A Travel in time: How Technology Has Changed the Way We Collect Transport Data in Auckland

Author/Presenter: Weiwei Jiang, B.S, M.S. (Transportation)

Transport Modeller, Joint Modelling Application Centre (JMAC), Auckland Transport

Email: weiwei.jiang@aucklandtransport.govt.nz

ABSTRACT

Data is everywhere, it is important, and it is getting big. Understanding the methods behind collecting essential transport data such as traffic count, travel time and travel pattern is valuable. It helps decision makers to understand the accuracy and reliability of the data, which can improve infrastructure investment decisions.

This paper presents an overview of different ways that are used to collect traffic count, travel time and travel pattern information. It will take the reader for a travel in time, to see how data collection technologies have evolved. The following questions are also considered: Will new technology replace the traditional way to collect data? Is there a clear winner when choosing the best way to collect data?

WHY DO WE NEED TO UNDERSTAND DATA COLLECTION?

Transport professionals rely on data to make evidence based decisions. Technology is changing the way data is collected, stored and processed. The purpose of this paper is to present a summary of current data collection techniques and how these are changing over time. It will help transport engineers, planners and modellers choosing the most suitable data collection technique.

Previous papers have compared different data collection methods based on the advantages and disadvantages. This paper compares them in more detail, based on velocity (speed of data processing),veracity(the accuracy of the data), and cost. The accuracy of the data could depend on the sample size and geographic coverage of the data, which is discussed within the Auckland context. The relative cost associated with each method, from a local government point of view is also discussed.

Different business function have different data requirements. Vallyon, Young, & Ross, 2014 summarise data requirements to assist different business functions, as shown in Table 1.

Bussiness Function	**Velocity Requirement**	**Spatial coverage Requirement**	**Veracity Requirement**
Real time operations	Importance: Very High. Data needs to be accessible in real time – preferably with alerts	Importance: High Needs to be accurate in identifying specific location to assist intervention	Importance: Moderate Don't need to quantify delay as accurately as other purposes
Operations and Network Monitoring	Ideally – continuous (but doesn't have to be real time)	Importance: High As above, or where interventions planned on major corridors	Importance: High Travel times useful for assessing impact of operational decisions
Capital investment	Importance: Moderate Annual Trend Data - Avoid bias due to seasonal variance	Importance: Very High Areas affected by major capital investment	Importance: Very High Need to accurately assess impacts, to assess benefits of investment
Strategic Planning and Modelling	Importance: Moderate Annual Trend Data - Avoid bias due to seasonal variance	Importance: Very High Particularly important where capital investment planned / completed	Importance: High Need useful KPI and a consistent approach year to year

Table 1 Data Requirements for Different Business Functions. (Vallyon, Young, & Ross, 2014)

Transportation models are often used to support transport infrastructure investment decisions. To build and validate models requires information on traffic counts, travel times and travel patterns and behaviour. The data needs to have good spatial coverage and accuracy, but less temporal information. This article will also discuss the application of the data, from the perspective of strategic planning and demand modelling by Joint Modelling Application Centre (JMAC), which co-ordinate Auckland-based transport modelling for Auckland Transport, Auckland Council and NZ transport Agency.

HOW DO WE COLLECT TRAFFIC COUNT DATA?

Traffic count information is essential for various business units such as capital investment, operations and planning. Traditionally, traffic count data is collected from manual counts, inductive loops, pneumatic tubes, and SCATS. More recent technologies include CCTV cameras and radar. Table 2 compares the different traffic count data collection methods, in terms of their suitability, geographic coverage in Auckland, veracity, velocity, and associated cost.

