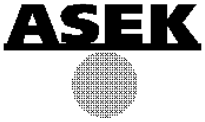
REVIEW OF
COST BENEFIT CALCULATION

Methods and valuations
in the transport sector

Summary in English



SIKA Report 2002:4

Preface

In the official document placing appropriations for 2000, SIKA was instructed to initiate a review of cost benefit methods and important calculation values. SIKA produced a progress report in November 2000 including proposals for further work, which has been substantially implemented. Work has been carried out in collaboration with the transport agencies and the Swedish Environmental Protection Agency. Researchers and other specialists have been invited to contribute to this work by participating in seminars and working groups.

SIKA's Agency Group, including representatives of the Swedish National Rail Administration, the Swedish Civil Aviation Administration, the Swedish Maritime Administration and the National Road Administration among others, have acted as the steering group for this work which has taken place in project form in a number of areas, mainly led by SIKA. A Coordination Group consisting of project managers and an additional representative of the respective transport agency and the Swedish Environmental Protection Agency has moreover worked on co-ordinating the activities and approaches in the various projects.

SIKA's Agency Group has taken a position on the recommendations in the report but not on the text otherwise. The Agency Group supports all the recommendations with one exception – the National Road Administration has made a reservation against the proposal to do cost benefit analyses of large investments with and without charges based on social marginal costs.

This is the third time that an overall review of cost benefit analyses and calculation values has been made for all modes of transport. On previous occasions, this work was referred to as ASEK – an abbreviation (in Swedish) for *Working Group for Cost Benefit Calculations*. We have retained this name for this review even though it has been organised somewhat differently and the working group no longer exists in the same form.

The project managers for the projects in the review have been Per-Ove Hesselborn, Roger Pyddoke, Inge Vierth, Kristian Johansson, Matts Andersson and Joakim Johansson, SIKA, and Susanne Nielsen, National Road Administration, and Magnus Toresson, National Rail Administration. Joakim Johansson, SIKA, has been overall project manager for the work, assisted by Åsa Vagland, SIKA.

Cost benefit calculations, assessments and analyses mean different things

Infrastructural investments and other measures in the transport sector can lead to different kinds of economic effects. Examples of such effects are changed travel times, accident risks, emissions and encroachment on natural and cultural environments. A *cost benefit calculation* is a calculation that includes the effects that could be identified, quantified and valued in monetary terms. Net present value ratio calculation is an example of this type of calculation. The step from cost benefit calculation to *cost benefit assessment* is to include the effects that have been identified as relevant but could not be quantified or valued in monetary terms. The concept *cost benefit analysis* is an overall concept for all analyses of a cost benefit nature which can be made of alternative courses of action.

Calculation values are adjusted upwards to take into consideration price increases and increases in real income

An index adjustment of the calculation values is necessary to prevent their value being reduced in relation to the price level in the economy as a whole. Of the calculation values taken up in this report the following are adjusted in accordance with CPI: time values for private travel, the "private" portion of business travel values, accident values, noise values and values for air pollution. In the case of carbon dioxide, no adjustment has been made pending the ongoing review of the environmental goals. The portion of the business travel values that reflects the company's profit is adjusted in accordance with changed wage costs. Goods time values are adjusted in accordance with increases in the market values for the respective commodity group. The costs of passenger and goods transport are adjusted in accordance with increases in the respective type of cost.

The calculation values are also adjusted upwards in accordance with increased real income (since the individual's willingness to pay depends on income). No difference is made, however, between different income groups or regions. However, values are adjusted upwards in accordance with increases that have already taken place in *average* income – more exactly in accordance with increase in real GDP per capita from the year in which the relevant valuation study was made to the year whose price level the calculation value is to be expressed in. The calculation values that have been adjusted upwards in this report in accordance with this principle are: time values for private travel, the private portion of the time values for business travel, accident values, noise values and values for the health effects of air pollution. Goods time values are based on market prices and are not to be adjusted in this way. The same applies to the business portion of business travel values and the costs for passenger and goods transport. No adjustments are made for carbon dioxide. Note also that *no* upward adjustment of the calculation values has been made with regards to increases in income during the calculation period.

