BUDAPESTI UNIVERSITY OF TECHNOLOGY AND ECONOMICS
DEPARTMENT FOR TRANSPORT ECONOMICS
TRANSPORT SCIENCE PH.D. PROGRAM

DEVELOPMENT OF APPRAISAL METHODS FOR THE WHOLE LIFE CYCLE OF TRANSPORT FACILITIES

overview of Ph.D. thesis

By:
Zoltán Békefi
M.Sc. in Transportation Engineering

Budapest, 2006

1. THE TASK AND PRECEDENTS OF THE RESEARCH WORK

Transport infrastructure development projects generally require a remarkable amount of financial sources, and effect the environment, the economy and a large number of passengers on the long term. In order to appraise the efficiency of transport projects and project versions, more and more indicators must be included in the assessment process during the pre construction and decision making period.

In order to guarantee the long term sustainable development of the transport network the importance of the environment friendly transport modes is continuously increasing, so when evaluating transport construction projects, multimodal project versions must also be appraised. Besides in the case of the long-distance transport projects (mostly in the case of the trans-european transport corridors) and the suburban transport projects the several transport mode versions can be considered as alternative project versions, and the comparison of these alternatives is also required during the decision making process.

In most of the cases the finances available for the development of the transport infrastructure are limited, they are remarkably less, than the proposed projects would require, so it's an important task to designate the most efficient projects or project versions. The criteria and indicators taken into consideration during the assessment process are very varied – depending on the transport modes, the level and the objectives of the assessment process –, currently there is no unified, general method applied in the international assessment methodology.

The appraisal methods applied in the practice are mostly used only for the preparation and the foundation of the decisions, but they are rarely used to control the real costs, incomes and efficiency, partly because of the absence of the instruments that could support this activity. The importance of such monitoring activity is emphasized by the fact that in the case of many transport infrastructure projects the costs are underestimated, and the revenues are overestimated during the planning period. As a result of these the necessity for the refinancing of the project can occur in a relatively short period after the activation of the project, and the appraisal of the project efficiency often has to be done repeatedly.

Many changes can occur during the operation, the "life" of the project, e.g. the real costs, revenues, the financing costs, the real economical environment indicators will differ from the forecasted values, and so the refinancing of the project can also be required. To handle these complex requirements a unified assessment method should be created, that is able to handle and control these parameters and is appropriate for the continuous re-evaluation of the project during the whole project life cycle. Partly based on the traditional assessment methods I have created a new appraisal method and software tool, that is appropriate for the completion of such complex analysis, and the continuous and repeated efficiency control during the whole life cycle of the projects.

The dissertation summarizes and presents the results of a 10 year long research and development activity.

2. AIMS OF THE RESEARCH WORK

By developing the model presented in the dissertation my aim was the creation of an efficiency assessment method, that is not only available for the preliminary appraisal of the projects, but also provides new tools and methods to

- control the fulfilment of the preliminary efficiency requirements during the whole project life,
- continuously re-evaluate the project to handle the consequences of the changes in the operation, the financing of the projects and the changes in the macroeconomy,
- analyse the refinancing possibilities of the project,
- analyse the consequences of the uncertainty during the whole project life cycle, generating and handling a large number of sensitivity analysis project cases,
- explore the values or ranges of the input variables, where the efficiency indicators fulfil the preliminary requirements,
- include hardly or not at all monetarizable indicators into the assessment process.

In order to fulfil the aims of my research activity I have created an assessment method, that can appraise a wide range of effects to the individuals, the society, the economy, and the environment, and that can handle the complex set of the criteria indicators in a unified structure.

It was an important aim to handle the more and more complex financing techniques (e.g. PPP) occurring in the national and international financing practice, and to calculate and control the use of the financing sources and the financing liabilities generated by the use of these sources accordingly to the international standards.

3. THE METHOD OF THE RESEARCH

A wide range of literature deals with appraisal methods supported by traditional tools.

In general two appraisal methods are applied to the assessment of the transport project efficiency, and to the comparison of the different project versions:

- Cost-Benefit Analysis: CBA
- Multicriteria Analysis: MCA

The Cost-Benefit Analysis can evaluate only monetarizable effects, at the same time it represents a reliable, objective assessment method. The results of an analysis completed by the Multicriteria Analysis contain much more uncertainty due to the subjective evaluation and the specialities of methods applied to summarize the results of the individual evaluations.

The appraisal can be carried out on two levels:

- financial, and
- social - economical level.

