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Summary:

Cost-benefit analysis as an evaluation tool for ITS investments

Introduction

Intelligent transportation systems (ITS) make use of advanced information technology to collect, process and present information on traffic conditions. The aim is usually increased mobility, traffic safety improvements, reduced environmental deterioration or combinations of these. ITS systems of various extents are used in goods transportation and individual and public transportation.

Cost-benefit analysis (CBA) is a tool for economic evaluation and for ranking alternatives. Since the form of CBA applied to infrastructure investments is developed for more traditional road investments, one might question the method's ability to evaluate ITS investments. In this report we try to answer this question and identify areas where ITS evaluation offers different challenges than in economic evaluation of traditional road investments.

ITS is a large field in continuous development. CBA is primarily a tool for systemising the basis for decisions concerning public spending. Hence we have chosen to delimit the project to ITS applications which are likely to be financed by the public sector. We assume that these primarily are applications where information in principle is available to all travellers, as opposed to applications of a more private nature such as in-vehicle safety systems and navigation systems. Our focus is mainly on traffic management systems. Many ITS applications in traffic management are used or are likely to be used in Norway.

Identification of problems

Traffic management can take place through restrictions and through information and recommendations. Regarding the former, we cannot find any reason to deviate from traditional CBA methodology. However, when traffic management is carried out through the provision of information, a few questions arise:

Firstly, there is a need for knowledge about how the travellers will respond to information. ITS is applied in order to influence decisions such as mode choice, route choice, choice of departure time and destination, or the decision to travel at all. How can we make realistic assumptions about travellers' responses when the ITS application is relatively new?

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Secondly, information gives travellers a better basis for decisions. Benefits might be of a different kind than what is the case for traditional road investments. How can we measure and value the benefits?

Simulation of travel behaviour

Often it will be necessary to use a transport model as a foundation for the cost-benefit analysis. Many transportmodelling software packages, among them TRIPS and EMME/2, assume that travellers are fully informed. With some adjustments it is possible to use such models for simulations of the traffic impacts of information. Alternatively, one could use models that are developed for ITS evaluation. For ITS applications that provide real time traffic information, dynamic models are more appropriate than the static models mentioned above. Some of the dynamic models require detailed data and can be quite time consuming for large-scale analyses.

A detailed modelling of traveller behaviour requires knowledge about how the travellers respond to information. Factors that influence the response is, among others, the tendency to react to information, how well the travellers know the area, capacity on alternative routes and the risk of the information being false.

User benefits

CBA calculations of user benefits to individuals captures the benefits that derive from behavioural changes that influence generalised costs (G) and the number of trips. These behavioural changes are just one of several types of consequences that ITS investments might lead to.

Among other possible consequences there are changes in time buffer and changes in departure time. With information about the travel time, travellers can reduce the time buffer imposed by uncertainty. Another possible effect is that travellers start earlier because they receive information about unexpected delays. Generalised costs will not necessarily change as a consequence of information, at least not the way G is usually defined. By including in G the costs of arriving late or early, one will take into account a kind of time costs that some ITS investments are intended to reduce. Instead of including the costs of unpunctual arrival, one could perhaps include a cost related to the variance of generalised cost.

Reduced stress and increased comfort is also one type of consequence of information. Such quality improvements may occur also in cases where there is no change in traveller behaviour, and using standard CBA we will not find any changes in user benefits. Quality improvements may be treated as part of the analysis of qualitative consequences that accompanies CBA in a complete analysis of consequences. However, if there is willingness to pay for information it should be possible to measure this quality improvement in monetary terms, for instance by means of interviews. In cases where other benefits of information is included (e.g., reduction of time costs) there is a risk of double counting.

Usually, we are not able to separate the benefits of information from the benefits that derive from the behavioural changes that follow from information. Instead of focusing on the travel impacts and calculating user benefits on that basis, one could

draw one's attention to the valuation of receiving information. User benefits could then be calculated by means of the travellers' direct valuation of benefits through stated preference surveys. That way, benefits that are not usually calculated in standard CBA would in principle be taken into account. In addition, one would avoid difficult data collection for transport models.

Other parts of CBA

Regarding the other benefits and costs which are calculated in CBA, we do not see any fundamental problems related to *valuation*, i.e. unit costs. However, some calculations depend on the output from a transport model, implying that there might be a problem of *measurement*, as discussed in the section on simulation of travel behaviour above.

It would be reasonable to use a shorter time horizon for analyses of ITS investments than for road investments. 10 years seems to be common in ITS analyses.

A lower discount rate than in CBA of road investments should be considered in CBA of ITS investments, on the grounds that a larger part of the costs of ITS investments are variable costs.

ITS investments are reversible to a greater extent than traditional road investments. Had it been common practice to include in CBA (in general) a cost of lost flexibility of decision, results of CBA of ITS investments would have become relatively better.

Examples

We have selected eight ITS applications and studied how they are evaluated in the literature, which consequences they are likely to have, and if standard CBA would be an appropriate evaluation tool. Of the eight applications, we consider the following to be no more problematic than traditional road investments with respect to CBA: Traffic management systems for tunnels, signal priority, ramp control (ramp metering) and electronic toll collection. Applications that require increased knowledge of travellers' response in order to do simulations are: Traffic management by means of information presented on variable message signs (VMS) etc., incident management, traffic management in case of severe air pollution, and advanced road pricing systems. Using CBA with standard user benefit calculation there is also a risk of not taking into account some of the benefits of the applications information given on VMS, incident management and advanced road pricing.

As an example for more detailed study we chose the traveller information system on the E18 through Vestfold County, run by the National Public Roads Administration. We have discussed different considerations that are relevant if one was to carry out a CBA of the project before it was implemented.

Conclusions and recommendations

In the main, CBA is an appropriate tool for economic evaluation of ITS investments. For many ITS applications the CBA methodology will be equally

suitable as for the evaluation of more traditional road investments. However, there may be greater uncertainty in ITS evaluation because of the new technology and because of the absence of historical data on travellers' response to information. Hence, predicting the impacts on travel will be more difficult. As ITS systems will provide traffic data this problem will be smaller in the future.

Some modifications of the methodology might make CBA a better evaluation tool for ITS. In order to make the calculations of the benefits of information more complete we could include the costs of arriving early or late. Further work is needed on how this time consumption should be measured and valued. Alternatively, we could include the cost of the variance of generalised costs. In that case there is a need to develop a calculation method.

There might exist a willingness to pay for information also when the travellers do not alter their behaviour. Surveys might be conducted to reveal the valuation of information in cases without behavioural changes. If it is impossible to reveal valuation in money terms this type of benefits should be treated in the analysis of the qualitative consequences of the investment.

Surveys of travellers' valuation of receiving information could alternatively replace "ordinary" user benefit calculation as a whole. Difficult data collection and risk of double counting of consequences would then be avoided.

A fundamental question is if the benefits of ITS applications in the main will be captured in standard CBA, or if the types of benefits we have discussed are of such an importance that further development of the methodology is needed. The answer can only be found through increased knowledge about the consequences of ITS. Therefore, it would be worthwhile anyway to try to measure and value the benefits we have mentioned which are not usually calculated. That way one might perhaps be able to make visible some possible weaknesses in the economic evaluation methodology when applied to ITS investments.

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