DOCUMENT DE TRAVAIL 2001-014

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Original manuscript : ISBN -
Version original : ISBN -

Série électronique mise à jour : 11-2001
One-line publication updated : 
Seria electrónica, puesta al día
Multicriteria analysis of the financial feasibility of transport infrastructure projects in Hungary

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PROBLEM’S HEADLINES: The success of the Central European Countries joining the European Union (EU) will depend on the accessibility to the markets. The consumers and the producers of the region have to gain market access for all the products and services produced in that region. This requires a good transport infrastructure network.
Ten years after the political and economic changes, these countries must face the fact that the required development of the transport infrastructure can not be realized using only public financial sources; they have to mobilize the private capital too.
The lack of governmental funds puts the feasibility of a public-private partnership type of project development in focus.
The transport infrastructure projects have the following special characteristics:

- a rather high initial investment,
- the profitability of these projects runs a long term risk which is above average whereas the payback periods are longer, and these conditions do not make these investments attractive for capital investors,
- an excess capacity is needed, therefore, the traffic load of the investment lags behind average, the planned average capacity is under-utilized during the period after launching the project,
- the service utilization shows a steady though slow growth therefore the gross present value of revenues calculated at the time of putting into operation is unfavorably low,
- a longer period of designing and construction, relatively low operating costs and low productivity.

Because of these special features, the correct presentation of the financial feasibility of the various transport infrastructure development projects has become a key question.
The computer program developed by the author and his team provides a special decision support tool to realize this aim. It is capable of analyzing the financial feasibility of this type of transport infrastructure development project, using a multicriteria evaluation.
Using a model of different characters of the project as macroeconomic, regional, traffic, environmental and timing (scheduling) parameters, many of these indicators can be transformed into monetary values, which can be taken into consideration in the various cash flows of the project.
The model identifies and examines indexes both for the whole lifetime of the project (refund time, average book value, return on own capital, net present value, internal rate of return, profitability index, minimal value of annual debt cover ratio, minimal value of annual interest cover ratio, return on equity, debt cover ratios) and yearly indexes for single years of the project realization (debt service index, foreign capital/own capital; liquidity indexes: rate of liquid resources, liquidity ratio, fast liquidity ratio, money ratio, payment period; profitability indexes:
revenue on assets, revenue on working capital, net profit rate, exchange rate of stored goods, average payment period, profit on assets, dividend ratio; market value indexes: exchange/benefit ratio, dividend revenue, market value/book value ratio).

Elasticity analysis carried out by the different indicators presented in the previous paragraphs, provides the possibility for generating possible or rational alternatives for the project realization, or it can be used for the identification of the ‘best’ project versions according to the different optimization criteria.

1. **Introduction**

As a result of the political transition in 1989 in Hungary, there have been significant changes in the economy of the country. These effects on the transport system – the changes in the foreign trade relations, the requirements for less quantity but for a much better quality of transport services, the radically restructured modal split – and as a heritage of the past, the accumulated underdevelopment of the assets have resulted in the necessity for a significant development of the transport infrastructure. Since only limited financial resources are available, it is particularly important to prepare feasibility studies for the projects, and detailed studies concerning the financing structure (Section 2).

Section 3 gives a short description of the main characteristics of the two most widely used methods for the efficiency assessment: Cost-Benefit Analysis /CBA/ and Multicriteria Analysis /MCA/. There is no international uniformity applicable project appraisal method, there are significant differences in the calculation procedures, mainly in the range of the criteria included in the appraisal. A short overview of the reasons of this diversity is presented in Section 4.

Sections 5 and 6 describe the method and software group for supporting the complex feasibility analysis of the transport infrastructure projects, that were developed by the authors. Section 5 introduces the possible evaluation levels of the efficiency analysis (financial, or social – economical approach), Section 6 presents the operation of the model.

The basis of the method is a detailed and sophisticated financial modelling system that provides a practical and modular structured frame for the feasibility analysis of large projects. The modelling of the effects of the risks and uncertainty and a detailed sensitivity analysis can also be executed according to the international standards. The method can include the monetarisable criteria (e.g. time saving, accident reduction) into the CBA, and makes it possible to assess the influence of the external costs and incomes on the feasibility of the project. On the basis of the result given by the CBA analysis and with the help of a newly developed MCA module, the order of the projects or the project versions can be identified. The MCA is even able to include the non monetarisable criteria into the research.

