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Powered-two-wheeler usage patterns on Melbourne tollways

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Abstract

Australia's cities are facing increasing concerns over traffic congestion and pollution which has encouraged an interest in sustainable transport choices. Most of the focus of this concern has been on cars, public transport and active transport; in contrast, the role of powered two-wheelers (PTW), specifically motorcycles and motor scooters) has received relatively little attention. The majority of research on PTWs focuses on the road safety implications, with relatively little known about patterns of usage.

This paper presents the results of an analysis of traffic counts at two major tolled freeways in Melbourne: one radial freeway close to the city centre and one orbital freeway 20 to 30km southeast of the city centre. Automatic vehicle classification equipment recorded hourly traffic counts and PTW counts from 2006 to 2012. The paper presents an analysis of the classified count data to explore the pattern of PTW use by time of day, day of week and across the seasons. Comparisons are drawn between PTW and non-PTW traffic and between the radial and orbital freeways. The paper concludes with a discussion of the findings and suggestions for future research.

1. Introduction

The rapid growth in motor vehicle ownership and use in urban areas has seen increasing concerns over congestion, safety, availability of energy sources and environmental issues such as pollution and climate change. The transport profession has responded through the development of a range of supply and demand measures to enhance the sustainability of the transport system. Most of the attention in the context of sustainable mobility is however focussed on the motor car (Sperling and Gordon, 2010) with relatively little attention given to motor cycles and motor scooters. Increasingly the term Powered-Two-Wheel (PTW) vehicle is being used cover a range of two or three wheel vehicles from mopeds (low power motor cycles typically with engines less than 50cc and usually with a maximum speed of 50 kph) to motor scooters and motorcycles (Victorian Government, 2009). The opportunities which P2W vehicles present from the perspective of sustainable transport have not been investigated in detail (Rose, 2009).

Research on PTW vehicles often has a road safety focus because these vehicles are over represented in crash statistics both in Australia and overseas (Christie et al, 2001; Christie, 2002; Harrison and Christie, 2005). When seeking to understand differences in crash rates

across different types of vehicles, information on exposure is critical. It is often a challenge to quantify exposure in PTW road safety studies because of historically low response rates to surveys of PTW riders (Amani Jordehi et al, 2013).

Traffic engineers have studied general traffic patterns for many years (Pignataro et al, 1993), and classified traffic counts are commonly conducted for short duration studies. However PTW vehicles are rarely considered, apart from in South East Asian countries where ownership per capita is much higher than in Australia (Amani Jordehi et al, 2013) and PTWers can account for 80 per cent or more of the vehicles on major roads (Hsu et al, 2003).

The growth in deployment of automatic traffic counting equipment has made it possible to study usage patterns in modes that have historically received relatively little attention in the literature. For example, installation of automatic counters on bicycle paths has made it possible to develop much richer understanding of bicycle usage patterns and the impacts of weather on bicycle ridership (Phung and Rose, 2007; Ahmed et al, 2012). The research reported here lays foundations for the development of similar understanding of PTW usage patterns.

The aim of this research is to enhance understanding of the temporal patterns of PTW vehicle usage. The study relies on data obtained from automatic classification equipment on two tollways in Melbourne, Australia. The availability of multi-year data facilitates the examination of temporal patters over a range of time scales. The research reported here is part of a broader study examining the management of PTWs as part of a safe, sustainable transport system.

The structure of this paper is as follows. The research context is described in the next section and that is followed by a discussion of the data on which the research is based and the methodology which is employed. The results of the analysis are then presented to characterise the patterns in PTW use over a range of time scales. Key issues arising from the analysis are then outlined and implications are identified.

