

Driver Speed Compliance in Western Australia

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Abstract

A state-wide speed survey was conducted over the period March to June 2000 to measure driver speed compliance and to collect baseline data for future annual surveys which will be used to measure changes in driver speed behaviours on the road network.

A stratified random sample was chosen which consisted of 194 sites across the state road network, covering Perth metropolitan and rural regions, National and State Roads, as well as Local Roads. Sample sizes by the strata were based on regional and road type vehicle-kilometres-travelled estimates. Traffic volume, speed and vehicle composition data was collected using vehicle classifiers.

The results of the survey indicated that over 45% of WA drivers in a “free” flowing traffic environment exceed speed limit and 12% exceed the enforcement speed limit. Speed compliance varies by speed limit between the metropolitan and rural areas, as well as between rural regions. Metropolitan drivers are more likely to exceed speed limits during the night hours while rural drivers tend to drive at higher speeds during daylight hours. Heavy vehicle drivers in the metropolitan area tend to exceed the speed limit more frequently than lighter vehicle drivers. Drivers in rural areas are twice as more likely to speed on 60 km/h local roads than metropolitan drivers. Over the total road network, driver speed compliance is less on week-ends than on working days of the week. Average non-compliance rate to the enforcement speed limit is not significantly different between metropolitan and rural drivers, being approximately 12%.

1. Introduction

In order to achieve a sustained reduction in fatalities and serious injuries, WA Police Services in June 1998 commenced the first phase of the proposed Coordinated Action Program: Speed Project (CAP: Speed). The main objective of CAP: Speed is a reduction of speed-related crashes, achieved through the increase in usage of speed and red light cameras. The CAP Speed program constitutes the key component of the WA’s Integrated Road Safety Program (IRSP).

CAP: Speed has been developed through three phases:

Phase 1 - Optimisation in usage of existing speed cameras (98/99).

Phase 2 – Increase in number of operational cameras, and development and implementation of a fully integrated electronic system which will link the detection, processing and enforcement of camera detected offences (2000).

Phase 3 – Fully operational CAP: Speed (2001).

It has been proposed that each of the phases should be evaluated with respect to the components of the program (Cameron, 1999). One of the five recommendations included in the evaluation plan suggested by Cameron referred to an annual survey of speed behaviour on WA’s roads. It was suggested that change in speed behaviour at general locations of the road network, as distinct from speed camera locations, would be more relevant to assessing the program.

The principal objective of the speed survey conducted in the state was to assess current driver speed behaviours at general locations of the road network and to collect the baseline data that will be used to monitor effects of speed enforcement programs over time.

2. Survey Methodology

Given that the WA road network covers a vast area, ranging from roads in dense metropolitan built-up area to open remote rural State Roads and National Highways, substantial care was taken in the design of the survey such that data collected would be representative of the state’s driver population. Factors like traffic exposure within each of 10 regions, types of roads within the regions, speed limits, and traffic composition were considered to form a basis for the design of the survey and distribution of survey locations across the road

network. Initially, it was envisaged that the sample of approximately 200 sites would be sufficient in size to provide reliable representativeness of driver speed behaviour on general road locations.

Determination of Sample Size by Region, Road Type, Traffic Volume and Speed Limit

The sample size for each the two main strata, region and road type, was based on the principal determinant taken as amount of exposure measured in terms of Million Vehicle Kilometres Travelled (MVKT).

The survey was confined to the top four types of road environment, namely, National Highways, State Highways, Main Roads and Local Roads. Local Roads are Local Authority roads and as such include district and local distributor roads as well as local access roads. Since there was no readily available MVKT split between State Highways and Main Roads, estimates of sample size by road type were based on the three road types: National Highways, State Roads (comprised of State Highways and Main Roads) and Local Roads. Estimates of MVKT by region and road type were obtained from a MRWA traffic modelling system. Under the assumption that the total speed survey would be comprised of 200 survey sites across the WA road network, the number of estimated sites by region was proportionally distributed over the road types based on traffic exposure.