Discount rate, lifetimes and tax factors are not adjusted

In the previous ASEK review, it was recommended that the discount rate should not include any compensation for uncertainties in the calculation and project risks. This recommendation is retained. Neither are there sufficiently strong reasons for changing the level of the discount rate. The recommended discount rate is thus 4 per cent. In addition, it is recommended that a standard corresponding to 7 per cent be applied as a business financing/interest expense, to be used in business profitability calculations (the discount rate of 4 per cent is used as before for commercial items in the cost benefit calculation).

Lifetimes are unchanged with the exception that the National Road Administration never applies lifetimes exceeding 40 years for bypasses and that all other lifetimes are reported in the national plans together with the net present value calculations. If the lifetimes are longer than the calculation period, the residual value can be taken up in the calculation. The tax factors are also retained at the existing levels, i.e. tax factor I is 23 per cent and tax factor II is 30 per cent.

The valuation of time in passenger transport is not adjusted although it is a prioritised task to obtain new values in the near future

There are a number of reasons why time values for passenger transport should be corrected. Existing empirical (data) for both private and business travel indicate, for instance, that a higher value should be given to delay time (or be valued in the event of it not being valued today) and that congestion time should be valued separately to take into account the additional costs that journeys in congested conditions give rise to. For business time values, there are also issues of principle attached to the choice of valuation approach that have to be clarified and which can lead to changed values. However, the basis for producing concrete material for new values has been considered to be too weak.

In the short term, it is recommended that a new review be made to consider adjustment of the parameter values already included in current valuation approaches and to make supplements for congestion and delays. It is intended that more reliable calculation values should be produced *before* the beginning of the next direction planning. In order for better values to be produced in the long term, it is important that new basic research is done in the area. Until new underlying material is available, it is recommended that the previous calculation values are adjusted according to the CPI index and adjusted upwards in accordance with real GDP per capita.

Small adjustments are made in the valuation of time and quality in goods transport -- priority is to be given to produce new values in the near future

In this field discussions have mainly concerned the valuation approach that is to be applied, if, for instance, the capital value method is sufficient to capture all relevant costs or whether there are logistic effects or similar effects which have to be valued separately. Other issues that have been discussed are the present

application of a cost of capital of 20 per cent, valuation of secondary time gains in the handling system, valuation of punctuality, valuation of changed delay risk, valuation of changed damage risk and additional demands for cost of capital relating to, for instance, new goods group categorisation. However, no major changes in costs of capital are recommended.

As regards costs of capital for goods time, only a "technical change" is recommended, which entails an adaptation of present calculation values to the new goods groups and the new base and forecast years. It is moreover recommended that the calculated goods time values be multiplied by tax factor I. Regarding the calculation values for changed delay risk, it is recommended that these be adapted to new commodity groups as well including tax factor I. Previous calculation values for delay time are no longer applied. In addition, it is proposed that the ongoing work of reviewing the calculation values be continued with the aim of producing more calculation values for *delays* (time and/or risk) *before* the start of the next direction planning.

The valuation of traffic safety has not been adjusted – new basic research is needed to produce more reliable values

The material that has been produced in this area in recent years does not provide sufficient support for adjusting accident values. However, current values are generally considered to be very uncertain since the studies the values are based on are still associated with problems at both the principle and practical level. The principal problems are, inter alia, related to the fact that it is very difficult for an individual to understand the meaning of reducing an already very slight risk for something as serious as fatalities, and also knowing how much this changed risk is worth in money. Knowledge is also lacking as to how road users' view of the risks that they expose themselves and others to varies in different situations. Thus, we do not at present have a basis for differentiating accident values in the way that can be needed.

It is therefore recommended that the previous values be retained, apart from an index adjustment according to CPI and an upward adjustment in accordance with increase in real GDP per capita. To be able to produce more reliable values in the future, which better reflect the road users' valuations of accident risks and how these vary in different situations, priority should be given to initiating different types of research and development initiatives in the area.

The valuation of noise is not adjusted – new research is needed to clarify the existing correlations for disturbance

There is a need to develop the existing noise valuations in several respects. Above all, it can be important to evaluate noise in the areas that at present lack valuations, which is the case, for instance, for various work and recreation environments. However, it has not been possible to produce any proposals for new valuations. It is recommended though that the present valuations are applied to evaluate noise disturbance in work and recreation areas in the same way as they are applied to evaluate noise disturbance in residential areas. It is also

recommended that an index adjustment be made in accordance with CPI, and an adjustment in accordance with increases in real GDP per capita.