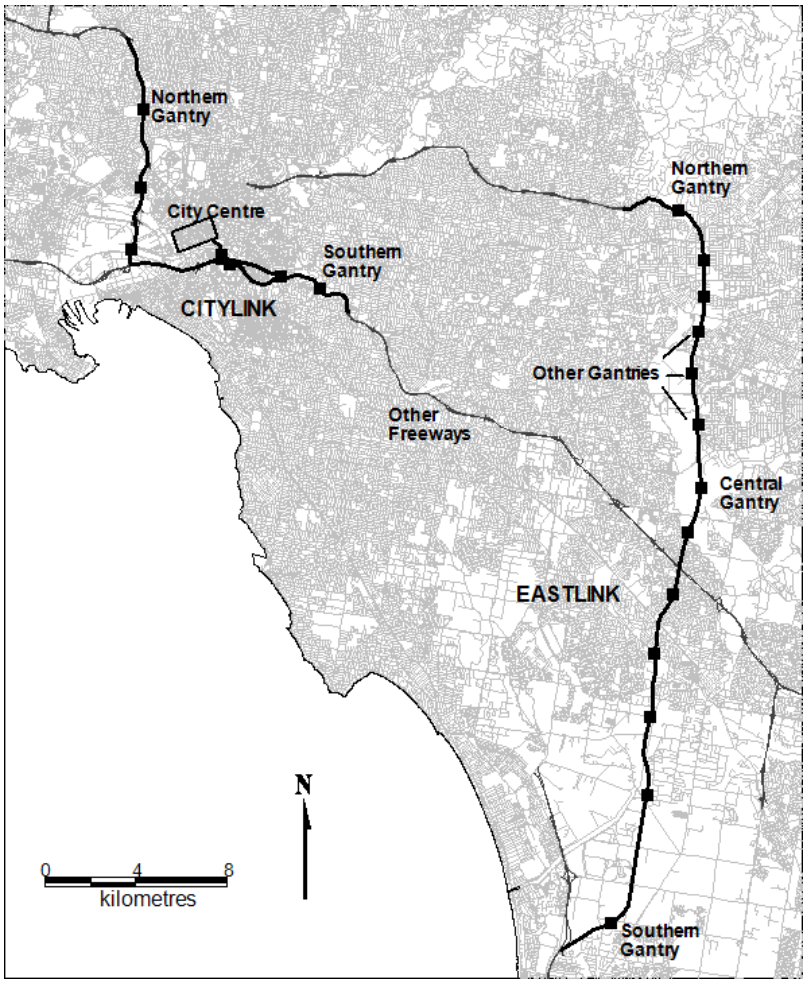
2. Research Context

Melbourne is served by a network of arterials, freeways and two tollways (see Figure 1). These tollways provide the motorcycle ridership data used in this report:

- CityLink, a 22-km radial tollway that passes from the city's north through the central city and passes to the inner south-east (continuing as a non-tolled freeway). It is the primary freeway access from Melbourne's north, west and south-east into the city centre. Motorcycles are not currently charged for using this tollway and their movements are recorded solely using video capture.
- EastLink, a 39-km orbital tollway that runs north-south between Melbourne's east and south-east. It connects several major suburban residential and activity zones. At its north end it connects to a freeway serving the city centre. Motorcycles are charged for using this tollway and their movements are recorded using a combination of electronic tags and video capture.

Both of these tollways use a series of gantries that use a combination of number plate recognition and electronic tag identification to track vehicle use. This system allows motorcycles and scooters to be distinguished from other vehicles.

Figure 1: Tollway locations in Melbourne



Both CityLink and East Link made data available for this study. Because of commercial confidentiality reasons we do not present raw traffic volume data but we do present indexed results.

3. Research Method and Data

This section presents a temporal analysis of the classified volume counts from the two tollways. Usage variability can be examined:

- by time of day,
- by day of week, and
- by month of year.

In addition, the analysis seeks to identify similarities and differences in the usage patterns across the two tollways.

The two tollways use different methods to record PTW movements. CityLink uses older video capture only whereas EastLink uses a combination of electronic tag technology and newer video capture. As with all classifications systems the data is likely to contain errors and those errors may differ in nature and magnitude between the two toll roads. However

undertaking an audit on the data was beyond the scope of this exploratory study so we have used the data as supplied, acknowledging the potential for error.

Data aggregated to monthly totals was provided by CityLink from April 2006 to December 2012. EastLink provided data from July 2010 to December 2012. Data was missing for December 2011 from CityLink and March/April 2011 from EastLink. Monthly data was used to show long-term trends and examine seasonality.

Hourly data was provided by CityLink for each day in 2012 and by EastLink from July 2010 to December 2012. These data were used to explore day-of-week and time-of-day ridership. For consistency, only the 2012 data was used for these analyses.