For the purpose of reducing data collection costs the minimum number of vehicles surveyed per day per location was chosen to be more than 1000, unless a suitable site could not be found. This was the case in rural regions with a small number of sample sites and overall low MVKT by road type. This data collection strategy effectively eliminated local access roads from the sample. The survey was intended to cover road sections with speed limits of 60 (posted and built up), 70, 80, 90, 100 and 110 km/h.

Survey Period

For the purpose of survey reliability, the data collection took place during expected stable weather periods, namely, between May and June 2000. The data collected on rainy days was excluded due to possible effects of road condition on “usual” driver speed behaviours.

Minimum data collection period per site in the metropolitan area was 2 days, covering 48 consecutive hours, while rural road network was surveyed over seven days. In order to control for the differences between days of the week, survey of the metropolitan network was arranged in such a way that each day of the week would be equally represented in the sample. Traffic volume classifiers were utilised in the survey for the purpose of collecting traffic volume, vehicle speed and traffic composition data.

Minimum Sample Size Requirement

Previous research has shown that a sample size of 50000 would be needed to detect 20% reduction in the proportion of drivers exceeding speed limits by 30 km/h (Cowley, 1987). Similarly, studies involving surveys of this sample size have been proved to be sensitive in detecting changes in the 95th percentile speed as small as 2 km/h between two consecutive years (Cameron & Vulcan, 1998).

A sample of speeds taken on eight locations on Western Australian road network covering a range of speed limits suggested that the minimum sample size of 1000 to approximately 16000 vehicles was required to detect changes of 1 km/h in mean speed, depending on road type and speed limit. The pilot survey suggested that the minimum sample sizes required to detect the change in 95th percentile of 1 km/h with 99% confidence level and error of 1 km/h, assuming speed variances of two surveys were the same would be approximately 2N. Therefore, the sample sizes for the strata may range between 1200 for metropolitan State Roads with 70 km/h zones and 16000 for rural State Roads with 110 km/h zones.

Speed Survey Methodology and Distribution of Sites by Strata

Selection of a physical location on a road was based on the following five criteria:

- (a) Traffic volume to be not less than 1000 and not more than 20000 vehicles per day per lane, unless sampling frame allows smaller volumes (eg. rural roads).
- (b) Speed limit 60 km/h or greater.

- (c) Locations to provide opportunities for “free” flowing traffic (eg. no major intersections, homogeneous speed limit sections, etc.).
 - (d) Sufficient representation of dual carriageway and multi-lane roads.
 - (e) Sufficient coverage of road types and speed limits areas within the regions.
- Most of the locations were characterised by representative speed limits for the road type.

Out of the proposed 207 roads/road links, 194 were surveyed, of which 115 were in the Perth metropolitan area and 79 in rural regions. Due to practical reasons one of the regions was not surveyed. The survey consisted of 60 and 31 locations on State Roads, 19 and 84 locations on Local Roads of rural and metropolitan road network, respectively. Traffic volume, vehicle speed, headway and vehicle class details were collected at each site in both directions.

3. Results

Two-day and seven-day surveys in the Perth metropolitan area and rural regions, respectively, resulted in over 3.3 million vehicle details, of which 2.2 million were considered to have travelled with “free” speeds. For the purpose of speed data analysis, a vehicle is considered to be travelling under free-flowing condition if its headway was four or more seconds (Committee MS/12, 1999). Vehicles with lower headway values were excluded from the analysis. The data was constrained to approximately 1 million vehicles recorded in rural regions and 1.2 million in the metropolitan area. If it is assumed that each vehicle passed the survey spot once a day, then the estimate of number of driver speed behaviours recorded would be 300 000 in the metropolitan area and 75 000 in the rural regions.

Analysis of the speed data suggested that under free-flowing condition, 45% of all vehicles exceed posted speed limits and 12% exceed enforcement speed limit (enforcement speed limit defined as speed of 10 km/h above speed limit). More detailed analyses indicated that driver speed behaviours (measured in terms of mean speeds, 85th percentiles, percentage exceeding speed limit and enforcement speed limit) varied between regions, speed limits, days of week, time of day and vehicle types. The results are presented in the sections below.