As a rule methodology difficulties are not occurring in the case of financial level assessments. On the other hand during a social - economical level assessment process external effects must be also evaluated (e.g. environmental effects, accident costs, synergistic effects to the economy and the whole society). For the evaluation of these external effects currently there is no internationally unified, widely applicable method.

In the dissertation I review and evaluate the different appraisal methods based on the Hungarian and the international scientific publications.

In Hungary in the last years Monigl ([Mon99], [Mon00]), Tímár([Tím02]), Tánczos([Tan98b], [Tan03]) published articles dealing with similar methodological issues.

From the international scientific literature it is worth emphasizing the research activity of Nash, C. ([Nas91], [Nas02]), the assessment method created for the TINA program, and the normative method created by the EU ([Ecd03a])

The complex evaluation method presented in the dissertation is a result of a continuous development. All of the elements of the method are verified in detailed analysis and also during the numerous applications in the practice. During the continuous development I was also taking into consideration the post-verification of the earlier projects, if it was possible.

Most of the processes included in the development process are based

- on the rich database of the numerous transport projects analysed by this method in the last decade,
- on the mathematical statistical analysing of this database,
- on the application of vector and matrix transformation methods to create a consistent way to handle cash-flow vectors and matrices,
- on the verification of state of the art financing methods in the real life

4. NEW SCIENTIFIC ACHIEVEMENTS, THESIS

1. **I have developed a new method to handle the project data, the cash-flow elements as matrices, and so it can support the execution of the calculations in a transparent, repeatable, well controllable way, and it supports the latter sensitivity analysis aims.**

The project costs are contained in the $\underline{\underline{CO}}$ matrix, which matrix can be broken up into two hypermatrices: the construction and operation cost matrices. A $\underline{CO_1}$, $\underline{CO_2}$, ... $\underline{CO_t}$ .. , $\underline{CO_n}$ cost vectors – which compose the cost matrix – can be constructed by the element by element multiplication of two vectors. This multiplication is signed by the $\otimes$ sign.

$$\underline{CO_i} = \underline{CO_i^Q} \otimes \underline{CO_i^{UC}}$$

where

$co_{it} = co_{it}^Q * co_{it}^{UC}$

i = 1, ..., n, t, = 1,...,m

$\underline{CO_i^Q} = [co_{i1}^Q, cc_{i2}^Q, ..., cc_{it}^Q, ..., cc_{im}^Q]$ represents the quantity of the production measured in physical measure, and

$\underline{CO_i^{UC}} = [co_{i1}^{UC}, co_{i2}^{UC}, ..., co_{tj}^{UC}, ..., co_{im}^{UC}]$ represents the actual unit costs.

In a similar way to the cost structure the incomes are stored in the $\underline{\underline{IN}}$ matrix, where the income values can also be defined by the multiplication of the performance values defined in physical measure and the unit income values.

For each of the two matrices (the cost and the income matrices) parameter matrices must be defined (called the $\underline{\underline{CO^P}}$ and $\underline{\underline{IN^P}}$ matrices), which contain the name of the cost and income vectors, the currency and the price index of the corresponding series. These data are used in the latter calculation steps and in the presentation of the calculation results.

The indicators of the economic environment are stored in the $\underline{\underline{ME}}$ matrix, to which a parameter matrix called $\underline{\underline{ME}}^P$ is also assigned.

With the use of the cost, income and macroeconomy matrices together with their parameter matrices two transformation matrices can be generated (called the $\underline{\underline{CO}}^T$ and the $\underline{\underline{IN}}^T$ matrices), with the help of these the so called "cash-flow before financing" ($\underline{CF}^{BF}$) time series vector can be produced.

After that the utilization of the financial sources and also the payment liabilities generated by these sources can be calculated.

After succesfully completing these calculation steps the tax calculations, and after that the calculation of the efficiency indicators can be performed.

2. I have extended the model by a new module, which supports the execution of an extensive range of sensitivity analysis in order to explore the effects of the uncertainty occurring during the project life.

The new module has two main purposes:
- the easy generating, handling and presenting of a large number of project versions and of the calculated data, and
- the support of the sensitivity analysis

The project versions can be varied by
- the different time schedule in the construction period,
- the technical realization versions,
- the financing structures,
- the tolling systems, etc.

With the help of the sensitivity analysis the effects of the changes of the following parameters can be assessed:
- construction costs,
- incomes,
- operation, maintenance costs,
- traffic volumes and traffic profile,
- exchange rates,
- macroeconomy indicators,
- financing conditions, etc.