Section 7 lists a few projects that were successfully analysed with the above given methods.
2. The effects of the political transition in 1989 on the Hungarian economy and the development of the transport system

The political transition in Hungary in 1989 had serious and negative results on the Hungarian economy. In the first few years of the changes of the economy between 1989 and 1995, the GDP decreased by 20%, and the performance of the economy reached the 1989 level only in 1997. Since 1998, the yearly average GDP increase is around 5%, in the long term it is expected to be around 3%.

The performance of the transport sector decreased even faster than the GDP; the transport of goods in a relatively smaller, the transport of passengers in a greater degree, e.g.: the amount of goods transported by railway decreased from 136 million to 46 million tons, the number of passengers from 260 million to 170 million.

Before the political transition, the demand for transport in the economy was unreasonably high, and this is why in certain segments even together with the increase of the economy we are going to find unnecessary capacity, even in the long run.

There have been great changes in the geographical directions and the quality requirements in the field of transport services:

- there is a greater demand for high added value goods instead of raw materials,
- the demand for high quality in transportation services has radically grown to a great extent (e.g. just in time), the transportation has to be linked with related additional services to be sold,
- the large factories, that employed thousands of people, have been closed down, the changes in the structures of the towns and the drastically increased number of private cars have brought about traffic jams in the peak hours,
- in the former years, 70% of the foreign trade was directed to the socialist countries, nowadays this rate has overturned; currently 70% of the foreign trade is directed to the EU member countries,
- tourism has increased significantly; 30 million visitors arrive in the country every year (this is 3 times as much as the Hungarian population),
- modal split has drastically changed, the proportion of the road transport has increased, the proportion of the rail transport has decreased.

These drastic changes require fast development of the infrastructure, but at the same time, the transport investments have special characteristics:

- rather high initial investment expenses,
- profitability of these projects runs a long term risk which is above average whereas the payback periods are longer and these conditions do not make these investments attractive to capital investors,
- capacity development can be made in large units only, therefore the traffic load of the investment lags behind average, the planned average capacity is under-utilized during the period of launching the project,
- service utilisation shows a steady though slow growth therefore the gross present value of the revenues calculated at the time of putting into operation is unfavourably low,
• longer period of designing and construction, relatively low operating costs and low productivity.

Because of these special features, the right presentation of the financial feasibility of the various transport infrastructure development projects has become a key question.

The joining of Hungary to the European Union (EU) – besides other needs – makes it necessary to provide the feasibility studies of the planned transport development investments, reconstruction as well as to apply the complex efficiency assessment procedures and methodologies already generally used for consideration and preparation of financial solutions on a national economic level in the EU countries.

Getting deeply acquainted with solutions used in the everyday practice of the EU member states and the systematic application of them is justified by the need for defining the role and function of the state in the central-eastern European countries after the gradual development of a market economy to comply with the new conditions. This made it necessary to transform the approach and data contents of previously applied calculation procedures.

At the same time in the region, the central budget sources have chronic deficits, and arising from the demand for restructuring the national economic systems, competition for external capital sources is increasing.

All these changes require the efficiency assessment at the national economy level suited to the new aims and databases related to this, in the field of large size transport infrastructure developments of significant effects, serving also the public interests.

More and more politicians of member states and accession countries realize, that the successful widening of the EU and turning it to be more competitive (also on the international basis, with respect to the U.S.A. and the well-developed countries in the Far East) the time-availability of modern transport infrastructure systems, which make it possible to “switch on” new markets in the geographical sense is of much importance. In accordance with this, building more roads and railway transport capacities, removing bottlenecks, establishing and enlarging new intermodal junctions and providing quality service on them have to be put into practice in the short term on the whole area of the accessible countries.

As a result of this, in the countries near the EU connection, hard competition has taken shape to realize the infrastructure investments needed along the designated Pan-European transport corridors as soon as possible. Because of the multiplier effect (Tánczos, K 1995) transport infrastructure investments have an indisputable reaction on the general economic and regional development. This is why it is of prime necessity for Hungary, that the country receives potential investors for project-level infrastructure development in the short term or come up well prepared, also with efficiency appreciation methods, which are an important part of the planning.

