Peer Reviews of Transportation Models
Toward a code of practice
by
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Abstract

This note explores some of the issues surrounding peer reviews of transportation models, including the roles of the model developer, the peer reviewer and the client. It discusses some of the issues that can arise during the process, the types of check that can be applied during the model building, validation and peer review process, and some of the matters that the peer reviewer should be aware of. It concludes with the suggestion that the PEM needs to be updated to better define the validation checks that can be made, and for Land Transport New Zealand in association with IPENZ to develop guidelines for the peer review of transportation models.

1. Introduction

As more and more reliance is being placed on Transportation Planning models for project planning purposes, there is a corresponding need for Peer Reviews to confirm that the models are appropriate for the task on which they are to be used. Indeed, it is now a requirement from Land Transport New Zealand that any model used for backing project funding applications is subjected to a formal peer review.

There is currently little or no guidance provided for peer reviewers in New Zealand, and this note is offered as the beginning of a possible 'Code of Practice' for peer reviewers to follow, and also as a check for model developers during the model build phase. To some extent, model checks are incorporated into the Project Evaluation Manual, but as shown in the paper, there are many more that could usefully be included.

Models by their nature tend to be complex. Over the last few years, the technology has changed significantly. Some of the changes include

- Intersection modelling has been brought into the assignment stage, often at a very detailed level, with delays calculated by individual movement
- Four step models, incorporating mode split and public transport assignments have begun to be used again
- Data is being imported and exported directly to GIS systems
- The outputs are required to be in line with recent legislation
- Hardware speeds mean that the models are able to be much more detailed in terms of zone size and network detail
- Period models are now required for project evaluation

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- Future networks tend to be more congested

As a result, it is easy to make a mistake, and while most should be picked up during internal quality checks, it is always worthwhile for a model to be looked over by a fresh set of eyes.

2 Roles of the various participants

There are generally three participants in a transportation study, with various contractual arrangements between them. Firstly there is the client – generally Transit New Zealand, a local authority, or a consortium. It is rare for the comments in this note to apply to studies for private companies, except in cases where a company is involved in, say, a toll road proposal.

Secondly, there is the model developer, whose responsibility covers development, proving and reporting of the model, given the requirements of the study brief.

Thirdly, there is the peer reviewer, who is required to provide independent advice on the suitability of the model and any limitations that might need to be applied.

The roles of each of these are discussed briefly below.

The Peer Reviewer

The peer reviewer has two distinct, but overlapping roles. Firstly, he must address the questions

- Has the model been competently built?
- Is the model 'fit for purpose' – in other words is it appropriate to analyse the issues being investigated by the study?
- Have the appropriate validation checks been carried out, given the data available from which to build the model?
- If the model is synthetic, are the parameters imported from other models appropriate
- Is the model responding appropriately when used in a predictive mode?
- Does it meet the tests defined in the Project Evaluation Manual

And secondly

- Has the correct data (as opposed to parameters) been used when applying the model?
- Do the outputs pass the 'reasonableness' test

In general, the peer review should be at a relatively 'high' level. The reviewer has to be cognizant at all times that there is no 'right' way to build a model. In fact there are as many different model forms as there are model developers.

Generally, it is not appropriate for the reviewer to suggest an alternative methodology. There are two good reasons for this. The first, as mentioned above, is that there are many different ways of putting a model together, and the reviewer needs to confirm that the method used will produce the required outcome, regardless of whether that is the way that he personally might do it. The second is that the reviewer is providing confidence that the model is appropriate – not taking on the responsibility of the developer. However, there can be exceptions.

In New Zealand, there have generally been three ways that a peer reviewer has been brought into a transportation study.

- Firstly, there is the case where a tenderer when bidding for the project has been required to include the peer reviewer in the bid. Although ostensibly the reviewer is independent, most of the issues get resolved internally and are never made public. The end documentation is generally a short report that the model and process followed is 'fit for purpose'. This process tends to remove the client from involvement in technical decisions, and is probably only appropriate where the client has limited technical expertise.

- The second case is where the peer reviewer is appointed directly by the client, but is brought into the study at an early stage. A long as the model is in the formative stages, then it may be appropriate for the peer reviewer to suggest an alternative methodology that might produce significantly improved and more robust results. The cost and time implications of adopting that suggestion can be discussed and agreed (or not) by the client and model developer.