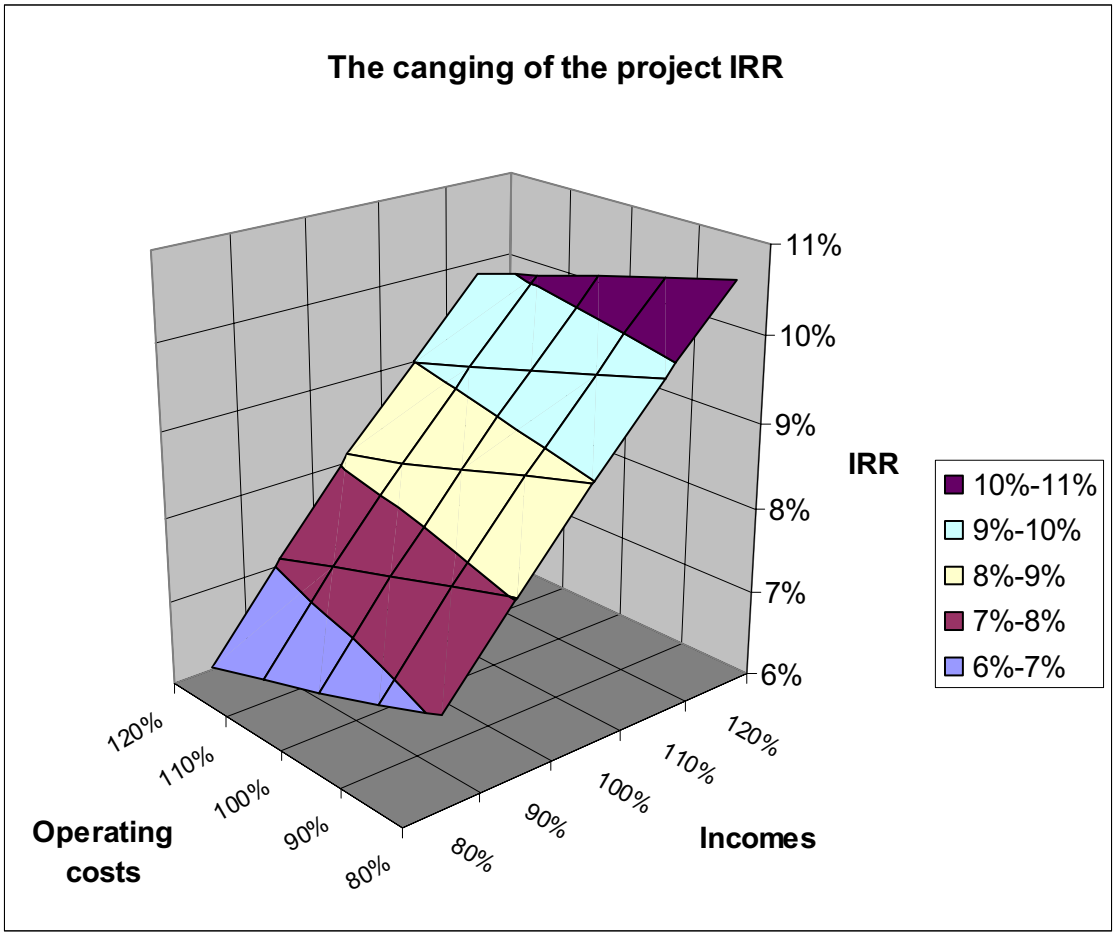
For the unified handling of these two rather different assessment types four version-handling matrices had to be developed (called the $\underline{\underline{CO}}^{VC}, \underline{\underline{IN}}^{VC}, \underline{\underline{ME}}^{VC}, \underline{\underline{FIN}}^{VC}$ matrices), which define the weight of the corresponding cost, income, macroeconomy and

financing source vectors during the calculations, or they define, if the vector is not included at all in the current project version or sensitivity analysis case.

3. I have developed a visualisation method for the better presentation of the results of the assessment calculations.

One of the most important benefits of the method presented in the previous sections is that it enables the execution of multivariate sensitivity analysis. But at the same time it emphasizes the need for the graphical presentation of the income and outcome variables.

For the most effective use of the built in methods the calculations should be executed in batch mode. The income variables and the results of the calculations represent a multidimensional space, from which two or three dimensional projection can be selected to visualize the effects of the changes of the income variables.