3.1 Driver Compliance to Speed Limit by Area and Speed Limit

Comparison in speed compliance to speed limits indicated statistically significant differences between regions, Metropolitan and Rural, in drivers’ tendencies in varying their driving behaviours. The largest proportion of vehicles exceeding speed limit was observed on 60 km/h road sections, higher in rural regions than in the Perth metropolitan region. Rural drivers tend to exceed the speed limit more with increase in speed limit, while metropolitan drivers tend to comply more with speed limits when on road sections with higher than 60 km/h speed limits (see Figure 1, below).

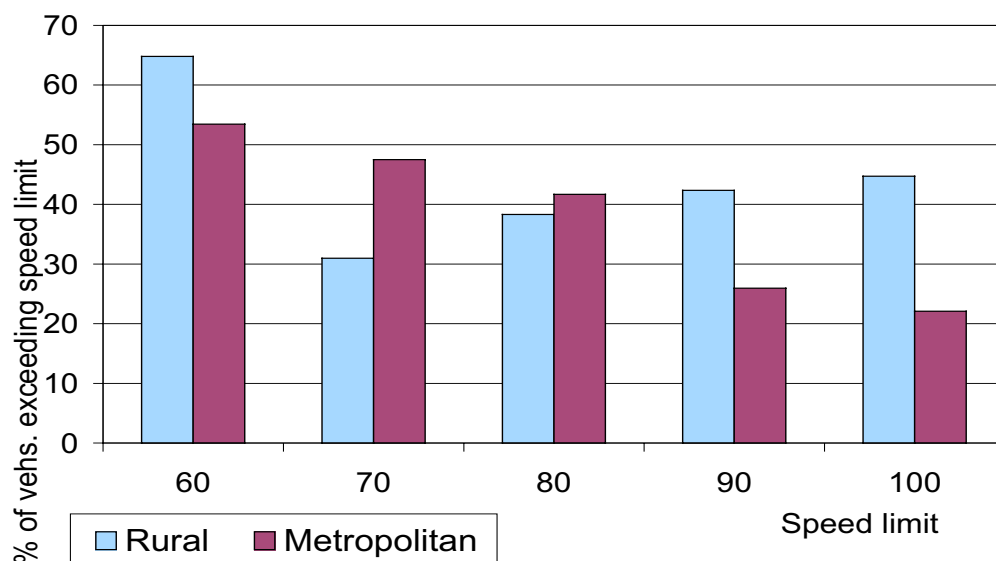


Figure 1. Speed non-compliance by area and speed limit

3.2 Driver Compliance to Enforcement Speed Limit in Metropolitan and Rural Areas

As with speed compliance to speed limit, the highest non-compliance to enforcement speed limit was observed on 60 km/h. On higher speed limit road sections, higher proportion of Metropolitan drivers tend to drive within tolerance of 9 km/h above speed limit than on lower speed limit roads. Contrary to Metropolitan, Rural drivers are more likely to exceed enforcement speed limit on higher speed limit roads, compared to the roads with speed limit of 70 km/h (see Figure 2). In both cases, the relationship between speed limits and percentage of drivers exceeding enforcement speed limits seemed to be linear, having negative and positive slopes, respectively.

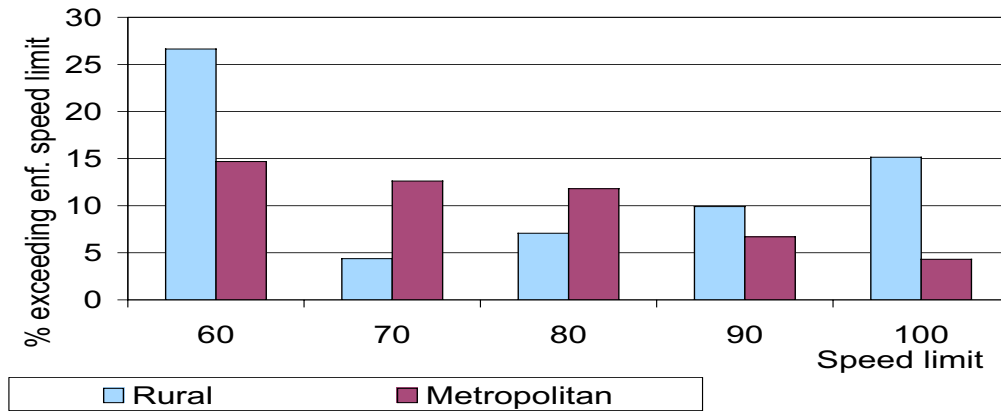


Figure 2. Speed non-compliance with enforcement speed limit by area and speed limit