The causes mentioned above and further EU requirements promoted the development of a complex model-system analysis, which with the indices suggested by earlier uses, simple efficiency calculations (net present value, benefit-cost ratio, internal rate of return) is capable of taking the special features of the Hungarian transport infrastructure investments (relatively high inflation rate, weak purchasing power, lack of reliable traffic data) into consideration.
Furthermore, the system is able to: handle all mentioned flexible objectives, calculate other important indices, find which various actors (investor, financier, state, national and international banks) could be interested in, calculate from the point of view of the feasibility of the project significant financial, economical and (taking the external effect into consideration) “quasi social” refoundation rate.

3. Trends in development of efficiency research methods

Usually two assessment methods are adopted for evaluations research and comparing different development versions in the field of transport infrastructure:

- Cost-benefit analysis (CBA) and
- Multicriteria analysis (MCA).

Of course, solutions in practice are based on the combined application of these two basic methods. In every case the goal-status of the realisation of the project and the situation without any realisation have to be compared.

3.1. Cost-Benefit Analysis (CBA)

The cost-benefit analysis takes the income, investment and operation cash flows into account during the whole lifetime of the project in such a manner, that in these cash flows beside the merely monetarised values, it registers also the monetarised values of many other effects concerning public interests. This assessment technique needs the proof of concerned effects in monetary units (e.g. to consider the travelling time effect, the value of time saving due to the realisation of the project is needed to be expressed in monetary values).

The cost-benefit analysis is used for deciding whether the social benefits expressed in monetary value exceeds the monetarised social costs, or not. This solution makes it possible for decision-makers to answer the question concerning the social net income of the examined project during the estimated project life cycle (or the extent of the sacrifices needed, because of general establishment loss).

Cost-benefit analysis used exclusively for efficiency evaluation of public (state) financed transport infrastructure projects makes it possible to find out the contribution of certain capital investors the realized goals, besides the financial profit. This procedure is suitable (appropriate methods taking into account) to analyse joint financed (public and private) cases, too.

The applicability of the cost-benefit analysis depends on the possibility for expressing the effect of the project realization in monetary values. It is very hard to monetarise the types of environmental damage effects like – e.g. – the psychological consequences of the increased traffic.

3.2. Multicriteria analysis (MCA)

Multicriteria analysis has been developed for analysing cases, which do not make it possible to take all the effects into account with their monetary values. Using this method, the decision maker’s opinion dose not have to be based on monetary values, it can contain objective figures. Multicriteria analysis is usually used in cases where more project variants, supplied with not only
monetary values, have to be ranked in order to select the best one of them. As a result of this, by using the MCA methods it is necessary to have more alternatives available (at least the two cases of one possible establishment and the “do nothing” i.e. status quo case), and for each one, non monetarised alternatives summarising the value of utility functions representing the considerations of the known assessment (usually with the scoring method).

3.3. The combination of the CBA and MCA methods

Using this method, in the course of the solution, with monetary values expressed the criteria are usually transformed to dimensionless utility functions, in order that nothing can stop to pull them together with the non monetarised ones. The priority order issued from this procedure can be unstable because of the many subjective units included in the algorithm.

4. Overview the methods for the analysis of effectiveness

At the international level, there is no a unified method in the field of feasibility analysis of transport infrastructure projects. There are many reasons for the development and application of different methods:

- differences in fund sourcing and allocation, and the operation of the projects: in the majority of the countries, the road and rail network is owned and operated by the national government, the state or the local authorities, although in some countries there are privately owned or operated transport services (e.g. the rail transport operations in the UK, Japan, some bus and commuter rail services in the USA, toll roads and bridges in the USA, concession motorway M5 in Hungary),
- differences in the criteria parameters included in the evaluation process: some criteria are common in all of the developed countries (time saving, accident reduction), other parameters are included into the analysis only in some countries (impact on the environment, land use, local development). The time saving and accident costs are well monetarised in the developed countries, although the money value of these parameters is different in each country. In the developing countries, the required database does not exist for calculating the money terms even of time saving and accident reduction, though due to the low level of GDP, these costs would also be low related to the other costs and revenues of the projects. The uncertainty in monetarising the impact on the environment, land use and other impacts is much greater, and there is no existing generally accepted method for calculating these measures.

5. Possible evaluation levels in efficiency analysis

Complex redemption evaluations can be carried out using

- financial or
- social – economical approaches.

The range of assessment factors and the data content distinguishes the two approaches.