CityLink provided data from two of their gantries, shown in Figure 1, which represented the gantries farthest north and farthest south from the city centre. EastLink provided data from each of 13 gantries. For ease of interpretation, data was analysed for the farthest northern gantry, the centre gantry and the farthest southern gantry (see Figure 1). Unless otherwise specified, results presented were averaged across the two CityLink and three EastLink gantries.

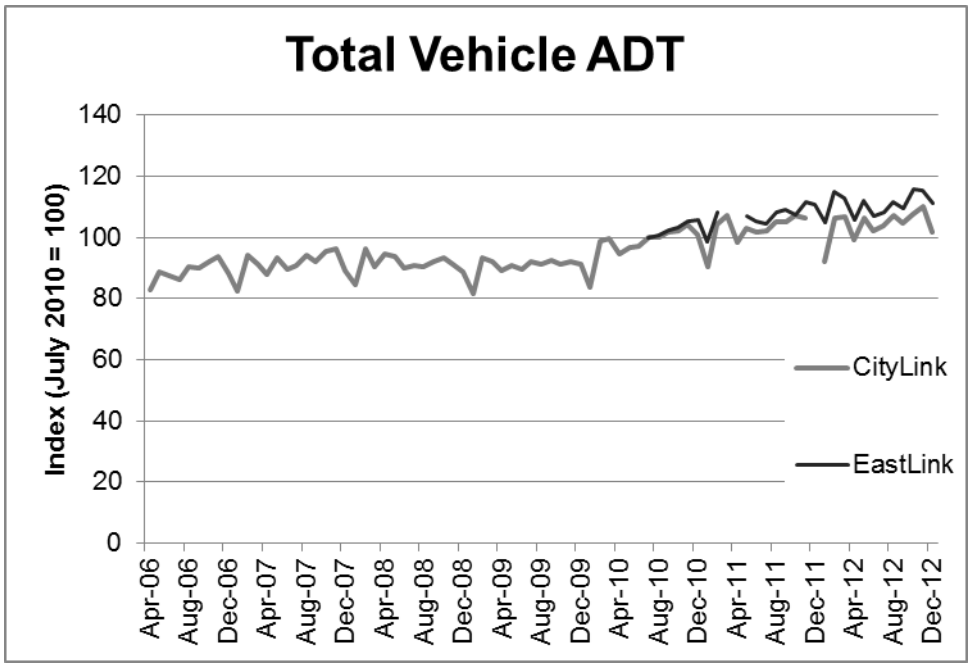
4. Results

Due to commercial confidentiality, no raw data are presented in the following results. Instead, volumes are converted into relative index values or percentages to compare the two data sources. In general, however, it is worth noting that CityLink carries a much higher volume of traffic than EastLink with up to eight times more vehicle passages.

4.1 Trends in use over time and by season

This section explores monthly trends in tollway use over time. Figure 2 shows the trend in average daily travel by month for all vehicles using the two tollways, indexed from July 2010. There is a clear seasonal pattern where vehicle passages drop significantly in January (during summer school holidays). Tollway use appears to be growing from 2010 onward; the growth rate is higher for EastLink than CityLink, but Eastlink is coming off of a lower absolute baseline.

Figure 2: Average daily travel by month – all vehicles



Motorcycles and scooters make up between 0.8% and 1.4% of total vehicle passages on CityLink and between 0.4% and 0.6% of total vehicle passages on EastLink.

Figure 3 presents average daily travel by month for motorcycles and scooters using the two tollways. This trend displays even stronger seasonality than Figure 2; the largest drops occur in June/July (winter) with a lesser drop occurring in January (summer school holidays). The patterns are very similar for both tollways.