Analysis of vehicle speeds by rural regions showed statistically significant differences in driver non-compliance to enforcement speed limits on 60 km/h Local Roads, ranging from 8% in Midwest and Goldfields regions to 40% and 50 % in South West and Pilbara regions, respectively. Similarly, significantly large differences were observed between the regions in mean speeds and proportion of drivers exceeding enforcement speed limit on the most common rural open road speed limit of 110 km/h (see Figure 3). Mean speed for the road type was found to be 102 km/h with 85th percentile of 115 km/h. Non-conformance rates to enforcement speed limit as well as mean speed were found to be significantly smaller among Goldfields drivers than drivers of the other regions. Kimberley region drivers showed a non-compliance rate of exceeding enforcement speed limit that was double the average of 7.6% for the area as a whole.

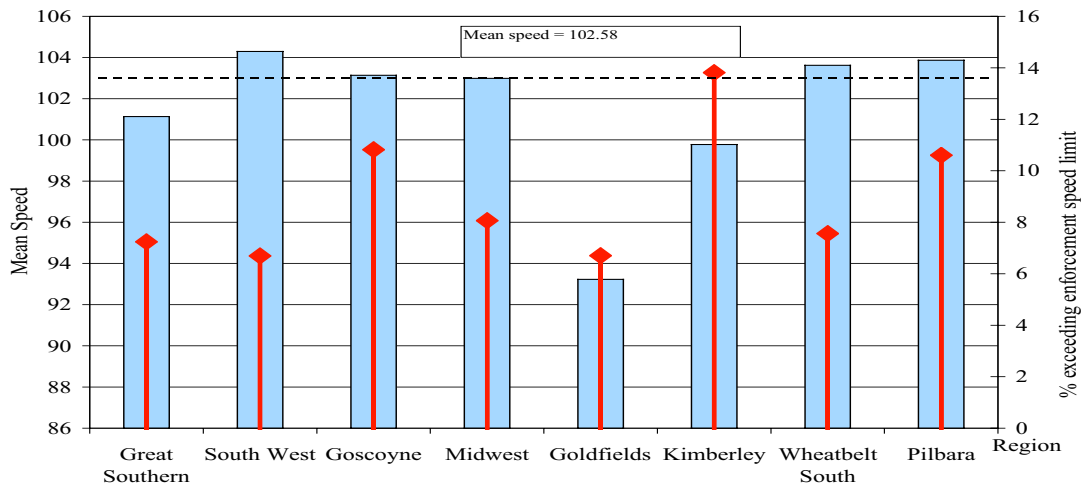


Figure 3. Mean speed and non-compliance differences between regions on 110 km/h State Roads, Rural Areas

The data represented in Figure 3 suggests that in some regions most drivers, on average, travel with high speeds, close to but not exceeding the enforcement speed limit. The largest discrepancy between observed and expected proportion of drivers exceeding enforcement speed limit, relative to the mean speeds, was found among Kimberley drivers. The different non-compliance rate may well be related to Police enforcement activities within

the regions. There appears to exist unwritten speed tolerance acceptance limits specific to some of the regions for which speed characteristics largely deviated from the average for the population.