The developed complex computer model is able to examine project feasibility based on the introduced efficiency research methods, in harmony with the desired evaluation level and the expected requirements.
5.1. Evaluation dependent on the financial view

The financial evaluation is used for the feasibility assessment of the project emphasised by the financial criteria. Extended for the lifetime of the project, it calculates cash flows in detail with all the necessary investment costs for the establishment of the project, ensuring income, expense savings, operation and maintenance expenses appearing after putting the project into operation. It analyses the minimum financial sources needed to cover the cash flow demand, the disposed sources, financial conditions (runtime, interest rates, fees, maturity period, paying by instalments, etc.).

Obviously, the financial view dispenses with showing costs and benefits only identified outside the examined system which can not appear through unambiguous market transactions directly in the calculation, with different important effects in connection with the quality of life of the society. This evaluation supports, in the first place, assessments carried out from the point of view of investors (like state, credit institutions, money-markets, private capital, etc.).

The model identifies and examines indexes both for the whole lifetime of the project (assessment time, average book value, return on own capital, net present value, internal rate of return, profitability index, minimum value of annual debt cover ratio, minimum value of annual interest cover ratio, return on equity, debt cover ratio) and yearly indexes for single years of the project realisation (debt service index, foreign capital/own capital; liquidity indices: rate of liquid resources, liquidity ratio, fast liquidity ratio, money ratio, payment period; profitability indices: revenue on assets, revenue on working capital, net profit rate, exchange rate of stored goods, average payment period, profit on assets, dividend ratio; market value indices: exchange/benefit ratio, dividend revenue, market value/book value ratio).

Our software for multicriteria applications may also be applied effectively to special cases such as
- analysis and financial control of sequential investments;
- individual and global feasibility analysis for a group of projects making up a large investment project;
- analysis of the competitiveness of the projects.

It may also be used for preliminary analysis of investment possibilities in order to give a favorable or unfavorable notice on their profitability.

Having this information using our model, it is also possible to examine the pros and cons concerning the fiscal maturity of the waiting investment projects.

The model is able to determine the value of the subsidy equivalent to the required amount of external benefit generated by the project to be financially feasible.

5.2. Evaluation dependent the social-economical efficiency assessment

The success and credibility of this analysis depends greatly on the quality of the available data. It is therefore desirable that we may find the data first at the lower hierarchical levels, then gradually at higher hierarchical levels before reaching the hierarchical level of the decision maker.

If the conditions for calculating the external cash flows, supported by the internal ones, are not available in reliable monetary values, the solution offered by the extended financial analysis option is also practicable and should be followed.
This extended financial model brings about an essentially needed “minimal net external benefit” after defining the minimal ROE (return on equity) value. This cash flow inserted into the model is only a fictitious income; it can be compared with the appropriate GDP percentage of well developed market economies derived from top-bottom direction calculations. The value is only approximate (in order of magnitude) because of the high level of uncertainties, and the external incomes can not be calibrated accurately.

In the case of the projects less important in size, it is naturally possible to estimate the external effects including the approximate financial determination of the corresponding values. These types of analysis are based in the theoretical conception put forward by Arthur Cecil Pigou (1877-1959). Let us note that the field of "Welfare Economics" (1912, 1920) is considered to be his creation. In particular, he is « responsible » for the distinction between private and social marginal products and costs and the idea that governments can, via a mixture of taxes and subsidies, correct such market failures -- or "internalize the externalities".

The “right” (i.e. fair and efficient) prices are hard to define since external costs are changing against the output volume and financial transactions to compensate damaged persons can only be worked out under imperfect informations. For all of these reasons and the effect of lacking in exact quantifying Hungarian data, it is practical to compare the quantified results from the external effects with the ones drawn from the global (obtained from the GDP) values.

6. Operation of the developed complex assessment model

From the overview and analysis of the most important features of the projects appearing in practice and the methodical requirements of the above described efficiency assessment conceptions, it seemed to be practical to develop a model which meets the needs of the most complicated tasks. According to this, the construction of the program package ensures data input and operation procedures in accordance with the maximal expectations (e.g. concession motorway project sized, 35 or 50 years project life). The model is suitable for separate and also optional aggregated examination of cash flows connected to various time schedule investments, operation, income, credit-demand or installment processes. The financial abilities of the project can be examined for the whole lifecycle, in case of lacking financial sources, necessary conditions can be defined (e.g. rate of own/foreign sources, credit installment conditions, etc.), and financial indices shown above can be determined in time.

