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TOPIC 13
PUBLIC SECTOR
PERFORMANCE

AN INTEGRATED ASSESSMENT AND APPRAISAL FOR KEY ACTIONS OF TRANSPORT POLICY

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Abstract

The purpose of the paper is to show that an integrated assessment and appraisal of key actions of transport policy, such as infrastructure investment and of supply-demand management, is possible by merging state of the art assessment and appraisal techniques. It requires sophisticated scenario modelling to generate the appropriate data input for the evaluation process. The evaluation method is subject to the purpose of decision making which can be an integrated systems design, the optimal design of policy action programs, the selection among project alternatives or the priority setting for projects. The examples which are given show that a straightforward sequence of econometric and decision models can be constructed to generate the data necessary for assessment and appraisal.

SYSTEMS APPROACH TO TRANSPORT PLANNING

Transport demand is not developing autonomously but in fact is driven by a number of influencing factors. Some of these factors can be controlled by the public, such as the investment in the transport infrastructure and the supply/demand side management. From the point of view of welfare maximisation these public actions should be designed in a way that the transport system will develop efficiently and sustainable.

The multi-dimensional objective system of the public sector and the complex interrelationships which occur as well within the transport sector as between transport and other economic sectors suggest to design the process of forecasting, assessment and appraisal in form of a systems approach. This means:

- All relevant feedbacks between the transport pattern and its influencing factors should be considered.
- All relevant objectives on the aggregate and regional level should be introduced in the decision making process.
- The induced spatial interactions should be taken into account.
- All relevant reactions of transport demand should be forecasted and assessed.
- Not only single projects but also comprehensive policy action programs—in particular: transport, infrastructure investments and supply-demand management—should be evaluated by an integrated systems appraisal.

The influencing factors of transport demand can be summarised by the following categories:

Socio economic development:
Population and economy are basic determinants of the growth of transport demand.

Development of individual preferences:
Preference of individuals, for goods, services and behavioural patterns lead to structural changes in time, in particular in the context with growing income.

Development of technology:
Car technology, transport infrastructure and organisational skills help to transform preferences into real behaviour.

Development of spatial structure:
Transport is a result from spatial activity patterns and therefore highly dependent on the spatial distribution of industrial and residential locations.

Change of the environmental situation:
The environmental sustainability issues become more and more important and driving force for political planning.

Political regulation:
Taxation and regulation, both are set by the state, usually aim at correcting for market failures such as natural monopoly and external diseconomies in the transport sector.

The driving factors themselves are forecasted by means of the scenario technique. A reference scenario is constructed assuming that business in the future is going as usual. If the decision maker is interested in the outcome of policy actions focusing on sustainability issues this can be modelled by an emission reduction scenario. Figure 1 shows the construction principle for the scenarios: Let the fat dot characterise the present situation. Then a scenario is described by the distances between the present state and the assumed future states of the driving factors (plotted on the rays which start from the origin dot). As the business-as-usual scenario reflects the trend development the distances of the future states on the rays are smaller compared with the reduction scenario.

