WELLINGTON TRANSPORT ANALYTICAL TOOLS 2019-21 UPDATE – TOUR VS TRIP MODEL SURVEY AND DECISION

PREPARED FOR GREATER WELLINGTON REGIONAL COUNCIL

October 2020

Stantec | JACOBS

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Stantec Jacobs | Wellington Transport Analytical Tools 2019-21 Update – Tour vs Trip Model Survey and Decision | October 2020

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Greater Wellington Regional Council

Wellington Transport Analytical Tools 2019-21 Update – Tour vs Trip Model Survey and Decision

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1.   Introduction

This technical note is part of a series documenting the 2019-2021 update of components of the Wellington Regional Transportation Planning Analytical Tools. The higher-level Analytical Tools are maintained and operated by Greater Wellington Regional Council (GWRC), who are the client for this project. This project is being primarily delivered by Stantec and Jacobs, supported by GWRC transport planners.

The project is organised into sequential stages, which encompass:

- Stage 1 – fix specified weaknesses and develop new modules to embed specific additional functionality; and

- Stage 2 – if required, rebuild the primary Analytical Tool which forecasts travel demand throughout the Region. This Tool is referred to in this report as the Demand Model.

Options and functionality were discussed in a scoping workshop ("Workshop") held 10-11 December 2019, which was attended by the client, key stakeholders, and the consultant team. In this workshop, the form of Demand Model to be developed in Stage 2 was discussed.

Options for the model form include:

- Trip-based; or

- Tour-based.

The current Demand Model is a trip-based model, which means each trip is forecast separately. So if you travel from home, drop the kids at school, then continue to work, these are two separate trips and no information on home location, income, demographics, etc is available for the second trip from school to work. Trip-based models are traditional and common place. The weakness of a lack of data on non-home based (NHB) trips (i.e. school to work) is understood and accepted.

An alternative is to develop some form of simplified tour-based model.   Fundamentally, while there are different options for tour-based models, it maintains the linkage between trips.

A third model type, which was not recommended and has been discounted from consideration, is an Activity-Based Model (ABM). ABM's are prevalent in the US but less so in the rest of the world. It was agreed that an ABM was a step too far for New Zealand at this time, given budgets and industry capability. It is noted that modelling tours is integral to an ABM.

Further detail can be found in Technical Note 1 which summarises the Workshop. The information provided here is for context to enable this technical note to be read in isolation.

While all agreed that we did not want to develop an ABM, trip-based versus tour-based models warranted further investigation. It was decided to collate experience of cities that had moved from a trip-based to tour-based model, in particular, the pros and cons.

This technical note reports the results of a short questionnaire sent to cities that had made this move. The cities were identified based on Stantec and Jacobs global connections, and by contacts supplied by INRO. It is noted that many locations using tour-based models, particularly in the US, have moved to ABM's and so identifying appropriate respondents has been challenging. In addition, the technical note summarises the decision made on the model form.

2.   Survey Questions and Respondents

The full questionnaire, including introduction, is included as Appendix A.

The questions asked were:

1.   How would you briefly describe your type of tour-based model (aggregate vs disaggregate, etc)?

2.   What size is the model?

3.   When was it developed?

4.   What main advantages have your organisation (or partners) experienced compared with your previous 4-step model? (Practical examples rather than theory)

5.   Are there any disadvantages your organisation (or partners) have experienced compared with your previous 4-step model? (Practical examples rather than theory)

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6. Has your tour-based model enabled any analysis that could not (or not as well) be carried out with your 4-step model?

7. Did you experience any issues with developing a tour-based model that differ from a 4-step model?

8. If you were rebuilding your model today, what type of model would you select? (4-stage trip-based, tour-based, ABM, etc)

9. Any additional comments?

The following organisation provided a response:

- Oregon Department of Transport (DOT), USA

- SANDAG (San Diego Regional Planning Authority), USA

- Florida Department of Transport – Florida Turnpike Enterprise, USA

- City of Calgary, Canada

- National Transport Authority, Ireland

So three respondents are from America, one from Canada, and one from Ireland.

