Infrastructure Project[1]

"Infrastructure Economics and Feasibility Study"

Prof. Dr.-Ing., Dipl.-Wirtsch.-Ing. H.W. Alfen

Dr.-Ing., Dr. (AM) N. Badasyan

Marienstraße 7a, 99423, Weimar

Contact Details:

Tel: +49 (0) 3643- 58 45 49

Email: norayrbadasyan@uni-weimar.de

[1] The data for the project and descriptions are derived from European Commission (2014), "Guide of Cost Benefit Analyses of Investment Projects: Economic Appraisal Tool for Cohesion Policy 2014-2020".

Contents

Project Description

The project consists of the construction of a new 16.4 km of tolled motorway, which constitutes a missing section on a TEN-T Corridor. The new motorway will reduce traffic on an existing road which carries annual daily traffic of more than 18,000 vehicles, most of which is transit traffic, and has reached its capacity limit. The current road leads traffic through several smaller settlements and one middle-sized town located in a valley, causing nuisance to residents through high levels of pollution in the form of noise and exhaust gases, and intersects with a number of lower category roads which adds to congestion, separation effect, and poor traffic safety. It is further characterized by a huge increase of traffic over the last 10 years (annual growth rate was 4.5 %) and a high share of freight vehicles (current share of goods vehicles is around 35 %).

Given the difficult characteristics of the terrain, the new motorway will need to include several bridges and overpasses as well as one tunnel. The technical description of the project and its components is as follows:

Component	Description
Motorway:	2x2 lanes (plus emergency lanes), width 27.5 m, length 16.4 km
Feeder road:	2x1 lane, width 11 m
Junctions:	3
Structures:	3 motorway bridges, total length 2,200 m 4 overpasses, total length 800 m, average width 8 m 1 tunnel, two tubes, length 2,200 m

Government (Team 1) plans to transfer the design, build, operation, maintenance and finance responsibilities to a private National Motorways Company Ltd (Team 2) for 30 years.

Project Objectives

The objectives of the project are to:

- provide fast and reliable travel for the long distance and transiting traffic;
- improve traffic safety;
- reduce impact of traffic on settlements.

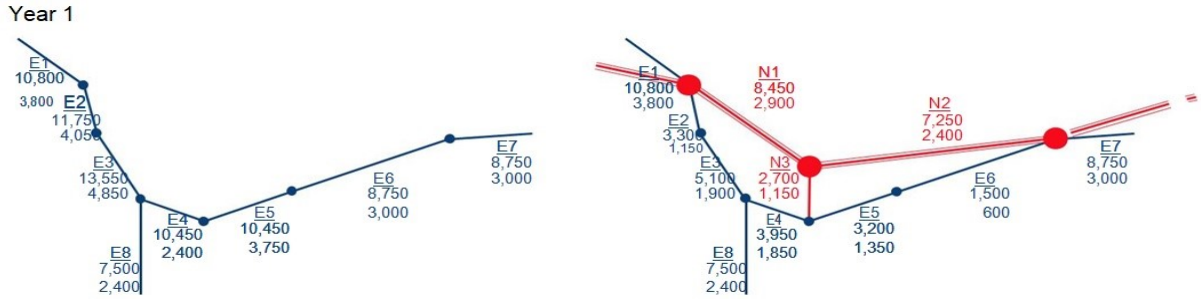
Demand and Option Analyses

A detailed demand analysis was used as a basis for the selection and final design of the preferred option. An options analysis also contained in this study compared two modified versions of a basic project solution that had emerged from a previously conducted pre-feasibility study. The pre-feasibility study had analyzed a range of options regarding:

- alignment;
- technical solutions and design parameters (bypass road, new 2 lane road, 4 lane express road or motorway);
- number, location and type of junctions;
- phased implementation (including construction of half profile express road).