4. The new methodology provides the possibility of exploring the values or ranges of the input variables, where the efficiency indicators fulfil the preliminary requirements

The multidimensional space generated by the results of the sensitivity analysis calculations can be cut by contour-lines in order to explore and define that project versions or sensitivity analysis cases, where the calculated output variables (the efficiency indicators) exceed a predefined level or they fall in a predefined range.

For executing these calculations a N_{bem}+1 dimension matrix – introduced in the 5.2.8 section of the dissertation – must be generated, where N_{bem} represents the number of the input variables used in the calculations. In this matrix the output (efficiency) indicators are calculated (stored) for all of the combinations of the input variables. With the help of these output variables it is possible to explore the project versions defined by the input variable combinations, where the output variables fulfils the predefined requirements.

5. I have developed a complex set of procedures so that we could include the results of the CBA calculations into the assessment process of the ELECTRE method to use the advantages of both of the methods.

During the appraisal of the investment alternatives the analysed criteria often contain discrepancy, and difficulties occur when monetarizing the criteria. To provide the opportunity to include such criteria into the assessment process a multicriteria module has been developed.

The method is based on the Electre II method (Roy and Bertier, 1973; Kiss, Tánczos, 1998). During the development of the module the purpose was not the transformation of the well known MCA method, but the utilization of the advantages of the Electre method and the transport oriented application of it for giving a deeper help to the decision making process.

6. **The newly developed method is capable to perform the appraisal not only during the project preparation phase, but it is also available for the continuous control of the effects of the financial and economical changes during the operation period of the project. It is also capable of exploring the reason of the divergence from the forecasted indicator values and supports to define the required changes in the project parameters to reach the predefined efficiency of the project.**

Reaching the goals is made possible by the development of the following features:

- after the project activation the real project costs can be processed in the model, and so the effects of the over- or underestimated costs and incomes can be corrected
- the flexible financing module provides an effective tool to plan a new financing structure in case of the need of a refinancing process regardless whether the refinancing is made necessary by planning mistakes (e.g. over- or underestimated costs or incomes), or a favourable financing position of the project (better financing possibilities due to the decrease of the risks).
- if a discrepancy is occuring from the projected parameter values during the operation phase of the project the complex sensitivity analysis module enables the model to explore the necessary changes in the project parameters to reach the predefined efficiency indicator values or ranges.

7. **The model helps defining the optimal financing structure of PPP type transport infrastructure development projects in case of different optimum criteria.**

I have classified the financial sources used for the financing of the projects in 5 classes:

- equity investment of the project owner(s). The amount of money invested in the project is signed by FIN_A, the share of it in the total finance cost is signed by α.
- subsidy provided by international financing institutions (e.g. EU Cohesion Fund). It is signed by FIN_B and β.
- subsidized debts provided by international financing institutions (e.g. EIB, EBRD). They are signed by FIN_C and. γ.
- local public sources (state, local government). They are signed by FIN_D and. δ.
- market based debts provided by commercial banks. They are signed by FIN_E and ε.

Using these notations the total financing requirement of the project is

$$FIN = FIN_A + FIN_B + FIN_C + FIN_D + FIN_E = FIN * (\alpha + \beta + \gamma + \delta + \varepsilon)$$

The mandatory regulations regarding to the sources (e.g. EU finance share can not be more than 85%, or the public source can not be less than 15%) can be handled as limit values during the optimisation process.

During the project construction and the financing structure definition significantly diverse optimisation goals can be set, e.g.:

- maximum use of the EU sources,
- minimum use of the public sources,
- the maximum improvement of the regional accessibility,
- the maximum development of the potential of the regional economy, etc.

The different goals can result in different optimal financing structures. With the help of the financing module the $\alpha, \beta, \gamma, \delta$ és ε indicators – which represent the share of the sources in the total source utilization – can be calculated.

5. EXPEDIENCE OF THE NEW SCIENTIFIC ACHIEVEMENTS

The methods and modules presented in the dissertation are continuously built into the project finance and decision support software tool, called INNOFINance and they are continuously developed based on the experiences of the prepared project efficiency appraisals.

The number of the EU supported and also the public-private financed transport investment projects is increasing, so the demand for the efficiency assessment appraisals also will be increasing. During the construction and the operation period of the transport development projects partly financed by private sources highly educated specialists, consultants must be employed by the public and also by the private partners. In this environment the presented methodology can be applied efficiently.