3.   Summary of Survey Responses

The responses by organisation are summarised in Table 3-1 to Table 3-3 overleaf. To ensure the tables are readable, Information is grouped according to:

- Model type, currency and scale;

- Advantages and disadvantages; and

- Analysis that was possible by moving to a tour-based model (pros), any difficulties in developing the model (cons); and what type of model would you select with hindsight.

Themes running through the responses are distilled below.

Advantages and analyses possible based on moving from a trip-based to tour-based model include:

- Linking all travel to the person/household type enables analysis that could not be undertaken otherwise. This includes impacts of planning and pricing policies on different population segments or geographic areas. The types of analysis referenced included social equity analysis, gender-based analysis, toll road modelling with better value -of-time representation, parking supply and pricing impacts, first and last leg of PT trip evaluation, and visitor/tourist modules;

- Mode and destination choice were more robust as inbound and outbound travel is linked in a tour-based approach;

- Better understanding of NHB trips;

- More informed sub-area analysis, with information about people/households available;

- Ability to move to a dynamic traffic assignment, improving temporal resolution. This is possible with tour-based modelling although it is not essential. The more detail on temporal distribution that is included, the more complex the model will become;

- Calibration was more informed; there were more small levers that could be adjusted compared with a trip-based model.

Common themes of disadvantages of a tour-based model include:

- Generally more complex;

- Additional complexity requires more staff training and industry upskilling;

- Potentially more costly to develop;

- To realise the advantages of the segmentation, more extensive data preparation is required. Datasets can be large and may require wider/different skills to manipulate and interrogate.

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- The increased level of disaggregation requires more data, and this could lead to more assumptions being required for future year inputs. More assumptions noted as making the model easier to criticize.

Of interest in Calgary, the tour-based model was found to be more intuitive for clients whereas in Ireland, the opposite was experienced with results harder to understand/explain and more model runs required per project. This difference is likely associated with the model functionality, and perhaps the market/industry maturity.

Also, while two respondents indicated calibration was more informed and could be finer tuned due to more small levers, Ireland noted the opposite with the increased level of disaggregation exposing more assumptions that could be challenged.

In terms of recommendations, nobody advised on developing a trip-based model. Two indicated a tour-based model was sufficient (as opposed to an ABM), while three recommended a full ABM. Four of our respondents are in North America where ABM's have been developed for several decades, so the market maturity is different. Our Irish respondent also suggested an ABM was preferred, which is somewhat interesting as they noted the more disaggregated the model, the more questions were asked on the assumptions.

Overall, there is more knowledge of the people/households affected by any change in tour-based modelling, which is offset by more complexity and more disaggregated data required.

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Table 3-1:   Model Type, Currency and Scale

	Oregon	San Diego	Florida	Calgary	Ireland	WTSM
Model Type	Disaggregate tour-based	Disaggregate ABM	Disaggregate tour-based (Stage-wide)	Disaggregate tour-based	Aggregate tour-based	Aggregate Trip-based
Coverage	State-wide	City/Region	State-wide	City	National (equivalent to State-wide in USA)	City/Region
Year Built/ Updated	2010	2018	2019	2018	2014	2013
Base Year Population (million)	6	3.2	20	1.4	4.5	0.5
Zones	3,000	5,000	12,000	1,980	18,000	225
Pop/Zone	2,000 (State-wide so less dense)	640	1,667 (State-wide so less dense)	707	250	2,222

Table 3-2:   Advantages versus Disadvantages

	Main Advantages	**Main Disadvantages**
Oregon	• Recommended ABM over trip or tour model • ABM best suited to answer questions on emerging technology (AVs etc) • ABM capable of considering impact of technology, pricing, policy, active modes, and emissions rather than focusing on evaluating road/PT infrastructure • More small levers available to calibrate in ABM/tour model. No need for the hammer required to calibrate trip-based	• Generally more complex which requires more training/support to operate • However complexity was not really related to trip vs tour-based modelling as you could develop a complex trip model or a simple tour model
San Diego	• Social equity analysis possible, which requires demographics linked to travel • Able to evaluate planning & pricing policies for targeted population segment (i.e. high or low income)	• Usually more complex • Requires more technically capable staff • Cost more to develop • Data preparation at finer geographic level/disaggregation required