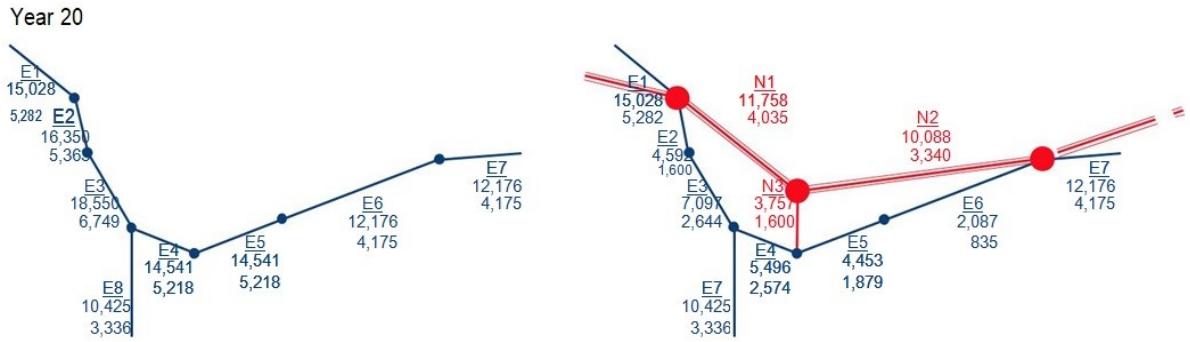
While the pre-feasibility study appraised more general project solutions based on multiple criteria taking into consideration the economic, engineering, traffic, environmental and social perspectives, the feasibility analysis compared only two remaining modified options based on cost-benefit analysis, where the highest ENPV dictated the preferred option.

The figures below depict the traffic forecast in the 'with the project' scenario (figures on the right) and the counterfactual 'without the project' scenario (figures on the left) for years 1 and 20 of the operational stage of the project. A single mode traffic model was used, covering only road traffic. It covers the impact area of the project, with a sufficiently disaggregated zoning system. It includes the national road network and most of the relevant lower category roads. Future improvements of the network (most importantly, the construction of the motorway which includes this project) are also included in the network model. Origin destination matrices are based on an origin destination survey from 2007. The assignment is based on minimizing the cost of travel (including time, distance and toll cost).



The traffic model was calibrated with traffic count data from 2012, and validity tests show that the model is sufficiently good in replicating the actual travel patterns. Future state matrices were multiplied by growth rates, which are based on assumed changes in population, economic activity, car ownership and transport cost. It was assumed that the traffic growth rate between 2017 and 2027 will be around 2 % per year, and around 1 %

after year 2027. It should be noted that no generated/induced traffic or switch from other modes is expected, since the project is not located in a major urban area and no specific changes in population, employment and land use pattern are expected. In the opening year of the project, it is forecasted that 11,350 vehicles per day will shift from the existing road to section N1 of the new road (9,650 vehicles per day on section N2). As a consequence, the traffic load on the different sections of the existing road will be notably reduced (7,000 vehicles per day in section E3 compared to 18,400 in the without project scenario).



Legend: Blue-existing road, red-new section

Investment Costs

The cost estimate for works and supervision of the selected option is based on detailed design, as the works have not been tendered yet. Land purchase is partially completed. The cost estimate is based on constant prices of 2015.

Investment cost component	Total cost
Planning/design fees, technical assistance	3,000,000
Land purchase	12,000,000
Building and construction, of which:	248,350,000
Earthworks	12,500,000
Vegetation	800,000
Road	48,000,000
Bridges	77,000,000
Tunnel	80,000,000
retaining walls	5,800,000
noise and safety barriers	7,500,000
public utilities	8,500,000
motorway information system	1,250,000
Buildings	1,000,000
other	5,940,000

Plant and machinery	0
Publicity	60,000
Supervision	5,000,000
Total Investment cost excl. contingencies	268,350,000
Contingencies (10% of construction cost)[111]	24,835,000
Total Investment cost incl. contingencies	293,185,000
VAT (recoverable)	56,630,055
Total Investment cost including VAT	349,815,055

The total project investment cost shown in the table above is considered eligible except the VAT, which is recoverable.