All valuations applied today are based wholly or partly on the valuation studies made for road traffic in residential environments. The disruption correlations can, however, vary between residential, educational, work and recreation environments, and between modes of transport. Producing better knowledge of how these correlations vary is a prerequisite to be able to produce valuations that better reflect how people experience noise in different situations. Other studies can also be important, for instance, to investigate the health effects that noise disturbances can lead to which the individual is unaware of.

No adjustments are to be made in the valuation of air pollution – however, a new valuation approach is to be applied in the next ASEK-review

With respect to particle and NO_x valuations, no adjustments are made pending clarification of some remaining questions. A study should therefore be initiated to obtain a relevant and accurate valuation of NO_x. Since there is a risk for double counting with regards to the health effects of particles and NO_x, consideration should be given at the same time as to whether an adjustment of the NO_x valuation should lead to an adjustment of the valuation of the effects on health of particles. Until new material is available, it is only recommended that an adjustment be made in accordance with CPI and in accordance with an increase in real GDP per capita.

Regarding future reviews, it is moreover recommended that the valuation approach applied today should be replaced by the so-called ExternE-model. The reason is that the model will be increasingly normative in the international work of estimating marginal costs for the environmental effects of traffic and will also be used in Sweden to an increasing extent. It is also appropriate to use the same valuation for all modes of transport and for different documentation for transport policy decisions. However, it is important that a review is made at quality assurance of ExternE values based on Swedish conditions before applying ExternE-based values.

Carbon dioxide valuation will be reconsidered when the ongoing review of the subsidiary transport policy objective for carbon dioxide has been carried out

The present carbon dioxide value is based on the current carbon dioxide subsidiary objective for the transport sector. The value will therefore be reconsidered only when the current review of this subsidiary objective has been carried out. However, this does not imply that the new value will be based on the new subsidiary objective, or remain unchanged if the review does not lead to any new subsidiary objective.

The starting point proposed by SIKA to apply to establish a new value

is that it should be linked to the *actual Swedish* climate policy ambitions. An alternative is therefore for the valuation to be based on an estimated cost to achieve the currently established climate policy goal. Another alternative is to base the valuation on a *revised* calculation of the costs to achieve the carbon dioxide subsidiary objective for the transport sector, which is accordingly to take place in conjunction with the present review being carried out. If the latter alternative is adopted, the carbon dioxide value can then be changed even if the subsidiary objective is retained. Basing the valuation on Swedish ambitions also means that the establishment of such a value in ASEK should not be an obstacle for Swedish authorities to use values that are more relevant for the context in cases where international consideration *must* be taken.

New costs have been produced for passenger transport

It has not been motivated to carry out a new survey to update costs in bus and coach traffic. These have only been adjusted according to index. With regards to car traffic, certain adjustments have been made. New values have been produced for the new car price, fuel prices have been adjusted upwards taking into account data from Statistics Sweden and the Swedish Petroleum Institute, tyre costs have been adjusted upwards taking into account the total price information from tyre chains in Sweden. A wage cost is also proposed.

With respect to air transport, new costs have been produced for the items Fixed cost distance, Marginal cost time, Marginal cost distance, Marginal cost time and Capacity use. In the case of train transport, it has not been possible to adopt and process the survey on which the new values were to be based, which has meant that only an index adjustment has been made in this area. New values will be produced when the new survey has been adopted. Costs for shipping have not been considered in the review.

Several changes have been made in the costs for goods traffic

The recommendations for new calculation parameters for costs in goods traffic contain a number of changes in comparison with previous values. A new mode of transport has been produced to reflect cars in commercial traffic, and the method of calculation for the transport costs of shipping has been revised. Another new development is that costs for air transport have been produced and some calculation parameters that were previously used but not presented have been highlighted. In addition to this, a new mode of transport has been introduced in Samgods/Samkalk, lorries without a trailer. The number of commodity groups and the number of vehicles with a trailer in Samgods/Samkalk has moreover been increased. The new calculation parameters have also been increased to 2001's price level.

No supplements in the calculations for taking the regional economic effects of infrastructural measures into consideration.