Evolution in Time	Method	Suitability	AKL Coverage	Veracity	Velocity(speed of data processing)	Cost
Traditional	Manual counts	Need accurate classification or turning movement	Specific sites	Very accurate, easily measured.	Infrequent	High labour cost
	Temporary Inductive Loop	Locations where tube count cannot be used		Accurate count on high volume road, lane by lane, speed, and vehicle classification	Temporary monitoring	Less expensive than Permanent Loops
	Permanent Inductive Loop	Selected sites which contributes to achieving network coverage	More than 100 count sites on arterial roads, more than 300 sites on motorway		24/7 monitoring or when needed.	More expensive than Temp Loops
	Pneumatic Tube	Lighter traffic volume,up to 4 lanes	Close to 2000 count sites per annum	Accurate count on volume, classification, speed. Requires free-flow traffic	Temporary	Cost effective, easy to install, compare to Inductive Loop
New	SCATS Intersection	Signalised intersections	Good urban area coverage	Reduced volume accuracy (especially during congestion), no classification	24/7 monitoring	AT own data
	CCTV	Useable where loops and tubes are not, installation and location important	Around 200 on motorway mainlines	No speed, classification unless process the video. Accuracy not great in conditions of poor visibility	Temporary/Permanent	Expensive licence purchase to process data
	Radar		Limited spatial coverage	Speed and occupancy, 97% accuracy is still under testing.	Temporary	Relatively inexpensive

Table 2 Comparison of Traffic Count Data Collection Methods

Traditional methods such as inductive loop and pneumatic tube technologies still remain dominant for collecting traffic count data, because they are relatively simple to use, accurate and cost effective. Technology is improving the way traffic counts information is stored and displayed, which is demonstrated in other presentations at this conference.

SCATS counts are widely used at signalised intersections or roads which do not have loops/tubes installed, due to its extensive geographic coverage, easy access and low cost. However the accuracy and reliability of SCATS still needs further investigation. JMAC is conducting research on the accuracy of SCATS counts and comparing it with manual count data. The initial result indicates that SCATS data is generally suitable to be used for intersection assessment, and on average is approximately 3% lower than manual count.

CCTV and Radar are some of the emerging technologies. They are useful where loops and tubes

are not, but they are more expensive and the accuracy is still being tested. When object recognition technology becomes more accurate and cost effectvie, they could be used more widely in the future.

HOW DO WE COLLECT TRAVEL TIME DATA?

Travel time information is essential for monitoring network performance, evaluating project benefits, and validate transport model. Floating vehicle surveys have traditionally been the only way to measure travel time variability. In recent years, technologies have developed rapidly. New technology can be divided into two main categories: tracking or matching. Tracking technology means constantly tracking the vehicle or devices in the vehicles, such as GPS. Matching technology means matching unique identifications at predefined locations, such as ANPR (Automatic Number Plate Recognition), Bluetooth and Wifi. The match rate of devices determines the accuracy of the data. Table 3 compares travel time data collection methods, in terms of sample size, Auckland geographic coverage, veracity, velocity and associated relative cost.

<table>
<tr><th>Evolution in Time</th><th>Method</th><th>Sample Size</th><th>AKL Coverage</th><th>Veracity</th><th>Velocity</th><th>Cost</th></tr>
<tr><td>Traditional</td><td>Floating Vehicle survey</td><td>Small sample size, a few an hour</td><td>Selected routes</td><td>Very accurate, readily measured. No peak spread</td><td>Infrequent</td><td>High labour cost</td></tr>
<tr><td rowspan="5">New</td><td rowspan="2">GPS</td><td>In vehicle navigation system depends on company's market share</td><td>good coverage, poor signal in CBD</td><td rowspan="2">Track individual vehicle route. Aggregate to segment level to maintain privacy</td><td rowspan="2">Continuous monitoring, not real time for road controlling authorities</td><td rowspan="2">Procurement from third parties</td></tr>
<tr><td>Fleet managed systems only have commercial vehicle tracking</td><td>could be biased toward the function/usage of road</td></tr>
<tr><td>ANPR</td><td>High match rate up to 90%</td><td>Selected locations</td><td>More accurate than Bluetooth</td><td>Temporary in New Zealand</td><td>Harder to install, processing is expensive</td></tr>
<tr><td>Bluetooth</td><td colspan="2">Up to 15% sample rate</td><td>Better at matching consistent speed over 40km/h</td><td rowspan="2">Real time ,continuous monitoring</td><td rowspan="2">Capital investment in infrastructure or procurement from third party</td></tr>
<tr><td>Wifi</td><td colspan="2">More variable match rate</td><td>Better at matching slow moving devices</td></tr>
</table>

Table 3 Travel Time Data Collection Methods Comparison

While traditional methods still remain popular in collecting traffic count information, technology has greatly changed the way travel time data is collected.