The newly developed assessment methods introduced in the dissertation are presented in the graduate and the postgraduate courses of the TUB Department for Transport Economics. Not only the theory of the project appraisal methods is educated, but the students also carry out case study works.

In the frame of international research cooperation programs these methods are educated also in other EU universities.

6. LITERATURE

6.1 The author's technical literature coupled to the dissertation

[1] Békefi, Z. - Dr Kiss L. – Dr Tánczos, K.: Multicriteria analysis of the financial feasibility of transport infrastructure projects in Hungary; *INFOR, /the official publication of the Canadian Operational ResearchSociety (CORS)/, Vol. 41, Number1, February 2003, p. 105-126.*

[2] Békefi, Z. - Dr Kiss L. – Dr Tánczos, K.: Multicriteria analysis of the financial feasibility of transport infrastructure projects in Hungary, Direction de la recherché; *kutatási jelentés, Université Laval, Faculté des sciences de l'administration, ISBN-2-89524-135-X, 2001. (az INFOR-ban megjelenő cikk ezen jelentés átdolgozott változata)*

[3] Dr. Tánczos, K. – Békefi, Z. – Kiss, J.: EDI supported pan-european river traffic; *CON'96, Future Information Technologies, 11th Austrian-Hungarian Informatics Conference, november 4-6, 1996. p. 47-56.*

[4] Dr Tánczos, K. – Békefi, Z.: The development of the transport infrastructure in the frame of the Hungarian Transport Policy; *Conference on Transportation in the Region of Central Europe, Prague, Oct. 23-24, 1997, p. 141-144.*

[5] Dr. Tánczos Lászlóné – Békefi Zoltán – Dr. Magyar István: A Budapesti Intermodális Logsztikai Központ Komplex Program hatékonysági vizsgálatai; *Közlekedéstudományi Szemle, 1999/12. p. 441-450. (A Magyar Logisztikai Társaság által az Év Logisztikai Szakcikke díjjal jutalmazva 2001-ben)*

[6] Dr. Tánczos Lászlóné – Békefi Zoltán: Támogató eszköz nagy méretű projektek pénzügyi tervezéséhez és lebonyolításához; *Banktech'98, Második országos pénzinformatikai konferencia, 1998 február 10-12, Budapest Sportcsarnok*

[7] Dr Tánczos, K. – Békefi, Z.: INNOFIN - A new methodology and program package for supporting decisions of financial projects; *7th Mini Euro Conference on Decision Support Systems, Groupware, Multimedia and Electronic Commerce, Bruges, Belgium, march 24-27, 1997.*

[8] Békefi Zoltán: Közlekedési létesítmények teljes élettartama alatti hatékonyságvizsgálatára szolgáló moduláris értékelési módszer kifejlesztése, *Közlekedéstudományi Szemle, megjelenés alatt*

[9] Zoltan Bekefi: Development of a Modular, Multicriteria, Multipurpose assessment method for Transport Project Appraisal *Periodica Politechnica, megjelenés alatt*

6.2 The processed literature in the dissertation

[Ban96] Banister, D.: Energy, quality of life and the environment – The role of transport; *Transport Reviwss 16(1), 1996. p. 23-35.*

[Ban98] Banister, D.: Transport Policy and the Environment: *London, Chapman and Hall. ISBN 0-419-23140-4.* 1998.

[Bek01] Z. Békefi – L. N. Kiss – K. Tánczos: Multicriteria Analysis of the Financial Feasibility of Transport Infrastructure Projects in Hungary; *Université Laval, Canada, Direction de la recherche, Working paper nr 11-2001, ISBN - 2-89524-135-X*

[Bek06a] Békefi Zoltán: Közlekedési létesítmények teljes élettartama alatti hatékonyságvizsgálatára szolgáló moduláris értékelési módszer kifejlesztése, *Közlekedéstudományi Szemle, megjelenés alatt*

[Bek06b] Zoltan Bekefi: Development of a Modular, Multicriteria, Multipurpose assessment method for Transport Project Appraisal *Periodica Politechnica, megjelenés alatt*

[Ben99] P. Benjamin: Private Finance and the Expansion of the European Motorway Network; *The Diebold Institute for Public Policy Studies, 1999.*

[Ber66] Berg Artúr: Közúti gazdaságossági vizsgálatok; *Útügyi Kutatóintézet, 45. sz. kiadvány, Budapest 1966.*