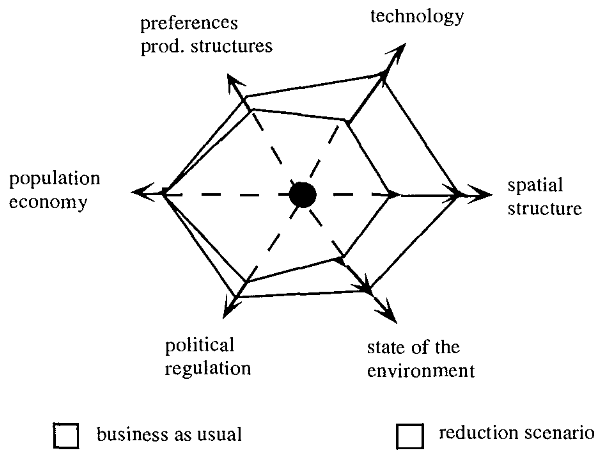

Figure 1 Influencing factors for the transport demand pattern

For the purpose of traffic forecasting it is usually assumed that there are only unilateral relationships directed from the influencing factors to the transport demand pattern. However, when an appraisal of transport policy measures is prepared the reverse relationships are assumed. This means that the impacts stemming from a changed transport pattern are estimated, assessed and appraised with respect to an objective system in which the variables which were treated as independent in forecasting now become dependent, driven by the change of the transport activities. Putting together the steps of forecasting and appraisal into one scheme of systems analysis it is clear that there is a close interdependency between transport and the influencing factors. These interdependencies and multiple feedbacks are not analysed in traditional forecasting and appraisal schemes. The reason is the high complexity of modelling. But modelling techniques have developed such that it is possible to introduce feedback mechanisms step by step into large scale models of the transport sector. In the following sections some ideas and also implementations will be described for an integrated systems analytical approach of transport modelling to improve the base for the integrated evaluation of political action programs.

THE NETWORK FOR MULTI-MODAL FORECASTING FOR INTERURBAN TRAFFIC

In the following a model is described which has been developed in the IWW (Institute of Economic Policy of the University of Karlsruhe) to prepare a systems oriented forecasting and appraisal. The modelling is performed on three levels: the European, the country and the regional level. The spatial modelling on the European scale is based on the so called NUTS 2-regions which form a basic classification of spatial modelling in the European Union (ca 200 regions). The counties are the relevant spatial units on the country level, for instance the German country model of the IWW comprises 360 counties for Germany and 85 regions for the European neighbour countries. On the regional scale a more detailed representation or spatial patterns is necessary. For instance the model for the German state of Baden-Württemberg comprises 135 regions which is about three times the number of counties. It is possible to combine the spatial model on the state's level with urban models which may comprise several 100 urban districts. The combination between urban, regional, country and European regions is defined according to the scope of actions which have to be assessed.

The modelling of the transport infrastructure should correspond to the defined scale. On the European level the road network model comprises the motorways and most of the interstate primaries. Furthermore the excess links to the centres of the NUTS 2 regions are added. On the national scale all primaries and the most important state roads are modelled. The regional network model also includes the states roads and the most important county and urban links. The IWW road network model for Germany comprises altogether about 60,000 links. The railway network is modelled by about 15,000 links while the network for the airlines comprises all together 6,000 links. The parameters describing the characteristics of a link are stored in a data bank, such as the originating and destinating nodes with their geographic co-ordinates, length, curvature, gradient, width, number of lanes, design speed, theoretical and practical capacities, and parameters for the speed-flow relationship. Analogously the characteristics of the railway links are defined using technical parameters (number of tracks, electrification, length of blocks, type of signalling, curvature) and parameters to characterise the average speed on the link for every train category and it's relationship to the load on the link. Additional characteristics for freight trains are added, such as maximum weight, need for additional locomotives at steep gradients, type of processing in marshalling yards.

For the purpose of environmental evaluation space is also modelled in form of a grid network. Such a grid network helps to model wind and climate conditions and local concentrations of air pollution, for example ozone concentrations. This model can be used to provide an interface between transport analysis and meteorologic and climate research in Europe: CORINAIR-data bank. IWW grid network for Germany is composed of squares of 10 km length.

DEMAND SIDE MODELLING FOR INTERURBAN TRAFFIC

The heart of the transport demand modelling consists of the well known four routines for simulating generation/attraction, distribution, modal split and assignment. For the case of Germany the passenger travel demand models can be calibrated by means of two large traffic data banks. First so-called KONTIV-field studies have been carried out in the years 1976, 1982 and 1989. A KONTIV-survey contains more than 100.000 trips and the social demographic characteristics of the travellers. These surveys have been supplemented by special surveys for long distance travel and some additional mobility studies of railway and airline companies in the recent years. The second data source is the so called base matrix which has been constructed from data on ticket sales (rail and air traffic) and traffic counts (car traffic). The first base matrix has been constructed for the year 1985 and a follow-up matrix in 1991.