Figure 3: Average daily travel by month – motorcycle/scooter

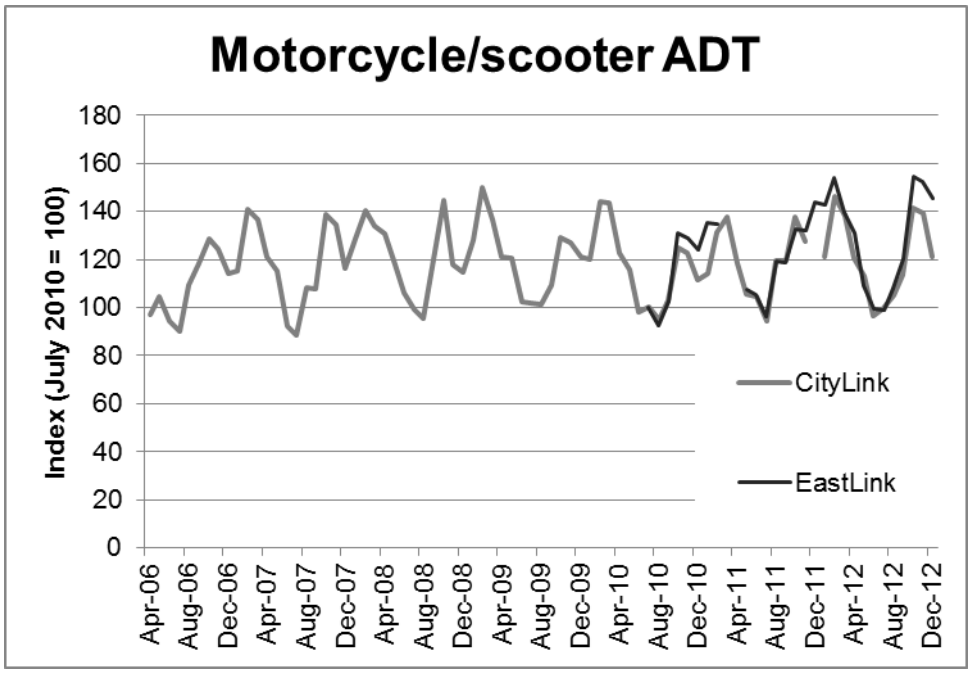
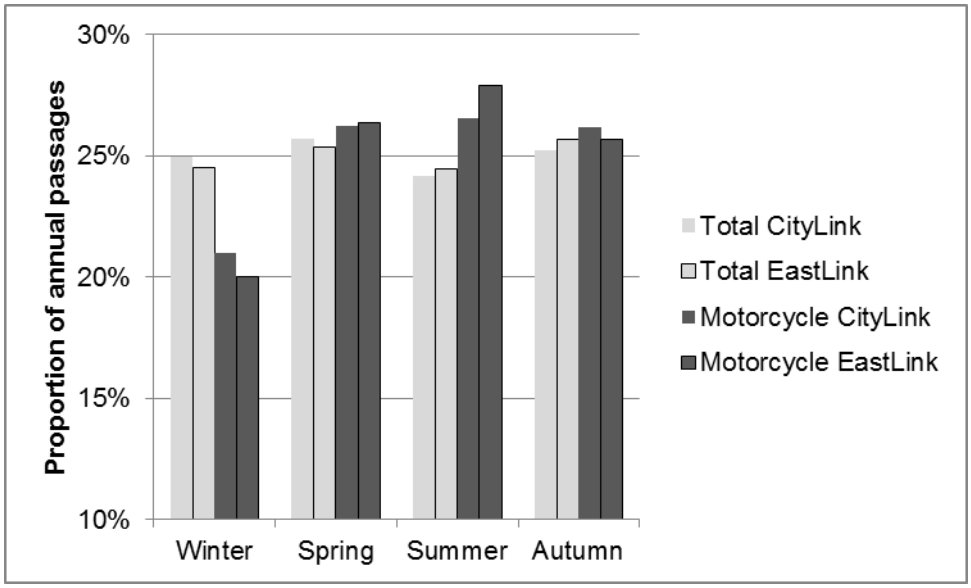


Figure 4 explores this seasonality effect directly by calculating the percent of annual passages that occur during each season. Total vehicle passages do not vary greatly by season, only ranging between 24% and 26% of annual passages. In contrast, PTW passages are more clearly seasonal; in winter CityLink PTW passages drop 21% relative to summer and EastLink passages drop 28% relative to summer.