[Boa99] A. E. Boardman – S. Hargreaves-Heap: Network Externalities and Government Restrictions on Satellite Broadcasting of Key Sporting Events; *Journal of Cultural Economics*, *1999, 23:3, 167-181.*

[Cec01] Commission of the European Communities: White Paper: European transport policy for 2010: time to decide; *Brussels, 2001*

[Cha87] C. B. Chapman – D. F. Cooper: Risk Analysis for Large Projects (Models, Methods & Cases); *John Wiley & Sons Ltd., UK, 1987.*

[Dre89] Drèze, J. – A. Sen: Hunger and Public Action; *Clarendon Press, Oxford, 1989.*

[Ecd03a] European Commission Directorate – General Regional Policy: Guidelines for Successful Public – Private Partnerships; *2003. március*

[Ecd03b] European Commission Directorate – General Regional Policy: Resource Book on PPP Case Studies; *2003. március*

[Far00] Farkas Gyula: A vasúti infrastruktúra használatáért fizetendő pályahasználati díj meghatározásának európai gyakorlata és módszertani kérdései – nemzetközi áttekintés; *Közlekedéstudományi Szemle, 2000/06. p.* 225-234.

[Gel93] Gelléri P. – Tánczos Lászlóné: Előtanulmány infrastruktúra-fejlesztési projektek rangsorolási metodikájáról; *ARAMIS Bt. 1993.*

[Gkm03a] Gazdasági és Közlekedési Minisztérium Közúti Főosztály: Útmutató a külterületi közúthálózati fejlesztések költség-haszon vizsgálatához, I. belső hatások; *Budapest, 2003. november*

[Gkm03b] Gazdasági és Közlekedési Minisztérium Közúti Főosztály: Útmutató a külterületi közúthálózati fejlesztések költség-haszon vizsgálatához, II. külső hatások; *Budapest, 2003. november*

[Hea05] HEATCO Deliverables 3: Key issues in the development of harmonised guidelines for project assessment and transport costing; *http://heatco.ier.uni-stuttgart.de/hd3final.pdf, 2005*

[Hof98] S. L. Hoffman: The Law and Business of International Project Finance; *Kluwer Law International, the Netherlands, 1998.*

[Kel00] Dr. Keleti Imre: Gondolatok a magyar gyorsforgalmi úthálózat fejlesztésének és működtetésének koncepciójáról; *Közúti és mélyépítési szemle, 2000/10. p. 341-351.*

[Ker83] Kerékgyártó Gy. – Stuber E.: A közúti közlekedési időmegtakarítások hatékonysági vizsgálatához felhasználható értékeinek meghatározása; *BME MLI, 1983., Kutatási jelentés*

[Kis94] Kiss, L. N. – M. Martel – R. Nadeau,: ELECCALC - an interactive software for modeling the decision maker's preferences; *Decision Support Systems 12, p. 311-326, North-Holland, Amsterdam, 1994.*

[Kis98] Kiss,L. N. – Tanczos, K.: Transport infrastructure investment project rankings under quasi-uniform resource allocating constraint, assisted by a multicriteria analysis process, *ITOR Vol 5., No 2, 1998, p. 103-122.*

[Kov89] Kövesné dr. Gilicze Éva – dr. Füzy Ferenc – Debreceni Gábor: Időtényezőn alapuló keresleti és kínálati függvények a városi közlekedésben; *Városi közlekedés, 1989/1., p. 1-7.*

[Köv00] Kövesné Gilicze Éva: A városi közlekedési infrastruktúra és a minőség kapcsolatrendszere**;** *Megjelent: Magyarország az ezredfordulón sorozat, „Közlekedési rendszerek és infrastruktúrák" kötet, MTA Budapest, 2000.*

[Kun99] Kundu, A – Bagchi, S. – Kundu, D.: Regional Distribution of Infrastructure and Basic Amenities in Urban India – Issues Concerning Empowerment of Local Bodies; *Economic and Political Weekly, 34(28), July, 10. 1999*.

[Lab98] M. Labbé – G. Laporte – K. Tanczos – P. Toint: Operations Research and Decision Aid Methodology in Traffic and Transportation Management; Vol. 166 of *NATO ASI Series, Series F: Computer and Systems Sciences*, Springer Verlag, 1998, p. 203-227.