Besides all this, the program system makes it possible to carry out sensitivity analysis which helps to simulate

- “external” (macroeconomic indices like inflation, interest rates, production and consumer price index, foreign exchange rates),
- income components (e.g. volumes of traffic, tariffs, transportation fees, etc.) and
- “internal” (the changes in the execution time schedule, the subcontractors implication, the energy consumption and that of gas also their price changes, etc.) application of more innovative technologies realization with changed technical contents, etc.) factor changes in connection with the model and it is possible to analyse and test the effect of these changes on the realization of the project.
The Control Panel of INNOFinance

Input and output data of the model are classified in different groups:

- macroeconomic data,
- the structure of the financing sources features,
- income forecasts,
- data of capital expenditures,
- data of operation expenditures.

The output (computed) data are structured in the next tables:

- data of the cash-low table,
- table of financial indices.

Operation flow of the model:

- composition of basic data trends,
- determination of cash flow sums,
- overview of the use and of the charges related to the sources of financing,
- preparation of output data tables,
- calculation of financial indices, drawing diagrams,
- performing sensibility examinations,
- generating new project alternatives which meet the threshold conditions, if needed.

The flexible model structure and the practically unlimited size of the database makes the quick analysis of many projects or project versions possible. From among the different project versions (often 60-80) in a first step, that are not financially or economically feasible many can be eliminated. After that it can be modelled, which parameters have to be changed to make those
project versions feasible, that are on the verge of efficiency, in what way can the feasibility characteristics of the projects be improved.

After these steps, we can determine those parameters that are to be used for ranking the projects. The group of these parameters can be defined depending on the given project. The most common indicators are:

- project IRR,
- ROE (Return on Equity),
- the minimum of the annual debt service cover ratio,
- the financing structure,
- parameters that are not or only hardly cash convertible (e.g. impact to the environment, land use, local development).

7. Multicriterion analysis framework

The multicriteria analysis is performed on the basis of the Electre II method (Roy and Bertier, 1973; Kiss, Tánzos, 1998). While developing this new module, our goal was not to reform one of the existing well known MCA methods, but using Electre that is well fitted to assess problems with insufficient input data, we wanted to realize a transport oriented application of this MCA technique to increase the reliability and soundness of the decision-making process.

\[ X_m = \{ X_1, \ldots, X_i, \ldots, X_m \} \], a finite set of alternatives (i.e. the project versions that are feasible on the basis of the CBA assessment;
• \( Y_{[n]} = \{ Y_1, \ldots, Y_j, \ldots, Y_n \} \), a family of criteria with regards to which each alternative is evaluated; and

• \( M_{[mxn]} = \{ M_{ij} = Y_j(X_i); i = 1, \ldots, m; j = 1, \ldots, n \} \), a performance matrix of the alternatives according to each of these criteria.

Moreover, we use the following subjective decision-maker (DM) defined elements:

• \( W_{[n]} = \{ w_1, \ldots, w_j, \ldots, w_n \} \), a set of weights (i.e. relative importance) associated with each criterion, where \( \sum_{j=1}^{n} w_j = 1 \) and \( 0 \leq w_j \leq 1 \), \( \forall j, j = 1, \ldots, n \);

• three concordance thresholds \( C_1, C_2 \) and \( C_3 \) such as \( 0 < C_3 < C_2 < C_1 < 1 \), as in Roy and Bertier, 1973; Guigou, 1977; Kiss, Martel and Nadeau, 1994;

• two sets of discordance thresholds \( \delta_j^U \) and \( \delta_j^L \) with regards to each criterion such as \( \delta_j^U > \delta_j^L \) and \( \delta_j^U < \max |M_{ij} - M_{i^*j}|, M_{ij}, M_{i^*j} \in M_{[mxn]} ; i \neq i^* ; i, i^* \in [1, \ldots, m] \) \( \forall j, j = 1, \ldots, m \), as in Kiss, Martel and Nadeau, 1994.

The interactive front services of our software offer the possibility to the DM to modify the default concordance and discordance thresholds.