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	Main Advantages	Main Disadvantages
Florida	• Improved toll road modelling with value of time sensitivities by demographic group • Allowed better temporal resolution (15 mins) in assignment (improved peak spreading modelling and dynamic pricing) by moving to Dynamic Traffic Assignment (DTA) • Enabled inclusion of Visitor tour model, again linking all travel to people involved	• Usually more complex • Requires more technically capable staff • Suggested slower run times, but this will be governed partially by complexity/detail included in either trip or tour model • Data preparation – more detailed inputs required • No commercial software available, although software vendors were making progress
Calgary	• Considered tour model more accurate representation of travel, although their trip model did not consider secondary trips (e.g., dropping kids off on way to work – school run not modelled). • Allowed policy testing linked to population segment (e.g. how a new LRT line would impact different age and income groups) • Enabled gender-based analysis (social equity); first/last mile of transit trip • More intuitive for clients	• Datasets very large, may be too large for Excel. Added complexity in manipulating • Calibration more challenging • Model uses random seed number which means results vary by run. However this was offset by ability to fix seed number, and also that varying results does reflect reality
Ireland	• Inbound and outbound trips linked improving mode and destination choice • Tracking parking supply based on duration, improving mode choice (i.e. car park availability effects choice of car) • Improved parking representation facilitated policy analysis of parking supply changes • More informed calibration (understanding NHB trips)	• Extra complexity has made the model harder to understand and manage. Led to more analysis being required and more scenarios evaluated per project • Greater disaggregation exposes assumptions that can be challenged

Table 3-3: Possible Analysis versus Build Challenges, and Recommendation

	Analysis Only Possible With Tour-Based Model?	Model Build Issues?	What Would You Recommend?
Oregon	• Ability to identify characteristics (person/household information) of people affected by changes	• Yes, project scope too ambitious and development too academic	• ABM and ActivitySim
San Diego	• More nuanced social equity analysis	• N/A	• Streamlined ABM • Said "4-stage being replaced, why continue working with them"
Florida	• Improved representation of value-of-time and ability to model temporal distributions	• Significantly more data preparation required (more disaggregation in data) • Run time issues due to model scale	• Tour based model and not ABM

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	Analysis Only Possible With Tour-Based Model?	Model Build Issues?	What Would You Recommend?
	• More informed sub-area analysis including information on characteristics (person/household information) • Multi-resolution - ability to run the model for certain areas only or different aggregations of time period		
Calgary	• Better understanding of NHB trips	• Calibration challenges but this team had not calibrated a 4-stage model before	• Tour based model and not ABM
Ireland	• More robust parking policy assessment	• Previously time periods were all separate but now interlinked which meant errors in one period impact other time periods	• Favouring ABM based on questions being asked now

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4.   Conclusions Based on Survey

Interpreting the responses, it seems that the type of analysis to be undertaken should predominantly govern the model form.

If the main application of the Demand Model will be infrastructure/service analysis, then a trip-based model may be sufficient.

If we need to understand the impact of pricing and planning policies on different markets, then we should move to a tour-based model. "Different markets" include home location and demographics (income, family status, etc) of people effected. So if we want to understand whether a policy primarily effects retired people, those with school age children, those living in Lower Hutt (as examples), then this can be only be achieved by moving to a tour-based model. A tour-based model would also allow the impact on transport investments and policies to be applied consistently on the whole chain of trips. As an example, the impact of PT improvements that lead to less people driving to the CBD for work would also be then reflected in a reduction in car mode share for intermediate non home-based trips during the day, which a trip-based model would not capture.

Developing a tour-based model will require Household Travel Survey (HTS) data, more so than a trip-based model. At this point in time the HTS is on hold due to travel restrictions imposed by the Government to fight the spread of the global Covid-19 pandemic, and its resulting impact on the economy and activity. Moving to a tour-based model could therefore extend the timeline for the model development.

5.   Decision Making Process

5.1   Recap Survey on Client Experience

A succinct summary of the main advantages of a tour-based model and the challenges is provided below, followed by our interpretation of the key factors determining model form.