New infrastructure can have important effects on regional development. The larger part of these benefits has been captured, however, by the analytical tools applied in the transport sector. At the same time, it is well known that the existing analytical tools do not capture all the effects on the regional economy. However, the assessment is made that the *additional* effects that arise on top of those that are captured in traditional calculations are small for the great majority of measures. There is still a lack of good tools to quantity the effects.

It is therefore recommended that additional benefits should not normally be added to the calculations. For measures where the additional effects can nevertheless be marked, a description of such expected effects is, however, an important part of the cost-benefit assessment. For measures where distribution policy aspects are significant, it is important to report distribution effects even though they are not to be taken into account in the traditional calculation.

It has not been possible to establish calculation values for the effect of the infrastructure on the natural and cultural environment

There is a lack of material at present to produce preference-based values for encroachment effects of a kind that could be used in cost-benefit analyses. Since encroachment effects are very heterogeneous, almost specific to situations, it is also an open question whether the values based on highly simplified assumptions of the homogeneity of various encroachment effects would really provide significant information in the underlying material for decision-making.

However, there is a point in beginning the development of a structure for sorting estimated encroachment values to capture the ranges of sizes for different kinds of effects. The cost-benefit calculations that the transport agencies carry out could then contain a calculation for the specific project design that it is ultimately decided to recommend. It should be possible to achieve this without considerable additional costs. The element of cost-benefit analysis which does not assume an economic valuation of the encroachment could be developed in this way.

It would also be of value if the transport agencies were able to provide a systematic account of the additional (or reduced) costs to society associated with different project designs with typically different degrees of encroachment. In this way, a knowledge base can be built up which would eventually show how encroachment of different kinds and extent was valued *de facto*. An analysis of material of this kind could also be used to determine the interval for valuation of different kinds of encroachment with the aid of which it should be possible to obtain an at least rough valuation of the residual encroachment.

Development inputs are needed to improve application of cost benefit methods in the area of operation and maintenance

Operation and maintenance activity account for approximately half of the National Rail Administration and the National Road Administration's appropriations. The activity is difficult and complex, as well-developed in technical terms as investment activities but associated with considerable deficiencies with regards to effect correlation and valuations as well as modelling tools to enable different kinds of analyses.

At present, a major deficiency is the absence of documented goal standards based on cost benefit assessments. Such goal standards should be developed. For these to be broadly used, it is also important to use user-friendly tools which in turn makes demands on users' competence.

At the same time as producing good methods and tools, continuity and competence must be increased over a very large and complicated area. In the present situation, the lack of quality-assured effect correlations also represents a big deficit. Investment is therefore required in production, further development and quality assurance of knowledge in many areas. In addition, additional investigations are required to produce calculation values that reflect the traffic users' valuations of improved standards on roads and rail.

Sensitivity analyses as a method for handling uncertainty and risk in strategic planning

An important issue is how the risks associated with investments should be handled in the light of the uncertainty that exists on surrounding world conditions and on the outcome of costs, passenger numbers and goods transport volumes. The recommendation that is made is that these uncertainties should in the first place be dealt with at the strategic level and that this is to be done by sensitivity analyses where net social benefit of packages of measures are examined.

Uncertainty about the outcome of the investment costs is analysed by comparing the net social benefit obtained when using the calculated cost with the net social benefit obtained when using the calculated cost plus a measure of expected (in a statistical meaning) discrepancy based on previous historical discrepancies between calculated and actual cost. In a similar way, the uncertainty of the outcome of passenger numbers and goods transport volumes is analysed by comparing the net social benefits obtained in different main scenarios. More important calculation values such as carbon dioxide value, petrol price, time values and risk values can be made the subject of uncertainty analyses in the strategic planning phase. Certain sensitivity analyses should also be carried out for individual items but to a considerably smaller extent.

There are correlations between measures that are important to take into consideration

Sometimes the net social benefit of a particular measure can be highly dependent on e.g. the other measures that have been carried out at the same time. To clarify the importance of taking these correlations in cost-benefit calculations into consideration, we have analysed three areas in this report where there is a large mutual impact on the effects (or net benefit) of measures. These are road safety measures, roads in big cities and the correlations between investments.