3.3 Speed Characteristics by Area

Metropolitan Area

Analysis of speed data collected in the Metropolitan Area on Local and State Roads with the same speed limits showed no large differences in speed characteristics of vehicles. Vehicles travelling on 60 km/h and 80 km/h State Roads had slightly higher (1.5 –2 km/h) mean speed than those travelling on Local Roads

Tendency for exceeding the speed limit and enforcement speed limit in a free flowing traffic diminishes with the increase in speed limit at the roads. Drivers on higher speed limit roads are less likely to exceed both speed limit and enforcement speed limit. Decrease in percentage of drivers exceeding speed limit and enforcement speed limit is approximately three times less on 100 km/h than on 60 km/h sections of the road network. Mean speeds of vehicles travelling on 60, 70 and 80 km/h roads are approximately equal to the speed limits, while on 90 and 100km/h roads mean speeds are about ten kilometres less than the posted speed limit. Similarly, 85th percentiles on lower speed limit roads (60, 70 and 80 km/h) are about 9 km/h above the speed limits, while the higher speed limit 85th percentiles are slightly higher than the speed limits. These statistics suggest that conformity to speed limits is stronger at higher speeds than on lower speeds. Overall non-compliance with enforcement speed limits across the Perth metropolitan network is 12.7%.

Rural Area

Drivers on rural 60 km/h Local Roads are twice as likely (27%) to exceed enforcement speed limits than the metropolitan drivers. However, Metropolitan drivers tend travel above speed limit on 70 and 80 km/h roads more frequently than Rural Area drivers, while such tendency is more observed with Rural drivers on the higher speed limits, 90 and 100 km/h. Mean speed of vehicles on 60 km/h Rural Local Roads is significantly higher than the mean speed on the same roads in the Metropolitan Area.

3.4 Speed Compliance by Time of Day

Metropolitan Area

Distribution of number of drivers who tend to drive above the enforcement speed limit is significantly related to time of day (see Figure 4). Percentage of drivers exceeding the speed limit is related to the hourly mean speeds.

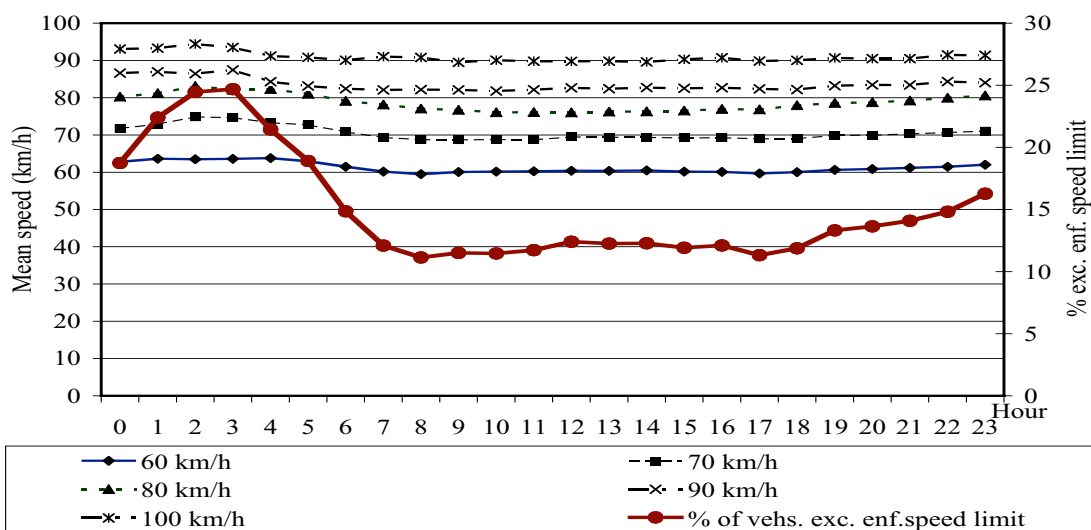


Figure 4. Distribution of mean speeds and non-compliance with enforcement speed limit by speed limit and time of day, Perth Metropolitan Area

The data suggests that drivers are more likely to exceed enforcement speed limit during low traffic volume hours, over the period 6 p.m. to 6 a.m., than over hours with more traffic on the roads. Proportion of drivers

exceeding enforcement speed limit varies over time of day, ranging between 11 and 25 percent, being the highest in the early morning hours, 2 – 3 a.m. The increase in mean speeds and proportion of drivers exceeding enforcement speed limits during the night hours might be associated with the traffic conditions at the roads. In addition, the increases could also be associated with enforcement and high risk drivers (risk being associated with age, alcohol). Although large proportions of the drivers tend to speed during the night hours, the number of speeding drivers is relatively small. However, this does not imply that traffic safety on the roads at these times is more acceptable than the one observed during day hours. The largest number of drivers expected to exceed enforcement speed limit on metropolitan road network over 4-hour period seemed to be most likely recorded between 2 p.m. and 6 p.m.

