TRAFFIC MANAGEMENT WORKSHOP 2004
TECHNICAL CONFERENCE

TECHNICAL NOTE

"SEARCHING FOR TRIP TIME RELIABILITY BENEFITS"

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Abstract

Trip time reliability describes how much the travel time for a particular trip may vary from day to day. This variability is due in most part to the levels of congestion on the route, with high levels of congestion generally making trip times more variable. As reliability of travel time is important to drivers and especially commercial operators, benefits from improving trip reliability were introduced into project evaluation in 2003. However, the "Trip Reliability Procedure" in the Transfund Project Evaluation Manual (PEM) is not widely used. The objective of this Technical Note is to improve understanding of trip reliability and where the benefits of improved trip reliability are hiding.

Rationale for Trip Reliability

It is more efficient for people to travel if they can estimate accurately the amount of time it will take to make their journey. If the travel time becomes less reliable (i.e. it can take anywhere from 20 to 30 minutes to make the trip) then people will start to make decisions to reduce the risks of being late. This will include:

- starting the trip earlier than they may need to
- putting more delivery trucks on the road to ensure deliveries make it on time
- putting float in the timetable

It is possible to measure the economic benefits of improving the reliability of travel times, in the same way that it is possible to estimate the benefits of reducing travel time. Surveys of Auckland drivers have found that drivers regard reducing the variability of travel time of similar importance as reducing the average travel time.

What is Trip Reliability

Trip Reliability reflects a statistical analysis of the travel times. In mathematical terms it is **the standard deviation of journey times for the same trip started at the same time on different days**.

Figure 1 shows how for a 20 minute trip, if there is a standard deviation of travel time of 5 minutes that it becomes difficult to estimate the time that the trip will take and drivers will tend to allow "spare" time in their schedule.

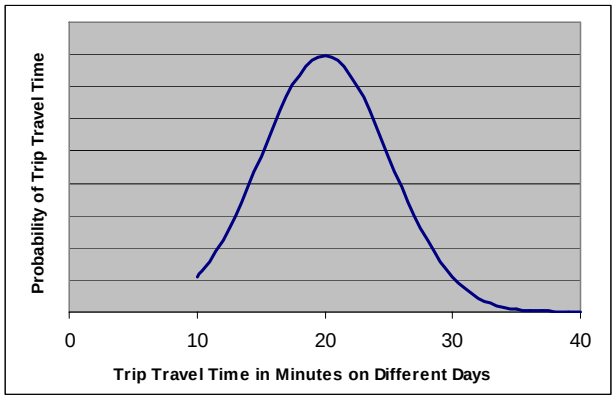

Figure 1: Probability Distribution of trip time with mean of 20 minutes and standard deviation of 5 minutes.

For the Transfund PEM procedures, trip reliability excludes:

- any variability of travel times that will be due to major incidents such as a crash or a breakdown in a lane;

…and includes:

- variability due to travel on links; and
- variability due to delays at intersections.

What changes trip reliability: **Congestion!**

One indicator of how congested a road is the v/c ratio. This refers to the ratio of volume to capacity. So where the ratio is equal to 1, then the traffic wanting to travel on the road is equal to capacity. Where the ratio exceeds 1, then more traffic will want to use the road than there is capacity and queues and delays will result (see Figure 2):

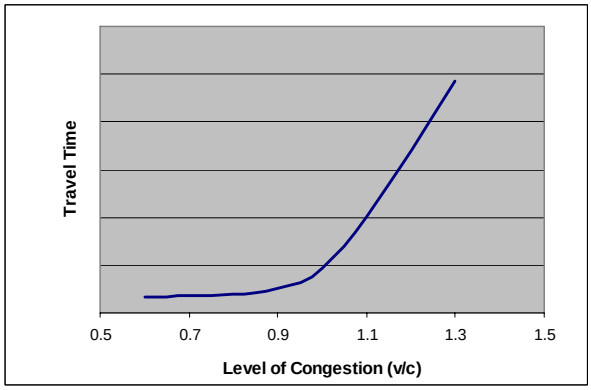

Figure 2: How travel time increases with increasing congestion.

Research I conducted for Transfund in 2002 created a relationship between v/c for a link or intersection and the variability of travel times. The shape of the relationship is shown in Figure 3. The key point is variability is insignificant below v/c of 0.9 and increases sharply as congestion increases until a v/c of around 1.3 where variability stops increasing.