By tracking individual vehicle travel route, GPS technology can eliminate outliers which do not travel straight from A to B, therefore providing more accurate travel time information. Bluetooth and Wifi are widely used to collect travel time information, especially in the CBD where the GPS signal is poor. Bluetooth and Wifi do not track travel routes, but the sample rate is higher. ANPR is better in almost every aspect to Bluetooth, but is more expensive. Therefore New Zealand hasn't established permanent ANPR matching yet.

When comparing different travel time collection methods, each technology has its comparative advantages. It is up to the business units to choose the most suitable method that fits their

requirement. Case studies of how the Operation and Network Performance team as AT uses these technologies are presented in this conference.

HOW DO WE COLLECT TRAVEL PATTERNS DATA?

It is very important for transportation planners and modellers to determine travel patterns and travel behaviours.

Traditionally, the Household Travel Survey has been used to understand travel behaviour, and the On Board survey is used to understand public-transport (PT) travel patterns. Household Travel Surveys still provide the most comprehensive and detailed travel information. The survey asks people when they leave and to where, and the purpose of their trips. It is a valuable tool in understanding people's travel behaviour, but the sample size is very small, the cost of labour is high, and they are typically conducted every 10 years. The Ministry of Transport is implementing GPS technology on the new national Household Travel Survey, which will provide more accurate trip information and more cost-effective.

One of the benefits of GPS technology, derived from actual use of the network, is that it is possible to identify aggregate driver behaviour such as preferred route choice. However the sample rate for GPS could be biased towards the function of the road, rather than net traffic volume, because it is largely used by fleet management companies in New Zealand (Vallyon, Young, & Ross, 2014).

AT HOP cards are a reusable prepay smart card that is used for travel on trains, ferries, and buses around Auckland. Around 60% of PT trips are made using HOP cards, which could present accurate PT user movement for any time period. Although it does not contain start or end of a trip data, it gives accurate stop to stop, along the route PT travel patterns. JMAC is currently analysising HOP card data, which will improve the public transport model, and it is useful for PT operation planning and performance monitoring.

With personal devices like smart phones, the use of location information to understand people travel patterns has developed rapidly. It is particularly useful to estimate the volume of a travel movement, when the cell phone company has a good market share in that area. Transport for Greater Manchester is using smart phone data to derive origin to destinition travel patterns, and build transport matrices. Auckland Airport also uses it to analysis work trip patterns to the airport and Auckland Transport uses it to measure the cross boundary travel patterns.

A comparison of the different methods used to collect travel pattern data is presented in Table 4.

Evolution in Time	Method	Sample Size	AKL Coverage	Veracity	Velocity	Cost
Traditional	Household Travel Survey	Very small, a few hundreds households in Auckland	Random sample	Very accurate, high quality. Detail trip purpose time of the day, mode	Every 10 years	Time and labour intensive
	On Board Survey	Very small, a few samples on public transport	Selected PT routes			
New	ANPR	High match rate up to 90%	Selected locations	More accurate than Bluetooth	Temporary in New Zealand	Harder to install, processing is expensive
	GPS	In vehicle navigation system depend on company's market share	Good coverage, poor signal in CBD	Good track along the vehicle route, no trip purpose, no people movement	Continuous monitoring	Moderate. Procureaggregate data from third parties
		Fleet manage system only have commercial vehicle tracking	Good coverage. Could be bias toward the function of road			
	Personal Device	Cell phone users, depends on company's market share	Very good coverage	Good track on people movement, no trip purpose		
	AT HOP	About 60% of public transport user in 2014/15	Very good on Public Transport Mode	Very accurate PT stop to stop movement, no trip purpose		AT owned