- The third, and least desirable approach is for the peer reviewer to be appointed directly by the client, but does not have any input until the model is complete. As often happens, the study is running late, and if the reviewer forces his opinion the developer may be tempted to acquiesce in order to get signoff. If this happens, there is a high risk of delays, of a model form that the developer is not comfortable with, and of no one being prepared to take ownership of the final model. This virtually defeats the purpose of the review, and may not end up with a better result. While the process can be managed, it requires a knowledgeable client to virtually act as an arbitrator.

The Client

The client, (or in many cases the Management Group) controlling the study has a very important role in a peer review. The review is being done for the client's benefit – it is to provide confidence that the model is 'fit for purpose'. Often the client will not have sufficient technical knowledge to be able to judge that for himself, and indeed it is better that an independent view is obtained.

The client is responsible for managing the process, and ensuring that the model developer and the peer reviewer are communicating. All requests for information, and responses should go through the client, firstly so that the client is aware of the requests, and secondly to be able to remove, or counter requests that might be unreasonable. In that respect, the client needs to act as a conduit, and in some cases a facilitator between the developer and the peer reviewer.

Although direct contact between the developer and the peer reviewer may, in some instances, be appropriate, it is better that the contact is kept formal, if only to limit the ability for misunderstandings to occur.

Finally, given that most transportation studies result in funding applications to Land Transport New Zealand (LTNZ), the client needs to provide the linkage to LTNZ, either by LTNZ having a representative on the management team, or by taking the responsibility for ensuring the LTNZ are aware of and approve of the peer review prior to the model being used for project analysis.

The Model Developer

Perhaps the most important function of the model developer is the need to provide comprehensive, clear documentation that describes the model. This should be a carefully constructed account of the way in which the model has been put together, and should contain sufficient information for any competent analyst to be able to reconstruct the model without reference to the original developer. Suggested contents of the report are discussed below.

It is the responsibility of the developer to ensure that this documentation is available, and that any deficiencies are remedied in a timely fashion. It is also important for the developer to respond quickly to requests from the reviewer. Finally, the developer should keep an open mind and be able to take on board suggestions that will improve the model.

If it is not clear as to how a piece of the model is working, then it is important that the developer provides an explanation to the reviewer

3. Elements of Peer reviews

Model Building

The primary document that a peer reviewer will look for is the model building report. At least, the report should contain:

- *Model purpose.* The reasons that the model has been constructed, and a summary of its applicability. If developed for a specific project, the project objectives may be usefully included.

- *Model form or model specification.* This is a detailed description of the various components of the model, and the linkages and feedback loops.
- *Calibration or estimation.* This section should describe the way in which the model parameters have been calibrated, or demonstrate providence and relevance if they have been imported from other studies. It needs more than just a statement that ‘the parameters were sourced from the Christchurch model’
- *Validation.* This section needs to show, at each step of the process, how the model, when applied matches the observed data. Ideally, the data used for validation should be independent from that used for calibration. Some of the checks that can be reported (depending on the purpose of the model) are:

    - Trip ends and totals by purpose
    - Trip length (or time) frequency plots
    - Mode split
    - Cordon and screen line comparisons, including stats and scatter plots for road and public transport assignments
    - Elasticity tests if a mode split model has been used – i.e. what is the response to a doubling of fares, or halving headways.
    - Parking occupancies and durations
    - Journey time (speed) comparisons
    - Turning movements and delays at critical intersections
    - Vehicle hours and kilometers of travel
    - Demonstration of convergence of the distribution/mode split/assignment loops
    - Demonstration of assignment convergence if an equilibrium assignment is used.

- *Data files*. It is good practice that the report should include a CD with all of the files used to run the model, including any batch file or other process control files. The values in the electronic files should correspond exactly with those in the report. If possible, software ‘viewers’ to look at the data files (particularly if they are not in ASCII format) and at graphical outputs should also be supplied.

The Project Evaluation Manual (PEM), in the section on Full Procedures (Worksheet A3.11(b) Base year Assignment Validation), covers several of these aspects, but generally only in terms of post assignment checks. In addition, it tends to concentrate on the more strategic end of the modelling spectrum, whilst increasingly these days, models are becoming more oriented toward detailed operation of a transport system. There would be benefit in a review of the PEM to include other measures as indicated above.