[Mak95] Makula L. – Dr. Tánczos Lászlóné: Döntéshozatal és társadalmi közreműködés az önkormányzatok közlekedéstervezési fejlesztési feladatai kapcsán; *Városi Közlekedés, 1995/04. p. 227-235.*

[Mar00] Marshall, S. – Banister, D.: Travel reduction strategies: Intentions and outcomes; *Transportation Research A, 34(4), 2000. p. 321-338.*

[Mic01] Spatial Planning for Urban Infrastructure Investment: A Guide to Training and Practice; *Michael Mattingly, DPU, London, 2001, 64 pages (ISBN: 1 874502 250)*

[Mon00] Dr. Monigl János: A városi közlekedés valós költségeinek és finanszírozásának egyes kérdései; *Városi közlekedés, 2000/01. p. 33-48.*

[Mon85] Dr. Monigl János: Korszerű módszerek alkalmazása a magyar autópálya-hálózat fejlesztési terveinek kialakítása során; *Közlekedéstudományi Szemle, 1985/09. p. 397-404.*

[Mon95] Dr Monigl János: A Dél-Budai metró hatásainak és esélyeinek újragondolása elé; *Város Közlekedés, 1995/03. p. 160-172*.

[Mon99] Dr. Monigl János – Dr Tánczos Lászlóné – Orosz Csaba – Kerényi László: A Budapesti Közlekedési Szövetség (BKSz) társadalmi-gazdasági hatás- és megtérülésvizsgálata – Hatásmérleg; *Megbízó: BKSz Előkészítő Iroda, Transman-BME, 1999.*

[Mor79] Morris, M. D. ‚Measuring the Condition of the World's Poor: The Physical Quality of Life Index; *Pergamon, New York, 1979.*

[Nas02] Nash, C. – Matthews, B.: Rail Infrastructure Charging in Europe – principles and practice; *European Transport Conference, Cambridge, 10-11. September 2002.*

[Nas91] C.A. Nash – J. M. Preston: Appraisal of Rail Investment Projects - Recent British Experience; *Transport Reviews, Vol 11, No. 4, p. 295-309, 1991.*

[Nel00] Nellthorp, J. – Bristow, A. L.: Transport project appraisal in the European Union; *Transport policy 7., 2000. pp. 51-60.*

[Qui98] Quinet: Principles d'économie des Transports. Economica; *Paris, 1998*

[Rot01] W. Rothengatter: Greening the Transport in Europe: External Costs of Transport and Strategies for Internalisation; *Unpublished Report, Germany. 2001.*

[Roy73] Bernard Roy, Patrice Bertier, La méthode ELECTRE II – Une application au média-planning; *in M. Ross (ed.), OR '72, North-Holland Publishing Company, 291-302., 1973.*

[Taj98] Tajgman, D. – Jan de Veen: Employment-Intensive Infrastructure Programmes; *Labour policies and practices*, *Geneva, ILO, May 1998.*

[Tan00] Dr. Tánczos Lászlóné: Integrált közlekedési rendszerek hatékony működtetésének feltételrendszere; *Akadémiai doktori értekezés, Budapest. 2000.*

[Tan03] Dr. Tánczos Lászlóné – Dr. Bokor Zoltán: A közlekedés társadalmi költségei általános és mód specifikus hazai sajátosságai; *Közlekedéstudományi Szemle. 2003/08. p. 281-291.*

[Tan85] Dr. Tánczos Lászlóné: A közlekedés hatékonyságának elemzése többkritériumos döntéselőkészítő módszerek alkalmazásával; *Közlekedéstudományi Szemle, 1985/11. p. 108-111.*

[Tan89] Dr. Tánczos Lászlóné: A többkritériumú elemzés egy újabb módszere: PROMETHEE; *Közlekedéstudományi Szemle, 1989/06. p. 274-278.*

[Tan94a] Dr. Tánczos Lászlóné: A londoni földalatti vasúti beruházási program gazdasági hatékonysági vizsgálata és a vizsgálatokat megalapozó elméleti háttér; *Városi Közlekedés, 1994/03. p. 134-137.*

[Tan94b] Dr. Tánczos Lászlóné: Az európai közlekedési miniszterek konferenciájának módszertani ajánlásai a közlekedési beruházások tervezésére és értékelésére; *Közlekedéstudományi Szemle, 1994/08. p. 281-289.*

[Tan94c] Dr. Tánczos Lászlóné: A közlekedés társadalmi költségeinek internalizálása; *Közlekedéstudományi Szemle, 1994/11. p. 389-397.*