For freight transport all freight movements of long distance traffic (longer than 50 km transport distance) have been documented until the year 1993. For the following years field study data have been compiled according to a new European statistical sample concept for freight transport. Surprisingly enough the latter data source seems to be more reliable than the former complete documentation, which is mainly due to the deregulation of road freight transport in the past years, ie there are no longer incentives for the firms to cheat the regulators by typing wrong data in the forms.

In the base matrices all traffic categories are corresponding to those used in the standard forecasting procedure of the federal long distance transportation planning. This means that a forecasted OD matrix is consistent with the base matrix of the past in the sense that all categorisations are identical. The matrix is the platform for all single demand models. Flexible demand modelling thus requires the construction of complete matrices to ensure consistency. An important feature of this approach is that the modelling of activities is complete in the sense that every traffic activity which refers to the spatial unit under consideration is explicitly described and can be aggregated as domestic, originating, destinating or transit traffic. Contrasting other approaches (eg corridor type approach) there is no problem with a clear definition of traffic induction (increase of vehicle miles by more or longer trips) and traffic diversion (change of the mode or of the route). In passenger transport traffic is categorised by travel purposes:

- journey to work
- business
- education

- leisure
- shopping
- vacation/holiday

and the travel modes are:

- car
- bus
- rail
- airplane

The IWW-transport model incorporates some special features, which deviate from the standard procedure. Examples are the combined generation/distribution model (Gaudry, Mandel and Rothengatter 1995) and the non linear asymmetric modal split model (Gaudry, Mandel and Rothengatter 1994). These have shown good forecasting qualities for the German case, not only for the comprehensive network wide traffic forecasting but also for the project oriented forecasting. In particular the nonlinearity property brings the model closer to reality because the demand responses with respect to a saved quantity of time depend very much on the prevailing level of service of the mode in question and its competitors.

The conventional four level approach seems to be insufficient to forecast all relevant reactions of demand on flexible demand management policy. Therefore some major changes and extensions have been added:

- Introduction of variables in the demand models which reflect the particular type of demand management action. For instance in the case of road pricing including different price levels over space and time the demand side modelling becomes much more complicated (this has been explored in a study for the Ministry of Transport, see Roland Berger, IWW et al. 1995).
- The choice of destination can be affected heavily by pricing strategies. Conventional gravity or intervening opportunity models are not able to describe regional or corridor effects sufficiently precise. Models which simulate spatial interactions on the base on defined "neighbourhoods" seem to be superior in this case. They help to squeeze out information which is hidden in the residuals of the standard approaches.
- Also the regional warehouse location planning can be influenced by traffic demand management policy. Therefore it is recommendable to add a model for the change of regional warehouse locations and the related logistics. It is obvious that warehousing reacts very sensitive to the ratio of transport and inventory costs.

TRANSPORT POLICY SCENARIOS

The basic issues for transportation planning can be summarised by the sustainability triangle where the edges represent the economic, social and environmental sustainability.

A policy action programme derived from these basic issues usually consists of:

- infrastructure investments,
- regulatory measures,
- pricing policy, and
- organisation and management.

Infrastructure investments, pricing policy and organisation/management are in general the key actions of policy scenarios. Optimally designed policy actions influence the development of traffic demand in a way that it becomes compatible with the sustainability issues.

Besides the construction of policy-action scenarios it is also possible to construct different scenarios for the development of population and economy, of people's preferences or of the future

TOPIC 18
ENVIRONMENT AND
SUSTAINABLE MOBILITY

VALUES OF TRAVEL TIME SAVINGS IN ROAD TRANSPORT PROJECT EVALUATION

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Abstract

Empirical results of many studies of the value of travel time savings (VTTS) are summarized. There is a substantial range in the estimated VTTS. The values of VTTS used for transport project appraisal by different agencies and countries also differ substantially. Important research directions are identified.

furthermore the indirect monetary effects which do not occur to the users of the transport facility. Summarising the direct and indirect effects which can be measured in monetary terms one results in a figure for the net social benefits or the social rate of return.