Figure 4: Proportion of annual passages by season and mode

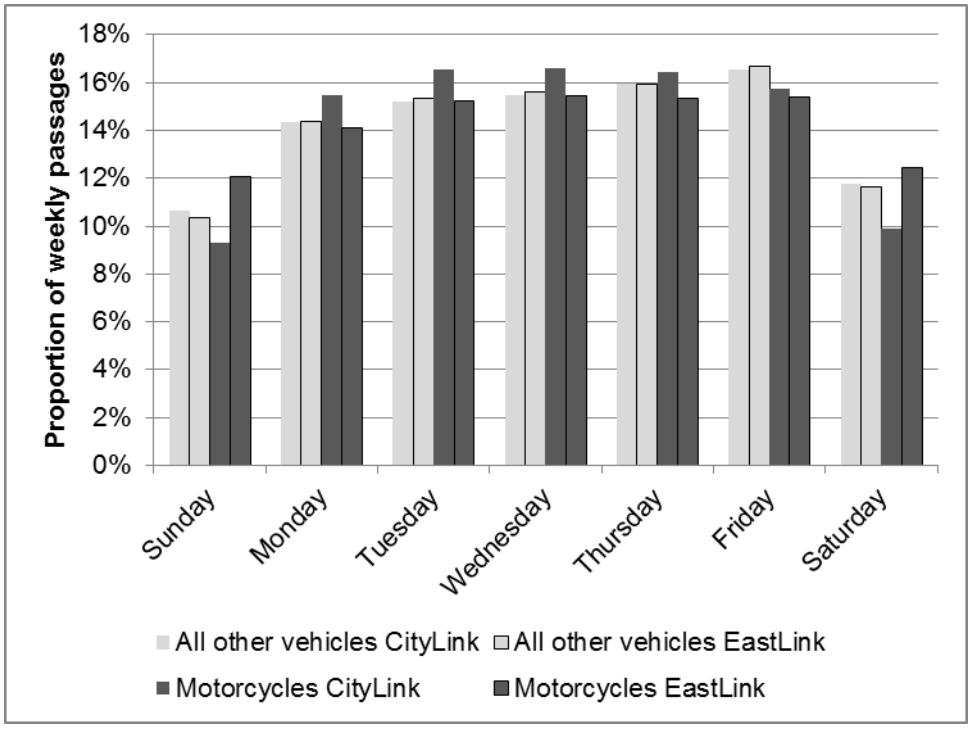


4.2 Variability in use by day of week

This section explores the variability in toll road use by day of week. On both toll roads, non-PTW weekend traffic is around 28% lower on weekends than weekdays. For CityLink, PTW traffic is even more skewed toward weekdays with weekend traffic sitting 40% lower than weekday traffic. In contrast, EastLink PTW traffic is only 19% lower on weekends.

Figure 5 shows the proportion of weekly traffic by day of week. Total vehicle traffic for both toll roads peaks on Friday and substantially reduces over the weekend. PTW traffic on both toll roads is fairly steady across the working week.