Pros of Tour-Based:

- Enables analysis not possible without linked trips. Examples included social equity analysis, toll-roads with more robust willingness-to-pay, parking supply and pricing impacts, and first/last leg of a PT trip;

- More robust mode and destination choice;

- More informed sub-area analysis.

Cons of Tour-Based:

- More complex;

- More disaggregate data required;

- More costly to develop.

Our interpretation of the responses was that the optimal model form depends on the analysis to be undertaken. If the primary application of the model is typical infrastructure analysis (new/changed roads or new/changed public transport services), then a trip-based model will likely be sufficient. If the focus is policy or pricing impacts that vary by market (geographic, household type, income band, etc), then a tour-based model will be required.

This summary was presented at a client workshop. The key points raised and discussed are summarised in the next section.

5.2   Salient Points Discussed

The decision on whether to remain with a more traditional style model or move to a more advanced model, which is newer territory for Australia and New Zealand, is a key decision in this project.

It was noted that this type of Demand Model often has a 10 to 20 year lifespan and hence a long term view was important. Countering this was a desire by the New Zealand Transport Agency to update transport models more frequently, which should be supported by increased funding.

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It was agreed that all models have limitations, and some of the constraints inherent in applying a trip-based model can be balanced by other types of analysis including elasticity approaches, other post-processing tools, and by making simple (but clear) assumptions and adjustments outside the model.

The additional cost as well as the considerably more disaggregate input data was of concern. While the disaggregated input data would be available from Census for the base year, more effort and assumptions would be required to produce future year land use inputs.

A tour-based model will have greater reliance on Household Travel Survey (HTS) data. Covid-19 and the resulting lockdown meant that the 2020 HTS data collection was put on hold. It will likely be some time (perhaps over a year) before the HTS can be resumed if data on "regular" travel patterns is to be collected. Hence if a tour-based model was to be developed, this would likely extend the project timelines and defer the availability of an updated model. In contrast, it will be simpler to develop a trip-based model with limited HTS data supplemented by other travel pattern data. Extended timelines were felt to be unacceptable, particularly relating to the ongoing Let's Get Wellington Moving (LGWM) project needs for robust transport planning tools.

6.   Decision

The decision made was that a Trip-Based Model would be developed on the basis that:

- Extended project timeframes and additional development cost were not acceptable;

- More disaggregated future year input data may be challenging to produce;

- Inherent weaknesses of trip-based models could be addressed outside of the demand model; and

- New zealand is moving towards more frequent model rebuilds, meaning there is less need to futureproof the next generation model for as long as 20 years.

It should be noted that this decision does not preclude the development of a tour based form (or other model form) at a later date.

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Appendix A   Questionnaire Sent

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By email

Hello,

Could we please have a couple of minutes of your time. In Wellington, New Zealand, we are going to recalibrate the strategic transportation model over the next few years. The model will be updated by Stantec and Jacobs on behalf of Greater Wellington Regional Council.

The current model is a traditional aggregate 4-stage trip-based model developed in 2001. We are considering whether we should retain a trip-based model or move to a tour-based model. We have discounted an Activity-Based Model (ABM) – there is no experience in this part of the world and so it is a step too far.

We would like to hear the <u>client experience</u> of moving from trips to tours (not an ABM).

We would really appreciate if you could complete the following questions. If there are specific details that you'd like to discuss, we are more than happy to talk.

Thank you.

Stantec New Zealand Practice Leader – Transport Modelling

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Our Question	Your Response
1. How would you briefly describe your type of tour-based model (aggregate vs disaggregate, etc)?	
2. What size is the model?	No. of zones: Population: Or Households:
3. When was it developed?	
4. What main advantages have your organisation (or partners) experienced compared with your previous 4-step model? (Practical examples rather than theory)	

5. Are there any disadvantages your organisation (or partners) have experienced compared with your previous 4-step model? (Practical examples rather than theory)	
6. Has your tour-based model enabled any analysis that could not (or not as well) be carried out with your 4-step model?	
7. Did you experience any issues with developing a tour-based model that differ from a 4-step model?	
8. If you were rebuilding your model today, what type of model would you select? (4-stage trip-based, tour-based, ABM, etc)	
9. Any additional comments?	

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