Table 4 Different ways to determine Travel Patterns

Smart phone data is powerful, but it still has some issues. It is unclear how reliable and accurate the data is. Therefore, data processing often takes longer than anticipated (Morris, 2015). In addition, the data provides little information about travel mode, and it does not contain travel purpose information. Therefore, the data needs to be filtered, based on a carefully defined trip purpose. For example, Auckland Airport defines a work trip as “people who have been at the airport for at least 1 hour per day for 4 out of the previous 7 days” (QRIOUS, 2015).

When comparing different methods of collecting travel behaviour and pattern, there is no clear winner. Surveys give accurate and detailed trip information for a very small sample, while advanced technology such as smart phone data can provide massive volumes without much detail of a trip. A good approach that takes advantages from both sides could be merging different data sources. Trip purpose and mode share information from survey results, can be infered to the huge volume of smart phone data. Therefore, it is cost effective, and has a good amount of data with detailed trip information.

CONCLUSIONS

Transport professions rely on data to make evidence based decisions. It is valuable to know how the key transport data is collected in order to improve decision making.

Traditional methods such as inductive loop and pneumatic tube technologies still remain dominate for collecting traffic count data. SCATS counts are widely used at signalised intersections. When technology reduces in cost and increase in accuracy, CCTV and Radar could be the future for collecting traffic count data.

Technology has changed the way travel time data is collected. While GPS can track vehicle routes more accurately, Bluetooth has a higher matching rate. ANPR is better in almost every aspect, except for its cost.

When understanding the travel patterns, traditional survey methods and new big data technology both have advantages. Household Surveys give accurate and detailed trip information for a very small sample. Big data such as AT HOP and smart phone can be used to analysis travel patterns. These big data are able to provide a much bigger sample than traditional surveys, but with less trip detail.

Every technology has its own advantages, by infering detailed trip information to big data, the advantages of both techniques can be combined. Future studies need to be focus on how to merge multiple data collection techniques, in order to achieve the most comprehensive result, in the most cost effective way.

ACKOWLEDGEMENT

The author started the project with little knowledge in this field, only the curiosity to learn more about different data collection methods. The author used qualitative methods to research a quantitative matter, by interviewing experts in the field.

Michael Penny and Andy Hooper from Auckland Motorways, and Wilma Joubert from Auckland Transport have given many valuable input and feedback to the traffic count section. Miguel Menezes and Bill Qu from Operations Planning& Performance Team, Auckland Transport, helped build the travel time section. Chris Vallyon from BECA, his previous IPENZ articles are the foundation of this article, and his generosity and expertise improved the travel time and travel pattern section. Lastly I would like to thank JMAC manager John Davies and the team members, who provided enormous support and help, and have shared many projects experiences which are used in this article. This article is a collected effort from individuals who have devoted their expertise knowledge and valuable time.

REFERENCES

Flatters, M. M. (2015). Unlocking Data to Achieve Smarter Outcomes. *IPENZ Transportation Group Conference 2015.* Christchurch.

Morris, T. (2015). *GM Mobile Phone OD Data Project.* Greater Manchester.

QRIOUS. (2015). *Auckland Airport-Traffic Analysis-Workers. February 01-May 31.* Auckland.

Schintler, L., & Zhu, S. (n.d.). *Big data for Transportation*. Retrieved from IRF Webinar: www.IRFnews.org

Vallyon, C., Young, R., & Ross, T. (2014). Solving Big Challenges with Big Data. *IPENZ Transportation Group Conference*.

Yip, P. (2014). Big Data: Transform Industries, Institutions, and Societies with Watson. Vancouver.

Young, R., & Vallyon, C. (2013). Money Well Spent? The Challenge of Finding Primary Data to Demonstrate Sound Infrasturucutre Investment. *IPENZ Transportation Group Conference*.