savings with road accident savings for this scenario are 6 % of the benefits.

In order to perform the economic evaluation it was necessary to investigate the impact made on the project with different parameters (e.g. an increase or decrease in road traffic, construction costs and changes in accident rates, etc.).

Three scenarios were used for carrying out the sensitivity analysis namely average/realistic, pessimistic and optimistic. Changing of the values of specific variables and assessing the time factors of the project as a well as using different cost-benefit analyses determined the analysis.

4. CONCLUSION

Monetary evaluation techniques for user elements (such as travel time costs, vehicle operating costs, and accident costs) have been developed. In parallel during the last decade, attention has been increasingly focused on the problems of measuring the environmental consequences of alternative schemes. This is because decision makers have required an improved judgment of the value of amenity to assist them in deciding on the need for a road and also its particular line. If environmental consequences could be quantified and incorporated into evaluation, then the elements of cost/benefit analysis using monetary values would become more comprehensive. It is important that a form of measurement is established which is not only valid, but is consistent with the user elements of cost/benefit analysis and is seen to be realistic.

References

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