Figure 5: Proportion of weekly passages by day of week and mode



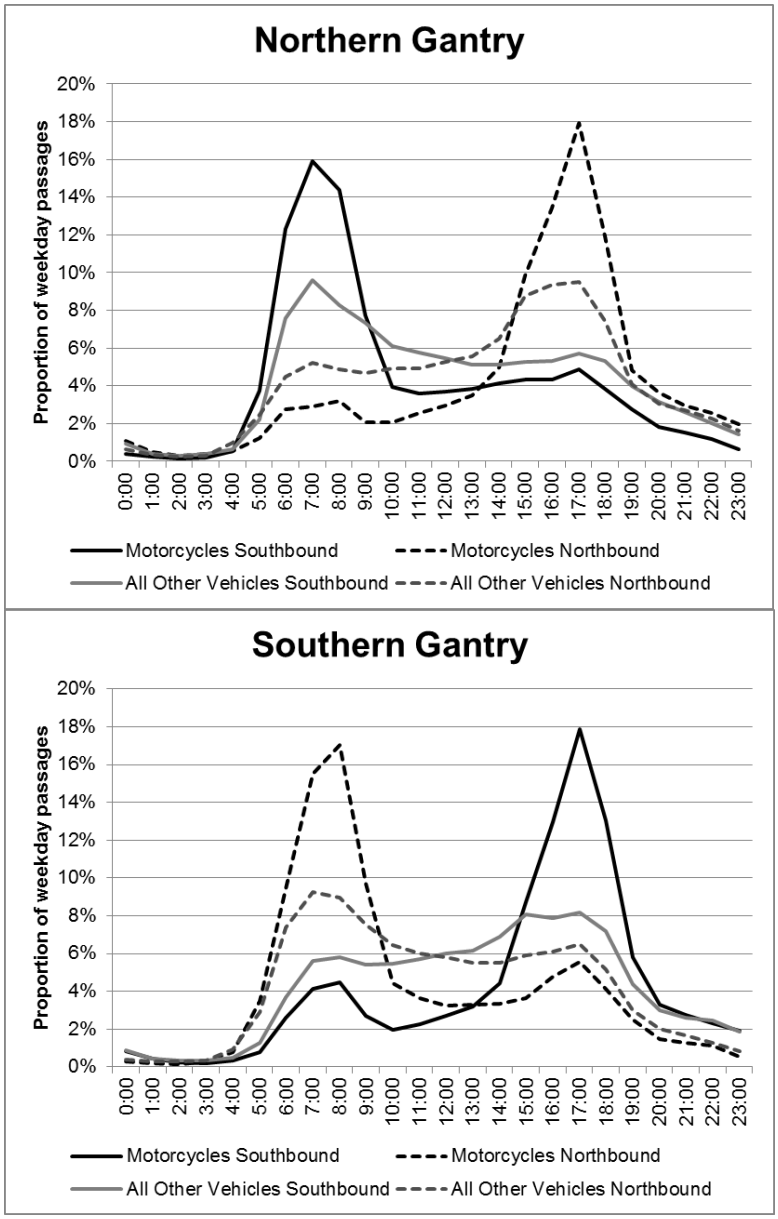
4.3 Variability in use by time of day

This section explores variation in tollway use by time of day on weekdays[1]. Figure 6 shows tollway use on the far northern and far southern CityLink gantries; Figure 7 shows tollway use for the far northern, central and far southern EastLink gantries (see Figure 1 for gantry locations).

Figure 6 clearly demonstrates the peaked use of the radial CityLink tollway for commuting. PTW use is much more strongly peaked than other vehicles, with over 40% of weekday PTW passages occurring in a three-hour window (compared to around 25% of all other vehicle passages).

[1] Hourly data in this section is drawn from the calendar year of 2012.