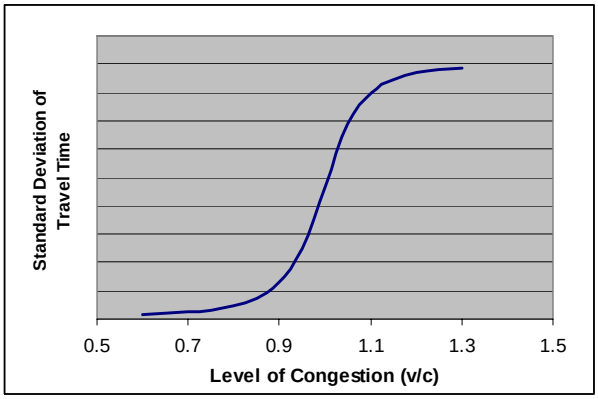

Figure 3: How travel time variability increases with increasing congestion.

The benefits from reducing trip time variability come from reducing congestion at points along the journey. Reducing congestion will also have the associated benefit of reducing travel time.

Typical Trip Time Reliability

For a 30-minute commute in Auckland we measured the standard deviation of travel time as around 6 minutes. For off-peak travel, in an uncongested network, the standard deviation of travel time would be around 1 minute.

Going Fishing for Trip Reliability: Where to drop your line?

All-day congested corridors

Where there is all day congestion, it is likely that there is very low trip reliability as the v/c ratio will hover above 0.9 for extended periods of the day. While travel time benefits typically may not change much dropping a v/c from 1.1 to 1.0, trip reliability benefits may be large.

Spare Capacity in Intersections

Intersections are a prime cause of poor trip reliability as while links are often at v/c of around 0.8 they are seldom at 1.0. Intersections are often at 1.0, and by providing spare capacity and dropping below 0.95 will give increasing trip reliability benefits even if travel time benefits slow.

One-way systems / co-ordinated signals

By introducing one-way systems or co-ordination on major routes and reducing the v/c ratio below 0.9 for major flows will give compounding trip reliability benefits – the higher the percentage of journeys that will have reduced travel time variability and the higher the trip reliability benefits.

There is an issue with trip reliability for SCATS adaptive coordination vs. fixed time signals. SCATS may improve travel times but may reduce trip reliability due to optimisation in congested conditions. Fixed time signals systems in some major United States cities may provide better trip reliability, albeit inefficiently?

Town Bypasses

Town bypasses will have high trip reliability benefits if they remove intersections / pedestrian crossings where the main road is controlled and experiences v/c of over 0.9. In this case, the evaluator needs to examine trip reliability benefits of peak traffic (weekends, holiday periods etc.).

Things you may not expect about Trip Reliability

- Worsening travel times may not mean worsening trip reliability.
- Trip time reliability is unrelated to journey length.
- Rural highways have relatively good trip time reliability.
- The best trip time reliability benefits come in the inter-peak (or any times where an improvement will drop v/c below 0.9). If the peak periods are heavily congested, then reducing v/c from 1.5 to 1.2 will have no effect. For the same location, reducing the v/c from 1.1 to 0.9 during the inter-peak will have an enormous effect on trip time reliability.
- For a significant improvement in travel time reliability on a journey, will need to reduce v/c to below 0.9 along almost the entire portion of the route. If only part of the route is improved, the chance of travelling faster on one stretch will likely be matched by the probability of travelling slower on another.

Traps to avoid with Trip Reliability:

- **Micro-simulation models cannot be used to calculate trip reliability.**
    - This is the most common mistake for evaluations being done using the PEM!
    - Micro-simulation models calculate the standard deviation of travel time between vehicles travelling in the same stream over the period. This is quite different to the standard deviations of travel time between different days.
    - Where an evaluation is based around a micro-simulation model, evaluators must calculate the v/c manually.

- **Not estimating trip reliability benefits for the inter-peak hours.**
    - Often in project evaluation we look at the two peak periods and an inter-peak hour.
    - This is likely to not be where the majority of trip reliability benefits will occur.

Author's Proposal:
Trip Reliability as the "Lost Ark" of Congested Networks

- Trip reliability is definitely relevant to congested urban areas with high levels of congestion all day – it is something that has been raised in surveys of Auckland road users as a major concern.
- The solution to congested urban networks may lie in **examining network developments that tackle trip reliability rather than network travel times**.
- The best way to improve trip reliability is to reduce v/c at intersections **along key journey routes.**
- These network developments are less likely to involve increasing capacity in peak times (as would be targeted by those focused on travel times), but rather the way the network is optimised (**one-way systems and signal coordination based on trip reliability** may be key solutions being overlooked).