CLASSICAL OUTRANKING CONDITIONS

Define

1) three pointer-sets :

• \( J^{(+)_{(X_i , X_i^*)}} = \{ M_{ij} > M_{i^*j}^* ; i, i^* \in [1, \ldots, m] ; M_{ij} \in M_{[mxn]} ; i \neq i^* , \forall j, j = 1, \ldots, n \} \) for all criteria to maximize; or

\( J^{-_{(X_i , X_i^*)}} = \{ M_{ij} < M_{i^*j}^* ; i, i^* \in [1, \ldots, m] ; M_{ij} \in M_{[mxn]} ; i \neq i^* , \forall j, j = 1, \ldots, n \} \) for all criteria to minimize;

2) three power metrics:

• \( W^{(-_{(X_i , X_i^*)}} = \sum_{j \in J^{-_{(X_i , X_i^*)}}} w_j \), the neutralizing power of \( X_i \) over \( X_i^* \);

• \( W^{(+_{(X_i , X_i^*)}} = \sum_{j \in J^{(+)_{(X_i , X_i^*)}}} w_j \), the preponderant power of \( X_i \) over \( X_i^* \);
\(W^{-}(X_{i};X_{i}') = \sum_{j \in J_{i}} w_{j} \), the preponderant power of \( X_{i} \) over \( X_{i}' \); 

3) a global concordance index:

- \( c(X_{i};X_{i}') = W^{(+)}(X_{i};X_{i}') + W^{(-)}(X_{i};X_{i}') \)

and

4) local discordance indexes:

\[ \Delta_{j}(X_{i};X_{i}') = \begin{cases} 
M_{i,j} - M_{ij} \text{ for all criteria to maximize,} \\
\text{or} \\
M_{ij} - M_{i,j} \text{ for all criteria to minimize.} 
\end{cases} \]

Given these definitions, we can specify in pseudo-code syntax the well known outranking conditions as follows:

If
\[
\begin{cases} 
W^{(+)}(X_{i};X_{i}') \geq W^{(-)}(X_{i};X_{i}') \quad \text{and} \\
c(X_{i};X_{i}') \geq C_{1} \quad \text{and} \\
\Delta_{j}(X_{i};X_{i}') \leq \delta_{ij}^{+} \forall j; j = 1,\ldots,n, 
\end{cases}
\]

or
\[
\begin{cases} 
W^{(+)}(X_{i};X_{i}') \geq W^{(-)}(X_{i};X_{i}') \quad \text{and} \\
c(X_{i};X_{i}') \geq C_{2} \quad \text{and} \\
\Delta_{j}(X_{i};X_{i}') \leq \delta_{ij}^{+} \forall j; j = 1,\ldots,n, 
\end{cases}
\]

then \( X_{i} \) strongly outranks \( X_{i}' \), i.e. \( (X_{i}, P^{(s)} \ X_{i}') \)

else

If
\[
\begin{cases} 
W^{(+)}(X_{i};X_{i}') \geq W^{(-)}(X_{i};X_{i}') \quad \text{and} \\
c(X_{i};X_{i}') \geq C_{2} \quad \text{and} \\
\delta_{ij}^{+} \leq \Delta_{j}(X_{i};X_{i}') \leq \delta_{ij}^{+} \forall j; j = 1,\ldots,n 
\end{cases}
\]

or
\[
\begin{cases} 
W^{(+)}(X_{i};X_{i}') \geq W^{(-)}(X_{i};X_{i}') \quad \text{and} \\
c(X_{i};X_{i}') \geq C_{3} \quad \text{and} \\
\Delta_{j}(X_{i};X_{i}') \geq \delta_{ij}^{+} \forall j; j = 1,\ldots,n 
\end{cases}
\]
then
\[ X_i \text{ weakly outranks } X_i, \text{ i.e. } (X_i P^{(W)} X_i) \]

else
\[ X_i \text{ and } X_i \text{ are indifferent or incomparable, i.e. } (X_i I X_i) \]
end if
end if

Taking into account the large-scale conception status of the feasible projects, it is pragmatically tolerable if only the strong outranking relations are effectively considered as preference (precedence) relations in the real applications context.

8. Applications of the model

Considering the flexible limits of concerned effects, our developed software is capable to carry out complex financial calculations extended for economic and social assessments. Among these, in connection with transport infrastructure developments examinations concerned

• the M5 and M7 motorway,
• complex economical level analysis of the Budapest Intermodal Logistics Centre (BILC),
• feasibility studies for purchasing new trams for Budapest urban transport,

have to be emphasized.

8.1. Financial feasibility analysis for the reconstruction and extension of the M7 motorway

After the political changes in Hungary in 1989, three concession companies owned motorway projects that were planned or even started.