Figure 6: Proportion of weekday passages by hour and mode: CityLink

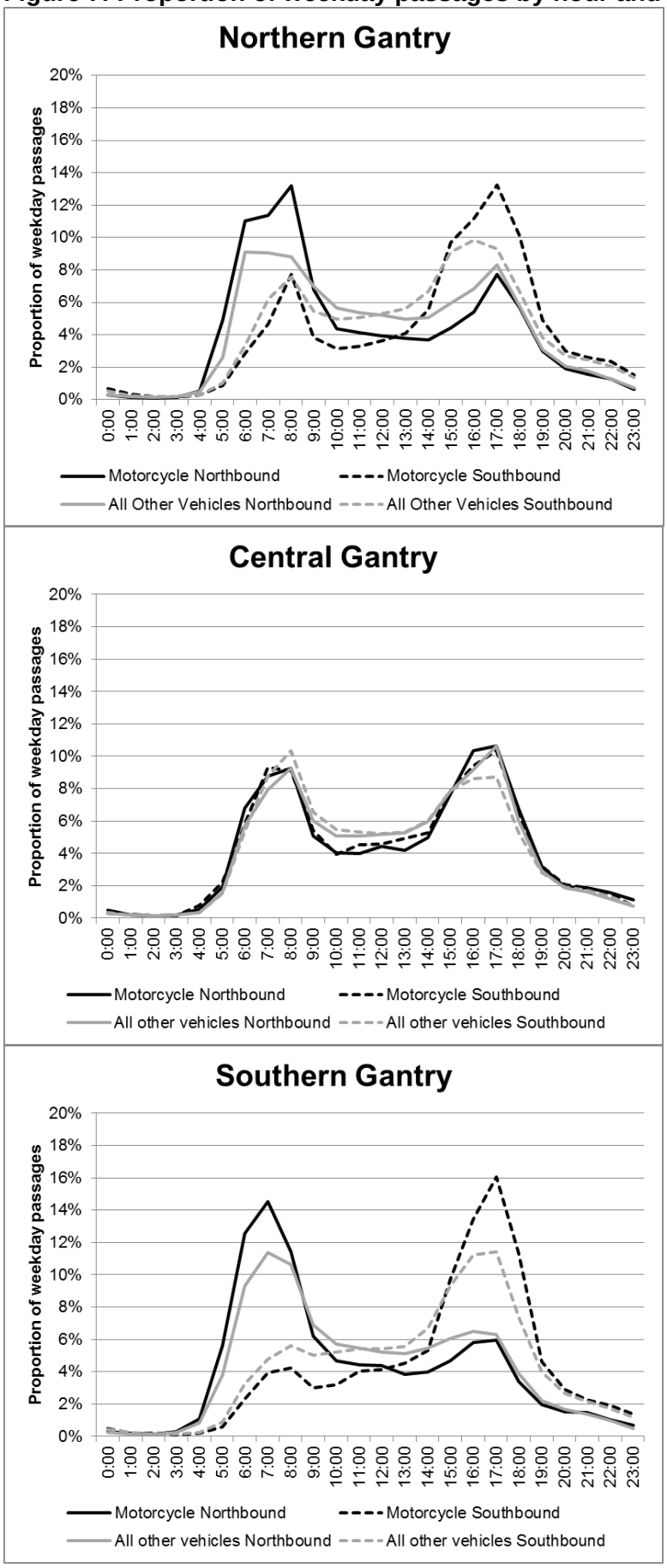


EastLink is an orbital tollway and its traffic patterns are more complex than those of CityLink. As Figure 7 demonstrates, traffic on the northern gantry is peaked toward northern AM and southern PM traffic, as most drivers are heading toward the freeway leading into the central city (see Figure 1). However there is a secondary peak in the opposite direction made up of people who work in the eastern suburbs. As with CityLink, PTW traffic is more heavily peaked than non-PTW traffic.

The central gantry in Figure 7 shows two even peaks in the AM and PM in both directions, reflecting its position in the centre of the orbital tollway. At this location, PTW traffic is *not* more obviously peaked than non-PTW traffic.

The southern EastLink gantry shows a traffic pattern most similar to the CityLink data, where traffic is peaked in a single direction and PTW traffic shows a stronger peak than non-PTW traffic.

Figure 7: Proportion of weekday passages by hour and mode: EastLink



5. Discussion and implications

Overall, this paper found many similarities in tollway use between CityLink and EastLink despite key differences in the two facilities (i.e. PTW pay a toll on EastLink but not on City Link and one is radial and the other orbital). Both tollways showed clear seasonality and peak-hour tendencies and both were used more often on weekdays than weekends. However CityLink showed a stronger peak hour, peak-direction focus whereas EastLink showed different peak hour profiles along its length.

Both tollways show similar trends in seasonality with winter associated with a fall of 21-28% in use compared to summer; this effect was not found for non-PTW traffic. Weather was found to have a significant impact on bicycle ridership in Melbourne (Phung and Rose, 2007; Ahmed et al, 2012) and this paper provides evidence that similar effects are impacting PTW riders. Two important questions about seasonality remain. The first is to understand which aspects of weather are driving the seasonality effect (e.g. temperature or rainfall). The second is whether different types of PTW are impacted differently; for example, are motor scooter riders more sensitive to weather and seasonal changes than motorcycle riders.

Weekend PTW use only dropped slightly on EastLink (18%) compared to CityLink (40%). This suggests that EastLink is more likely to be used for weekend recreational PTW trips. There was very little variability in PTW use across the work week. This finding contrasts with responses to a recent rider survey in the CBD (Rose and Delbosc, 2013) where PTW riders were more likely to say they would use public transport on a Friday. A drop in ridership on Fridays is not evident from the toll road data.

In almost every tolling location, PTW use is far more peaked during the peak hour than conventional motor vehicle traffic. This possibly reflects the lower impact of congestion on PTW riders because of their option to filter through stationary or slow moving traffic. They do not have the same incentive to travel outside the peak to save time. Furthermore, cars can be used for a wider range of non-work trips (e.g. dropping off children, carrying heavy loads) which may take place outside of peak commuting hours.

This paper is among the first to explore the use of PTW on major roads using a comprehensive dataset. However it is limited in that only two roads were sampled and both of them were toll roads. It would be desirable in future to expand the number and type of roads and if possible to include data from freeways rather than tollways.

Acknowledgments

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