The discussions in the report lead to some concrete recommendations. One is that it should be shown in a strategic analytical phase how net social benefits of investments in new roads, reconstruction of existing roads, and other targeted traffic safety measures are affected by being calculated on the basis of current speeds or with "optimal" speeds, i.e. speeds that minimise the total use of society's economic resources. Another recommendation is that net social benefits should always be calculated for major road projects with and without charges based on social marginal costs (The National Road Administration have made a reservation against the proposal that charges be based on marginal costs – it is more relevant, it is said, to base the calculations on *planned* road charges). A third recommendation is that the correlation between different investments should be analysed for a selection of cases, for both the correlation between different distances on the same route and between different routes.

No standardised benefit amounts should be added to costs as a method for handling utilities and costs that are difficult to value

At present, there is no general recommendation on how utilities and costs that are difficult to value are to be dealt with. The National Rail Administration has in its calculation manual adopted a very restrictive approach, while the National Road Administration proposed an approach in *Effektsamband 2000* which entails that a standardised benefit corresponding to the additional cost plus tax factors can be added to the calculations for measures that are associated with utilities that are hard to value.

In this report, SIKA has argued that such utility standards should *not* be added to the calculations. SIKA:s position is that all utilities that are added to the calculations should in principle be derived from studies that aim at clarifying the utility of the measures in terms of willingness to pay.

It is important to design the investment calculations so that thay can be followed up

A study made by SIKA shows that it is difficult for railway investments to make a correct comparison between the traffic that is included in the net social benefit calculation and the traffic that actually takes place some time after the investment has been completed. An important reason for this is that all investments in a plan are calculated as if they were started on the first day of the plan period. It is

therefore important to change the design of the calculations so that they can be followed up.

SIKA therefore proposes the following procedure: For major projects (larger than SEK 1 billion) that are constructed in stages, an assumption should be made about the order in which the stages will be built. Thereafter an attempt should be made to describe a conceivable course of events for the adaptation of the volume of traffic to the expansion in capacity. Given a description of the development of the transport offered, a simplified forecast of how passenger volumes will develop can be made. This forecast can be made as an interpolation between present travel volume and the travel volume in the forecast year with the aid of elasticity assessments. A calculation should then be made for this realistic development of the traffic volumes.

Clearer demands should be made on documentation of forecasts

A major infrastructure project is valued during its planning, as a part of different packages, typically with a number of different forecasts. It has proven difficult retrospectively to recreate these various forecasts. This is related to the forecast models being successively further developed and the documentation of input data and forecast prerequisites not being sufficiently extensive and systematic. The same problem applies for the calculations carried out at different stages in the process. It would therefore be apposite if SIKA and the traffic agencies together worked out guidelines for how the prerequisites and forecasts as well as calculations and their prerequisites could be documented.

The cost benefit analysis can be modified to comply better with the current decision-making situation

Traditional cost-benefit calculation methods based on valuations derived from the individual preferences of citizens constitute a scientifically well-founded, well-known and tested method for producing a basis for decision-making. When the cost-benefit method is used in the transport sector, a traditional arrangement of the cost-benefit analysis should therefore be applied. In certain well-defined cases, however, it may be necessary to expand or modify the cost-benefit analysis to correspond better to the current decision-making situation.

In a situation where political decisions have been made on the balances to be struck that constitute a starting point for the analysis, it may accordingly be more relevant to design the cost-benefit analyses so that they indicate *which social costs can be associated with achieving particular goals* rather than those that are expected to be effective in a cost-benefit sense. In a planning or decision-making situation based on already given and highly detailed goals, it should be possible to adjust the monetary values on which the cost-benefit calculations are based so that they correspond to the stated goals. A prerequisite is that the politically given restrictions for the cost-benefit analyses are very clearly stated in the planning directive or equivalent.

In a traditional cost-benefit calculation, valuations derived from political decisions can never be regarded as a fully satisfactory replacement for valuations that are derived from citizens' individual preferences. When the prerequisites are lacking to obtain valuations of the latter kind, it should be possible in certain cases to use the values derived from binding political decisions of the latter kind to make the calculations more complete.

THE SWEDISH INSTITUTE FOR TRANSPORT AND COMMUNICATIONS ANALYSIS

The Swedish Institute for Transport and Communications Analysis, SIKA, is an agency that is responsible to the Ministry of Industry, Employment and Communications. SIKA was established in 1995 and has three main areas of responsibility in the transport and communications sector:

- To carry out studies for the Government
- To develop forecasts and planning methods
- To be the responsible authority for official statistics

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