In the second row section it is indicated that a quantitative evaluation of a subset of effects might be possible, but not in monetary terms. In this category all effects are analysed which can be assessed by using cardinal scales. This holds in particular for some criteria of environmental and regional development policy. Summarising all monetary and cardinal evaluations one results in a cardinal measure of utility (MCAC).

Valuation Method		Economic					Regional/Urban					Environm./Safety					Valuation Criterion
		E1	E2	E3	E4	E5	R1	R2	R3	R4	R5	S1	S2	S3	S4	S5	
Monetary	dir	X	X	X	X	X											PRR
Evaluation $	ind							X			X	X	X	X			CBA
Quantitat. Evaluation *card. ut. index*									X						X		MCAC
Qualitative Evaluation *ord. ut. index*							X			X						X	MCAO

See also: ITS, IWW et al. 1995

Figure 3 Valuation methods and criteria

Finally there might be effects which cannot be measured in terms of money and cardinal utility. Examples are the visual intrusion in urban environments or in landscape, or the disturbance of biodiversity. If such effects play a role for decision making than only nominal or ordinal scales (using the judgements better, equal or worse) can be applied. Also the final aggregation of the single impacts has to be performed in this case using ordinal scales (MCAO). Examples for such ordinal approaches are given in Saaty and Vargas (1985).

It is obvious that in the process of a design of an optimal transport system not many plans will be generated and assessed. Usually the number of system alternatives is not higher than two or three. In this case it is possible to apply multicriteria analysis and to adapt interactive procedures to develop the design of the system in a learning process between the policy maker, participating interest groups and the system's analysts. If project alternatives are to be evaluated (for example different alignments for a railway track) then a subset of the list of decision criteria will apply. This means that the process can be simplified by reducing the number of columns and in many cases also the number of rows by omitting the irrelevant parts. For the purpose of budgeting and priority setting it is possible to concentrate on cardinal figures, in most cases the monetary evaluation will already provide enough information for this decision purpose. This shows that—starting from the general evaluation sheet exhibited in Figure 2—the process of assessment and appraisal can be adjusted flexibly to the needs of the decision makers. This includes the data requirements as well as the sophistication of modelling instruments.

SENSITIVITY AND RISK ANALYSIS

Let us assume that there are two scenarios for investment and supply/demand management, denoted as scenario I and II. A cardinal multi-criteria analysis has been applied yielding the results uI and uII for the utility indices of the alternatives. The objective criteria are as listed above and summarised by aggregate indices E (economy), R (urban and regional aspects), and S (environmental and safety aspects). The associated weights for the aggregate objectives are w_E, w_R and w_S, respectively, and the sum of weights is normalised to 1.

Under these assumptions we can go through a little exercise which we call the indifference analysis. The final step of a cardinal additive utility calculus in MCAC looks as follows:

$u^I = w_E E^I + w_R R^I + w_S S^I$ u: utility; I,II: alternatives

$u^{II} = w_E EI^I + W_R R^{II} + w_S S^{II}$ w: weights; E, R, S: objectives

If $u^I = u^{II} \Longleftrightarrow I \approx II$, that means both alternatives are indifferent. From this we can derive a simple indifference curve:

$w_E = a + b\, w_S$ where the coefficients a and b result after solving the equation for w_E and defining the sum of weights $w_E + w_R + w_S = 1$.

The second part of the sensitivity analysis is the definition of a relevant area for the variation of weights w. Let us assume that there has been a brain storming, a delphi approach or some other type of structured preference revealing process, resulting in a mean value, an upper and a lower value for every weight. Thus we can derive a relevant area for the combinations of weights as shown by the shaded area in Figure 4.