Estimates include all costs incurred for planning at feasibility stage and during the implementation period of the project, while the cost of all preliminary activities (pre-feasibility studies, surveys carried out before the feasibility study) are treated as a sunk cost and are thus not included.

Toll from freight vehicles is collected on behalf of the National Motorway Company by a toll collection company, through the pre-existing electronic toll collection system based on a combination of GPS and GSM technology. There is no physical investment necessary to extend the tolling on new sections, the motorway operator pays a fee for each toll transaction made on his road and receives the collected toll.

The following average unit costs were calculated to appraise the cost estimates of the most significant investment components, which were found to be well within the cost range of other comparable projects:

Investment component	Unit cost
Motorway, total	EUR 16.3 million/km
Motorway, excluding bridges and tunnels	EUR 6.8 million/km
Bridges	EUR 1,151/m^2
Tunnel	EUR 18.2 million/km

Operation and Maintenance Costs

Routine maintenance cost for the new road is estimated on the basis of average maintenance requirements on the existing motorway network in the country and current

maintenance practice of the motorway operator. Average routine maintenance cost is thus assumed to be EUR 34,000 per km of motorway.

Routine maintenance cost for the existing road is assumed to be the same in the with and without project scenarios and is thus excluded from the assessment.

Periodic maintenance of the new road is estimated on the basis of the expected schedule of periodic maintenance works. The timing of the works was determined on the basis of the observed maintenance cycle in the network of existing motorways in the country (e.g. re-pavement after 10 years, bridge repair after 15 years, retaining walls repair after 20 years, etc.); average cost of these works is also based on cost observed in the past.

Periodic maintenance of the existing road is excluded from the analysis. The decrease of traffic will extend the life of the infrastructure elements by a few years and consequently the maintenance cycle will be longer, however, it is assumed that maintenance measures will remain the same.

Operating cost of road includes toll collection cost; traffic management of the new section will be done from the existing traffic control center without any additional cost and is thus excluded from the assessment. It is assumed that toll collection cost is EUR 0.12 per transaction (i.e. passage of a motorway section between the two junctions).

Revenue

The private company (Team 2) collects the tolls only from goods vehicles: for light goods vehicles (including buses) EUR 0.10 /km; for heavy goods vehicles EUR 0.20 /km. The assumed share of light goods vehicles (including buses) is 55 %, for heavy goods vehicles it is 45 %.

Financial and Economic Analyses

The analysis is performed using a 30-year reference period which is common for road projects. A residual value of the investment is considered at the end of the reference period; the residual value is EUR 13 million in the financial analysis which is calculated on the basis of the net present value of cash flows generated after the reference period (based on the perpetuity formula) and EUR 150 million in the economic analysis (based on the depreciation formula and corrected by the conversion factor). The financial and economic analyses use constant prices. A real discount rate of 4 % is used in the financial calculations, while a 5.0 % social discount rate is used in the economic analysis. VAT is reimbursable and thus excluded from the analysis.

Financial Analyses

Please, check the Excel File “Financial CF” for the analyses. The initial Cash Flow is organized mainly based on equity finance.

Economic Analyses

For the purpose of socio-economic assessment, the investment cost estimate was corrected for fiscal effects by factor 0.91 (excl. cost of land which was not subject to fiscal correction). The routine maintenance cost was corrected by factor 0.88. Fiscal correction factors are based on share of transfer payments in labor and energy cost and their respective share in overall cost.

The socio-economic analysis includes following monetized benefits, which are consistent with the project objectives, i.e. faster travel on a safer road with separated carriageways, travel time savings, vehicle operating cost savings, accident cost savings.

Project benefits, related to the reduction of negative impacts (pollution and noise) within settlements were not quantified, given that these were not considered to be of importance in monetary terms, but the socio-economic analysis does include project impact on the emission of CO2 as the main global environmental impact of transport.

