Institute of Transport Economics
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**Summary:**

# Towards a framework for cost benefit analysis of maintenance strategies

*Increasingly, it is being realised that we need to improve maintenance of our transport infrastructure. But how, and by how much, should the maintenance budgets be increased? This is obviously something that must be established through economic analysis. However, it is not as straightforward as one might think to establish a system for performing cost benefit analysis of enhanced maintenance. It requires some new thinking, new forms of data collection and of database organisation, econometric analysis of unfamiliar relationships and, generally, an effort to improve our knowledge in the field. All of this will need to be addressed in a systematic way in the coming years.*

## The purpose of the study

Commissioned by the Methodology Unit of the organisation in charge of producing the National Transport Plan 2014-2023, TØI has used literature surveys and interviews with key personnel in the transport authorities to assess the practical possibility of doing cost benefit analysis of maintenance and rehabilitation policies and of increasing the maintenance budgets.

## The main elements of the report

In chapter 2 we outline the basic framework for economic appraisal of maintenance strategies and maintenance budget increases. A key concept is that of an infrastructure object (or just an object, for short). Typical objects are stretches of road, stretches of railway line, tunnels, bridges, airports, harbours, parts of the coastal fairway. The objects consist of components, which may be the different layers of a road; rail, sleepers, grade and subgrade, switches, energy supply and information systems on the railway; coating, water pumps, lights, traffic management and information systems in tunnels, etc. At any time, an object is in a particular state, described by a vector of state variables. The level of traffic, the environment and age make the state deteriorate from one period to another, while an inventory of feasible maintenance and rehabilitation measures may regenerate the object wholly or in part. Any state is associated with certain costs to the user (in the form of time loss, accident risks, driving costs, increased risk of disruptions to the service etc.) and to the agency (in the form of necessary unplanned maintenance), any maintenance measure being associated with a cost to the agency and often also to the users.

The objects and the state vector must be defined in such a way that there is a definite functional relationship between the state and the costs, and the measures

must be defined in such a way that there is a definite relationship between the measure and the improvement of the state. Furthermore, objects should be defined such that it has a uniform state throughout and that any measure taken should apply to the object as a whole. Preferably, there should be no economic dependency between adjacent objects, i.e. the cost of any measure taken should not depend of the measures taken on adjacent objects. Preferably also, the budget constraint should apply to a set of similar objects, not to any collection of dissimilar things.

Inspection plays a very different role in economic appraisal and in short term maintenance planning. While in short term planning, it is the key to the selection of the objects or components that need to be maintained, rehabilitated or replaced, the purpose of inspection in an economic appraisal framework is to provide data to assess the functional relationships between state, costs and measures.

All of this makes the requirements of the economic appraisal framework rather different from ordinary maintenance management systems, and requiring us to rethink and redesign our data collection, database construction and analysis tools.

In chapter 3, we survey the organisation of maintenance in the transport agencies, in chapter 4 we discuss the availability of data, and in chapter 5 we assess the need for better knowledge about the necessary relationships, all to be able to point out the steps that need to be taken to establish cost benefit analysis of maintenance.

## Findings and conclusion

We find that current forms of data collection are not sufficient for the purpose of economic appraisal. For the estimation of degradation and the effect of maintenance measures, we will need a database with historical data on each object, i.e. panel data. The data must cover the state of the object in each period, as well as factors thought to influence the state, like maintenance, performed, weather, traffic and the state of deeper layers of the construction. At the moment, such panel data, suitable for estimation of the necessary relationships, are lacking. We need to survey the uses and purpose of the data that are now collected, and to pay sufficient attention to the need for estimation of relationships needed in economic appraisal.

Also, we will need to improve knowledge in the field at many levels. Informal knowledge in the organisation needs to be formalised and passed on to new workers. Engineering knowledge of the relationships in each particular field needs to be developed further, and resources must be made available to the experts in the transport agencies and other relevant organizations, so that they can take part in international research and learn from advanced experience elsewhere. Finally, we need a high level of competence in mathematics and econometrics to be able to use the most advanced planning methods and econometric methods.

As a whole, this amounts to a program that must be integrated with the National Transport Plan and financed through projects in the agencies and a project in the Research Council of Norway. Maintenance must become a more prominent part of transport policy than has been the case up until now. There is a possibility of using economic analysis to choose between measures and to find optimal

strategies, but without a carefully planned strategy for the construction of databases and information systems, and without the necessary resources to build up knowledge in the field, the data we collect will not be put to proper use, and the small experiments in cost benefit analysis of maintenance policies will continue to be just illustrations of possible relationships.