

## Taking the time to understand uncertainty

**A study on how to best allow for travel demand uncertainty in transport investment decisions recommends a flexible and considered approach.**

Uncertainty is a pervasive element of transport decision making. From the uncertainties inherent in traffic modelling to the approaches taken to value options, the sources of uncertainty are many.

The research study stresses the need for a process that acknowledges and addresses these uncertainties, as part of improving investment decisions.

Economist Anthony Byett who led the study says, 'While it is natural to improve the traffic forecasts that inform investment decisions, it is also important to acknowledge fundamental uncertainty exists about the future.'

'Our research report explores the uncertainties within transport modelling and the ways flexibility in the face of uncertainty can add value to a transport project. We recommend a process that explores the nature of the key uncertainties pertaining to a transport investment and actively searches for robust solutions in the face of uncertainties. The process is transparent in setting the trade-offs inherent in alternative solutions in front of decision makers.'

The report sets out a decision-making methodology that could be used within New Zealand transport appraisals. The methodology draws heavily on real options analysis, as a means of providing insights into how decision making occurs under uncertainty. Three case studies in the report illustrate how the methodology works.

The authors note that while the methodology has been formulated with travel demand in mind, it is equally suited for considering uncertainties in relation to other aspects of transport investment.

The report also contains a toolkit for use by transport planners, investors and other decision makers, which outlines the eight-step methodology described in the report and how to use it in practice.

### Shortcomings with the current approach

At present, there is a well-established procedure within New Zealand transport appraisal of presenting alternative fixed investment choices to decision makers. The approach is based on the net present value of expected benefits and costs from an investment to society, and provides a consistent and rigorous means of assessing these benefits and costs when there is certainty about the investment's future outcomes.

However, the approach usually ignores management's ability to adapt to changing circumstances in the future, for example by changing investments over time, by increasing or decreasing their scale, delaying their timing or switching to alternative investments. These are examples of real options, namely the ability to invest (or divest) in real assets over time, but this adaptability is generally not well treated within a standard investment appraisal.

### Sources of uncertainty in transport investment decisions

Uncertainty differs from risk. Under risk conditions, a planner can base projections and scenarios on a well-defined probability distribution, so expected values and variation around those expected values can be defined. By contrast, under uncertainty conditions, the planner cannot rely on a known, well-specified model and probability distribution for determining events that may be material for the planning decision.

Uncertainty may arise from a number of sources.

- Parameter uncertainty exists when a modeller knows the 'true' form of a model that describes potential outcomes for the variable being modelled, but does not know the 'true' parameters.
- Model uncertainty arises when the modeller is unsure of the correct variables (and/or their functional form) to include in the model.
- Fundamental uncertainty arises when unknowable developments may occur for which there is no basis in history or theory to predict their likely impact.

Historical examples of the latter form of uncertainty include the advent of the train, invention of the telegraph and invention of the car. Current examples include the impacts of electric vehicles on issues of climate change and the impact of autonomous vehicles on transport flows.

Future travel demand is a major source of uncertainty within transport appraisals. In general, asset managers make major investments in transport infrastructure in order to lower travel costs for users over the next few decades. However, the actual benefits that are achieved will depend on how travel demand evolves over a long period. Demand can be influenced by external events (such as GDP and population growth) and by changes in other parts of the transport network (such as the development of alternative routes or transport modes).

Instead of committing to a fixed up-front investment, it may be better if managers can adapt their investment over time, as certainty about demand increases. Similarly, it may be best for managers to provide some initial infrastructure, in order to discover whether demand exists and its extent. Both of these scenarios are examples of real options, but there is a possibility these options will be ignored in a standard transport appraisal, either by not being quantified or not being acknowledged at all.

### Formulating a new approach

The research team found there were numerous opportunities for decision makers to adopt a more adaptive approach to project design and decision making, even if this provided some challenges in the valuation stage. Valuation models provide insights into when various options might be valuable – and under what conditions. Ensuring these opportunities are explored, or are not extinguished, was a major part of enabling a more flexible approach.

The report recommends a broader approach to decision making than that currently used. The new approach involves identifying the uncertainty of relevance to the investment decision, as well as ways the investment may be adapted over time and ways this process might be improved by seeking

learning opportunities within the investment. An example of the latter would be where decision makers not only take into account the knowledge available at each stage of the process, but also the potential for new knowledge to evolve over time.

The report authors stress that the study did not find a single definitive answer on how to reduce or deal with uncertainty. Nevertheless, it has demonstrated that:

- a thorough process is required in the face of large uncertainties, rather than the adoption of a single go/no-go benefit-cost ratio
- learning and adaptation can be of significant value, even if this involves a trade-off between interim costs and reduced incidence of poor returns
- the use of one discounted expected value as the basis for a decision criterion does not transparently capture the risk propensity of decision makers.

In practical terms, the recommended approach entails the use of decision trees and scenario planning. It draws on quantitative analysis to provide insights, but not necessarily dictate the answer. It also fits closely with the New Zealand Transport Agency's better business case methodology, and is intended to complement rather than replace the cost-benefit analysis approach.

However, the report cautions that 'by virtue of the presence of uncertainty' the approach is 'inevitably imprecise' and will need to be adapted to the circumstances in which it is used.

'In short, our key recommendation is that decision makers take more time to understand how uncertainty interacts with decisions, and give more prominence to adaptive solutions that provide them with ongoing flexibility in the face of uncertainty,' the report concludes.