The M7 motorway was the first motorway in Hungary built in the 60s. It links Budapest (the capital of Hungary) to lake Balaton, the most popular holiday and recreation area of Hungary. The quality of the concrete surface of the 100 km long motorway is already very poor, as a result of the bad construction quality and the lack of necessary maintenance and renewal activity in the past decades.

In 1997 and 1998 several feasibility assessment studies were prepared for the Ministry of Transport, Communication, and Water Management concerning the reconstruction and the extension up to the Hungarian border of the M7 with the implementation of a toll system. The main aspects of the studies were:

• the scheduling of the project (phase one implementation, phase two for the implementation and extension together with only a minimal rehabilitation of the old section),
• the funding of the project (entirely state owned, concession company owned, joint venture /PPP/),
• the application of a moderate toll structure together with a state provided partial shadow toll, i.e. marginal payment.
The financial positions of all the main actors of the project (the state, the financing institutions and the concession company) have been evaluated, using many financial indicators (IRR, ROE, NPV, debt service cover ratios).

One of the most important conclusions of the calculations was that the minimal total implementation cost occurred in the case of the state only owned project. But by analysing the quantity of required financial sources, it was realized, that both in the cases of state owned and concession company owned projects, the financial resources were limited but that the national and foreign financial markets were most probably accessible. Implementation resulted such financial resource quantities, what appeared on the national and foreign financial markets probably accessible.

![Distribution of Financial Sources](image)

8.2. Financial feasibility analysis of the extension of the M5 motorway

Currently there is one concession company (called AKA) that owns and operates a motorway in Hungary, it is the M5 motorway. This road which goes from the south of Budapest in the direction of Szeged and Romania is currently about 100 km in length. It was constructed in 1996-1997 and since that time the users have to pay tolls at toll gates.

The concession contract between the state and AKA gives the right to AKA to extend the M5 an additional 60 km up to the Hungarian border. Before and during the discussions concerning this extension of the M5, Eurout Ltd, the technical consultant of the Hungarian state ordered a great number of financial feasibility assessments using the computer model described above.

The analysed cases were constructed from the following parameters:
• the scheduling of the project (the implementation of the highway in the first phase, the motorway in the second phase),
• the funding of the project (several allocations from the state, AKA funds and debts),
• the different toll levels,
• distribution of the sources and financial credits taking into account the state sources, the private sources (AKA).  
The purpose was to find the implementation cases,
• that were acceptable to AKA,
• and to analyse the cash-flow positions of the state in the short and long terms in order to select the most favourable project versions.

8.3. Complex economical level analysis of Budapest Intermodal Logistics Centre (BILC)

Near the south limit of Budapest, a new Logistics Centre was planned partly to replace the old combi-terminal called Jozsefvaros of MAV (the Hungarian State Railways). The state
• is building a new railway combi-terminal called Soroksar and
• providing the land for the logistics centre equipped with all the necessary infrastructure for the area (water, electricity, telecommunication, road links, ...).

The construction and operation of the logistics centre is being done by a consortium of private logistic companies, who were selected following an international competitive bidding procedure.  
The most significant financial parameters were
• the unnecessary reconstruction cost at Jozsefvaros,  
• the increasing revenue of MAV not loosing it’s proportion in the combi-transport as a consequence of the high quality rail service of the new Soroksar combi-terminal,  
• the taxes and other revenues.  

A detailed environment protection assessment has been prepared concerning the BILC project. Related to the ‘do nothing’ case, significant external revenues were obtained by
• decreasing the environment stress (air and noise pollution, unfavourable traffic effects on the settlement) in the area of Jozsefvaros (the old combi-terminal is built relatively close to the centre of Budapest and can be reached by the heavy trucks only on old, congested roads and in partially populated urban areas).  
The other external effects
• water and other pollution,  
• ground pollution,  
• effects on the fauna and flora,  
• changes in the landscape installation, didn’t produce significant external costs or revenues.  

Evaluating the external effects is always difficult. In the BILC case e.g. the quantitative estimation of the air pollution could be evaluated and the values could be estimated using two sourcises:
• the top-bottom direction: on the basis of the international research data, the local databasis and the performance indicators of the Hungarian economy, a rough cost could be evaluated,
• the bottom-top direction: analysing the project cash-flows, in the case of the shortage of financial resources, it can be modeled, what additional financial sources would be required to ensure the financial balance or profitability of the project.