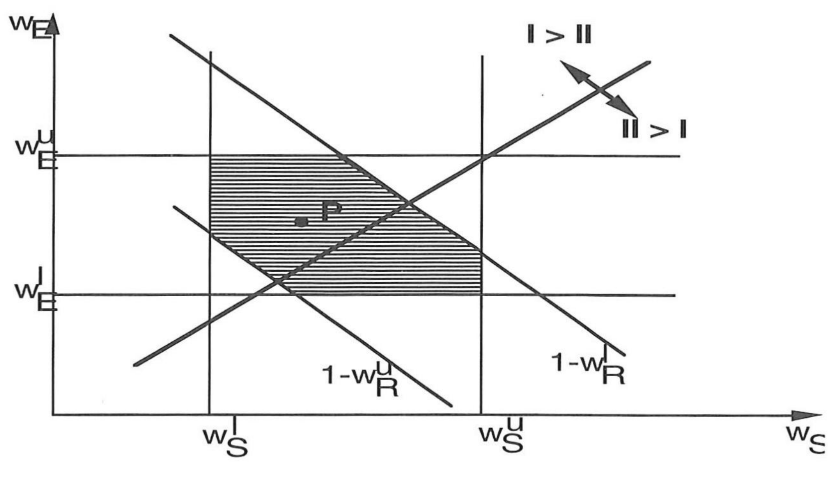

Figure 4 Indifference analysis

I, II: alternative scenarios under consideration

w_i : weight for aggregate objective i (i: *E*conomy, *S*afety, *R*egional Aspects)

w^u, w^l: upper or lower limit for the value of the weight

P: point in the indifference map resulting from average values for the weights.

After these preliminary steps we can draw the indifference curve in the weight diagram and analyse the preference situation (thick line in Figure 4). Suppose the result of MCAC using the mean values for the weights has been the point P which means that alternative I is better than II. Then we can learn from the picture whether or not this evaluation is robust enough. If the indifference curve lies outside the relevant area of weights then the result is robust with respect to variations of weights. If is lies inside the evaluation might change and it can be seen immediately which area of weights will lead to such a change to the evaluation. The options for the further procedure are: (1) stop the process because the decision maker is satisfied with this result; (2) discuss a change of upper and lower bounds for the weights to reduce the set of weight combinations, or (3) discuss a change of the alternatives, ie change the properties of the scenarios and start the evaluation process again.

The last point which has to be addressed in the context of project appraisal is risk analysis. Risk analysis is extremely important if projects are to be financed privately or by a public/private partnership. First of all, risk analysis is not identical to sensitivity analysis such that additional steps have to be added to the procedure. It is expedient to identify the following types of risk (see Flyvbjerg, Bruzelius and Rothengatter 1995):

- costs risks;
- market risks;
- sector policy (including force majeur) risks;
- capital market risks.

Having performed the appraisal calculus on the base of the MLD-principle (*M*ost *L*ikely *D*evelopment contrasting the EGAP-principle which suggests that *E*verything is *G*oing *A*ccording to *P*lan) risk analysis requires to:

- identify the elements of the appraisal associated with the highest impact on the outcome in the case that the MLD-state of the world does not come true;
- calculate the variance of these variables; and
- calculate and plot additional indifference schemes for PRR, CBA or MCA appraisal; in the case of PRR the weights in Figure 4 can be substituted by the rate of discount and the tariffs (or factor prices for construction) to plot the area of robust results.

Risk analysis also includes the problem of risk allocation which usually is to distribute risks among capital owners, construction firms, banks and the tax payer.

CONCLUSION

The purpose of the paper was to show that an integrated assessment and appraisal of transport policy programmes is possible and requires that sophisticated scenarios are constructed to generate appropriate data inputs for the evaluation process. The type of evaluation is subject to the purpose of decision making which can be an integrated systems design, the design of action programmes, the selection among competing project alternatives or the priority setting for projects or political actions. Furthermore the approach also generates the information necessary for performing a financial viability calculus. This is important when private capital is to be involved in financing the facilities. A series of different decision criteria can be constructed in a comprehensive way which guarantees for the internal consistency of the overall assessment and appraisal calculus. Although the resulting impact matrix looks rather complex it has to be noticed that the implementation problems are not so much related to the size of the impact matrix but with the requirements for a reliable forecasting and assessment of all effects. The suggested sequence of methods provides a good opportunity for modelling feedback mechanisms between the transportation patterns and it's influencing factors. This makes the model package a helpful instrument for sensitivity and risk analyses.

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