Travel time savings (in minutes saved per person) are quantified with the help of the traffic model on the basis of average speeds achieved by cars and goods vehicles on the existing and new road links (see table below), their length and assumed traffic volumes. As a consequence of the project, it is estimated that the average car using the full length of the new motorway will save around 12 minutes in year 1, while goods vehicles will save around nine minutes. Time savings for vehicles remaining on existing road are around four minutes per vehicle.

Section	Length (km)	Without project				With project			
		Year 1		Year 20		Year 1		Year 20	
		Cars	LGV+ HGV	Cars	LGV+ HGV	Cars	LGV+ HGV	Cars	LGV+ HGV
E2	1.7	51.4	46.5	41.0	40.2	64.7	53.8	62.5	53.4
E3	3.6	35.2	35.2	31.9	31.9	38.8	38.6	32.5	32.4
E4	3.1	42.7	42.1	32.3	31.8	57.2	53.0	52.9	49.6
E5	3.7	40.6	39.3	34.5	33.9	54.8	51.0	53.9	50.2
E6	5.6	69.0	57.6	55.1	47.5	79.1	63.6	78.7	63.6
N1	5.7					104.8	75.2	98.4	72.4
N2	10.7					113.0	74.5	107.7	72.5
N3	2.0					79.7	70.0	78.6	69.6

To monetize the benefit of VOT savings, the following additional assumptions were made:

Variable	Assumption	Comment
Average occupancy, cars	1.8 persons	Based on different surveys carried out in the country
Average occupancy, goods vehicles	1.2 persons	
Trip purpose mix, cars	20 % work trips 80 % non-work trips	
Trip purpose mix, goods vehicles	100 % work trips	
Unit value of time, work trips	EUR 12.90 per hour	Estimate based on average wage in the country (EUR 9 per hour) and assumed labor related overhead (33 %)
Unit value of time, non-work trips	EUR 4.30 per hour	Estimated at 1/3 of value of time for work trips
Escalation factor for VOT		GDP per capita growth, with elasticity factor of 0.7

Vehicle operating costs (VOC) savings are calculated for different types of vehicles taking into consideration national vehicle fleet, speed and road capacity, road condition and road geometry. The software used applies nationally calibrated values and crew cost has been excluded to avoid double-counting.

Accident cost savings are related to the fact that the majority of the traffic will be diverted to a safer motorway, with separated carriageways for each direction and grade-separated crossings with lower category roads. Analyses of traffic safety revealed that the traffic fatality risk on the existing road is 10.7 fatalities per one billion vehicle-km, whereas on a motorway it is 3.1 fatalities per one billion vehicle-km. It was estimated that the construction of the new road will save around 0.6 fatalities in the opening year and around 0.9 fatalities in the final year of analysis.

A prevented road fatality in the country is estimated at EUR 677,500 (estimate based on values derived from a literature review). It is assumed that this value will grow at the same rate as real GDP per capita, with an elasticity factor of 1.0.

CO2 savings are related to the fact that due to the more favorable alignment the distance travelled for the majority of the traffic will reduce, while the traffic flow remaining on the existing road will be smoother. The assumed unit cost is EUR 31 per ton of CO2 (in 2013 prices), with an annual growth of EUR 1.

Please, check Excel File “Economic CF” for the results and further economic analyses.

Tasks for Team “Public” and “Private”

1. Please, describe the organizational model of the project.
2. What other alternative organizational models would you consider for the project? What would be the pros and cons for the analyzed organizational models for your project?
3. Prepare for the presentations and negotiations with the members of the other team.

Team “Private”

1. Please, describe how other alternative business models can impact your cash flow? Which model would you choose and why?
2. Develop a Cash Flow using Project Finance financing model (currently you have purely equity finance). Check the financial viability of the project. What other alternative financial models can you use to make the project viable (in case needed).
3. Consider options and methods to decrease the life cycle costs of the project.

Team “Public”

1. Please, describe how the alternative business models will impact the economic benefits of your project. Which model would you choose and why?
2. Develop an economic analyses study considering all the possible economic benefits for the project.
3. Monetarize the identified benefits and consider them in the economic analyses.
4. Identify the organizational model with the possible highest value for money approach.