The calculation of the two amounts provides a very rough comparison to investigate, if at the socio-economical level, the external revenues ensure the ‘incomes’ that are necessary to finance the money shortage of the project.

The conclusions of the BILC assessment were that the NPV of the project cash flow presented a positive value already after 10 years even without taking the external effects into consideration, and the payback period is rather insensitive to the decrease of the projected incomes.

8.4. Feasibility study for purchasing new trams for Budapest urban transport

The busiest tram line of Budapest is also the busiest line of Central Europe, its capacity is close to the lower capacity level of a metro line. The Budapest Municipality Office of Lord Major and the BKV (Budapest Transport Company) decided to buy new low floor vehicles for this important tram line. This action has a positive influence on the whole Budapest tram network because a major part of BKV’s tram fleet is more than 40 years old, and many of its coaches should already be scrapped.

We surveyed the cost savings due directly to quantifiable impacts by matching them against the investment costs, as these savings incur clearly at the corporate level:
• the maintenance costs projected for 1000 km have decreased substantially, by 50%,
• energy consumption: as a result of the more efficient operation, the modern driving and the recuperation of the breaking energy resulted in a 30% decrease in the overall energy cost related to the old vehicles to be scrapped.

The other external effects
• the old vehicles had to be overhauled every 16 years, these costs may be saved in the case of new vehicles.

The indirect economic impacts have been calculated on the basis of:
• the money value of the time savings for the national economy achieved by all the passengers,
• in the calculations, the following elements were considered:
  - the time saving of the improved quality of the service which had a secondary effect of attracting passengers,
  - increasing the revenues generated,
  - decreasing the use of individual means of transport, thus decreasing the vehicle congestion, decreasing costs for the owners of vehicles and decreasing the risk of accidents therefore the costs of damage; accidents can be cut down as well.

With regard to the external effects, no substantial improvement compared to the old trams could be experienced. Based on an earlier analysis by BKV (made for the purpose of information), we carried out an analysis on the assumption of not implementing the project of purchasing the new
trams. We assumed that we would have to replace the capacity of the trams by buses because of
the scrapping of the old trams and assessed the increase of air pollution and its impact. According
to the results, this unfavourable solution would result in the emitting of additional 26.3 t CO, 34.8
t CH, 788 t NO and 17.7 t of soot in the air each year.

9. Conclusion

The drastic changes in the economy of Hungary after the political transition in 1989, the
development of the transport infrastructure of the country arose an important premise for the
development of the whole economy. The shortage of local financial funds made it very important
to support the decision-making process with solid feasibility analysis, the joining process to the
European Union, the accessible international financial funds made it possible and necessary to
apply methods that are found in developed countries. But the lack of an internationally unified
evaluation method and the specificities of the Hungary’s transient economy (high inflation rate,
quick changes in the economy, higher uncertainty and in many cases the lack of data that are
commonly accessible in the developed countries) it was necessary to draw up an evaluation
method mostly for the analysis of the transport infrastructure projects, that are harmonised to the
international practice, and take into consideration the latest research results in the international
science and the specificities of our country, i.e. Hungary.

This form of modelling developed for the investigation of special cases can be regarded as a
complex feasibility evaluation procedure extended also for the consideration of the monetarized
social impacts of the project. This type of approach provides possibility for the government to
decide if the project could be considered as financially feasible because of its significant social
benefits. This calculation leads to the ranking of the projects according to their “financial
maturity”. If one project has a high priority in this rank, it is easy to attract private money to
provide the required capital.

The method and computer model called INNOFinance that supports the assessment process has
successfully been applied for 6 years for a wide range of transport infrastructure projects. In the
case of the existence of the required data, a very detailed financial feasibility study can be
produced with the system, with many project versions, financing structures (only state owned,
private or joint venture /PPP/), a wide range of sensitivity analysis and with the presentation of
the financial positions of all the participants of the project (owners, financing institutions, state or
local authority institutions).

Socio – economic level assessments can also be performed; convertible into cashcriteria (e.g.
time saving or accident reduction costs) can also be included into the CBA analysis.

The model is currently extended by a new multicriteria module to support the ranking of the
projects and to increase the reliability and soundness of the decision-making process. The goal
was not to reform one of the existing well known MCA methods, but using Electre is well fitted
to assess problems with insufficient input data. We wanted to realize a transport oriented
application of this MCA technique.
This paper also introduces some relevant applications of the software concerning the last four years.

References