[Tan95a] Dr. Tánczos Lászlóné: A közlekedési externáliák meghatározási módszerei; *Közlekedéstudományi Szemle, 1995/02. p. 49-53.*

[Tan95b] Dr. Tánczos Lászlóné – Dr.Timár András: A közlekedésgazdaságtani kutatások és a közlekedéspolitika összefüggései a Közlekedési Miniszterek Európai Konferenciája (CEMT/ECEMT) 40 éves gyakorlatában; *Közlekedésépités- és Mélyépitéstudományi Szemle, 1995/03. p. 32-38.*

[Tan96] Dr. Tánczos Lászlóné – Makula L.: Az M0 autóút komplex értékelésének módszertani alapjai; *Városi Közlekedés, 1996/04. p. 202-209.*

[Tan97a] Katalin Tánczos – Zoltán Békefi: INNOFIN – A new methodology and program package for supporting decisions of financial projects; *7th Mini Euro Conference on Decision Support Systems, Groupware, Multimedia and Electronic Commerce, Bruges, Belgium, March 24-27, 1997.*

[Tan97b] Katalin Tánczos – Zoltán Békefi: The development of the transport infrastructure in the frame of the Hungarian Transport Policy; *Conference on Transportation in the Region of Central Europe, Prague, Oct. 23-24, 1997, p. 141-144.*

[Tan98a] Tánczos Lászlóné – Békefi Zoltán: Támogató eszköz nagyméretű projektek pénzügyi tervezéséhez és lebonyolításához; *Pénzinfo II. Országos Pénzinformatikai Konferencia, 1998 február 10-12, Budapest*

[Tan98b] Dr. Tánczos Lászlóné – Murányi M. – Orosz Cs. – Gedeon A.: A közlekedési nagyberuházások; *Közlekedéstudományi szemle, 1998/09., p. 332-340.*

[Tan99] Dr. Tánczos Lászlóné – Békefi Zoltán – Dr. Magyar István: A Budapesti Intermodális Logsztikai Központ Komplex Program hatékonysági vizsgálatai; *Közlekedéstudományi Szemle, 1999/12. p. 441-450.*

[Tem97] TEM TRAINING on a financial program for comparing proposals submitted to tenders and monitoring economics and cash flow of implementation of major transport investments; *Lecturers: Katalin Tánczos and Zoltán Békefi, Budapest, 14-16 October 1997.*

[Tem98] TEM Training Course on Decision Support Sytems for Infrastructure Project Planning, Lecturers: Katalin Tánczos and Zoltán Békefi, Prague, 9-10 November, 1998

[Tho99] M. Thobani: Private Infrastructure, Public Risk, Finance & Development, *A Quarterly Magazine of the IMF, Volume 36, Number 1. 1999. Electronic document:* http://www.imf.org/external/pubs/ft/fandd/1999/03/thobani.htm

[Tím00] Dr. Tímár András: Útépítés a kelet-európai gazdaságokban; *Közlekedéstudományi Szemle 2000/03. p. 100-108.*

[Tím02] Dr. Tímár: Közlekedési létesítmények gazdaságtana; *BME egyetemi jegyzet, AULA Kiadó, 2002.*

[Tím94a] Dr. Timár András: A városközi közlekedés költségeinek fedezése; *Közlekedéstudományi Szemle, 1994/05. p. 161-172.*

[Tím94b] Dr. Tímár András: Ajánlatok értékelése autópálya koncessziós versenytárgyalások során; *Közlekedésépítés- és mélyépítéstudományi szemle, 1994/05. p. 141-150.*

[Tím99] Dr. Timár András: Hogyan finanszírozhatók az autópálya-építések az Európai unióhoz csatlakozni kívánó öt közép-európai országban? *Közlekedéstudományi Szemle, XLIX. évf., 9. szám, p. 346-357.*

[Tod96] Todd Littman: Transportation Cost Analysis for Sustainability; *Victoria Transport Policy Institute, Victoria, B.C., Canada, 1996. p. 16-39*

[Tod99] Todd Litman: Traffic Calming Benefits, Costs and Equity Impacts; *Victoria Transport Policy Institute, Victoria, BC, Canada, 1999.*

[Un98] The United Nations: Public/Private Partnership (A New Concept for Infrastructure Development); *New York and Geneva, 1998.*

[Wei01] Weisbrod, G. – M. Gvorak: Alternative Methods for Valuing Economic Benefits of Transportation Projects; *Symposium of the Transportation Association of Canada, February 2001.*