Use of the model as a predictive tool

It is one thing to produce a model and show that it replicates existing measurements - that is it performs well as a descriptive model. It is quite another to be able to show that the model functions well as a predictive tool. There are many instances where models have been adjusted so that observed movements are replicated, but in the process, the causal relationships are destroyed. The use of matrix estimation techniques (where the trip matrix is externally modified to better match counts) is a common form of this, and is a process that is often abused. There have even been instances where the trip matrix has been manually altered to get a turning movement 'right' with no thought as to how that adjustment could be replicated in the future.

Some of the matters to be considered when looking at a model as a predictive tool are:

- *Future Landuse*. Is the future distribution of households and jobs realistic? Has car ownership been forecast, and are the results reasonable? In some cases the client may have supplied the landuse, but it should always be looked at in the context of transport needs.
- *Model application*. Has the model been applied using the future landuse? There should be a discussion on the distribution /mode split/ assignment convergence, and a description of the additional capacity needed to obtain convergence
- *External Traffic*. Has the change in traffic external to the study area been correctly treated?
- *Deficiency Analysis*. The converged matrix from the convergence step may be assigned to the 'do nothing' or 'do minimum' in order to highlight deficiencies in the network for links and intersections. This is a useful, but not essential step in the model proving process, but it does give an insight into the way that the model is behaving as a forecasting tool.
- *Reporting*. Trip length (time) frequencies should be reported and compared against the validation year. The growth in traffic should be reported, both in terms of volumes, and vehicle minutes and kilometers of travel. Also, report the change in journey times from those used in validation.

In this stage, there is no 'correct' result – it is largely a matter of whether the results look reasonable, and are in the expected direction.

Things to look for during a review

As noted earlier, models are as varied as the analyst building them, but there are a number of matters of which the reviewer should be aware:

- Is the 'precision level' of the model appropriate to the issues that are to be addressed? A paper prepared for Auckland City Council[2], stated that

  '*The necessary precision of a transport model should be rationally determined by careful consideration of*

[2] '*Transport Model Forms for Central Business District Newmarket Retail Development'* John Foster, Traffic Design Group 1994

- *The decision making process within which the model is embedded*
- *The nature and accuracy of the necessary output information*
- *The criteria on which alternative courses of action are being judged.*

The report defines three precision levels defined by the amount of landuse activity in each study zone, and the conditions under which each level is appropriate.

- Have special generators (ports, airports, Universities, hospitals) been appropriately treated, with care taken not to compromise the predictive ability of the model?
- Has the zone system been prepared in such a way that the landuse in each zone is largely homogeneous?
- Have any factors been used during the model build? If so, has their use been described, and are they appropriate.
- Has matrix estimation been used? If so, how has the predictive ability of the model been retained?
- Has the network been derived from a GIS. If so, has the connectivity been checked? If not, have distances been correctly coded?
- Has the network been correctly coded? (The reviewer should make sample checks.)
- Are the paths taken between key zone pairs reasonable?
- What proportion of trips are intrazonal?
- What is the response of the distribution model to a small change in generalized cost?
- Do the electronic files match the report?
- If a previously built model has been used for a specific project evaluation, has local area validation been carried out?
- If a future fixed matrix is being used, is the demand roughly in equilibrium with the likely future transport supply?

4. Conclusion

Peer reviews of models are an important, and increasing part of modern transportation planning. These notes have identified some of the issues that have arisen in recent studies and could form the basis of a code of practice for the reporting of model development, and for the peer review of them.

It is essential that the peer reviewer is independent from, and removed from the model build, and that the techniques used in the model are not imposed by the reviewer. Having said that, it is often very useful for the reviewer to be involved early on in the process, particularly if the proposed model is complex. Any potential flaws in the process can be identified and corrected early on.

Also, the reviewer needs to resist the temptation to get involved in too much detail. It is generally not useful, and often counter-productive, involving considerable expense for what is often little if any gain.

It is appropriate that Land Transport New Zealand, perhaps in association with IPENZ, review the model building and validation criteria included in the PEM, supported by guidelines to model builders and reviewers of what is considered a ‘good’ model. The quality of the models and confidence in their results can only improve as a result.