Examination of the relationship between hourly mean traffic volume and the mean speeds for the sample of vehicles for each of the speed limits showed significant relationship between the mean speed and traffic volume. The relationships are in the shape of logarithmic functions.

Rural Area

Contrary to Metropolitan drivers, rural drivers are less likely to exceed the enforcement speed limit during night hours than daylight hours (see Figure 6). At the network level across all speed zones, average speeds during daylight seem to be slightly higher than during the night. However, mean speed on open 110 km/h roads is fairly constant over all time periods.

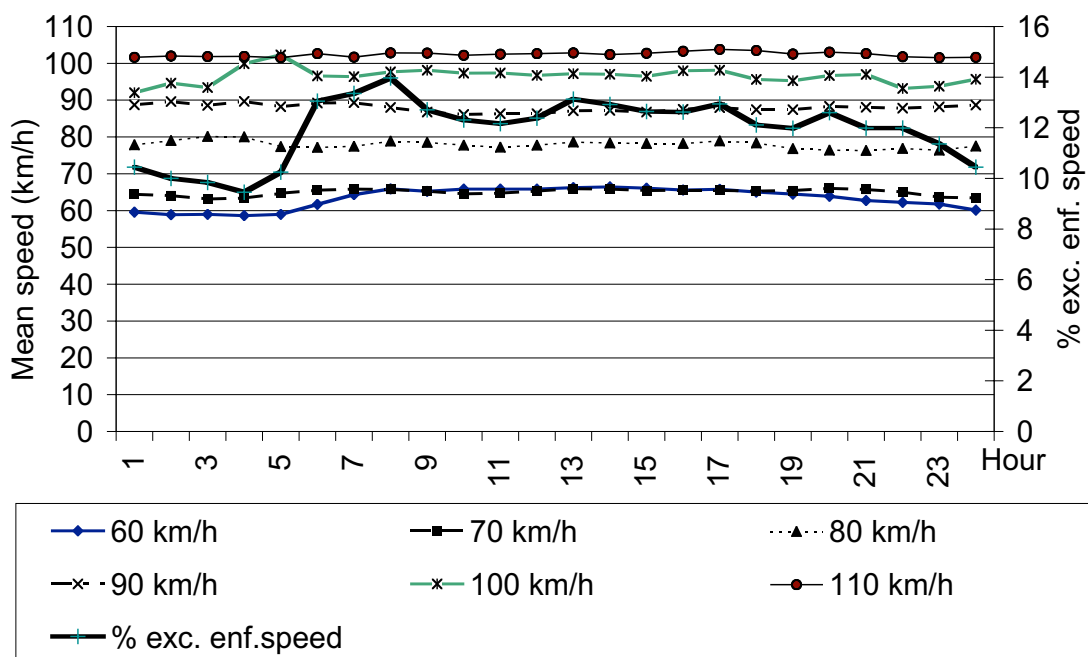


Figure 6. Distribution of mean speeds and non-compliance with enforcement speed limit by speed limit and time of day, Rural Area

The largest number of drivers expected to exceed enforcement speed limit at the Metropolitan and Rural Area road networks over 4-hour period seemed to be most likely recorded between 2 p.m. and 6 p.m.

3.5 Differences between Vehicle Types in Speed Compliance

In the Perth Metropolitan Area, drivers of heavy vehicles (AUSTROADS class 3 and above) were found to comply less with speed enforcement speed limit than the drivers of light vehicles. Heavy vehicle non-compliance rate ranged from 4% on 100 km/h roads to 30% on 60 km/h roads under “free” flowing traffic conditions. Light vehicle non-compliance to the speed limit was between 4 and 13% (see Figure7).

At lower speed limits, 60 and 70 km/h, heavy vehicles had higher mean speed than light vehicles, approximately 4 km/h. The difference in mean speed between the vehicle types is reversed at higher speeds, light vehicles travelling at higher mean speed than heavy vehicles.

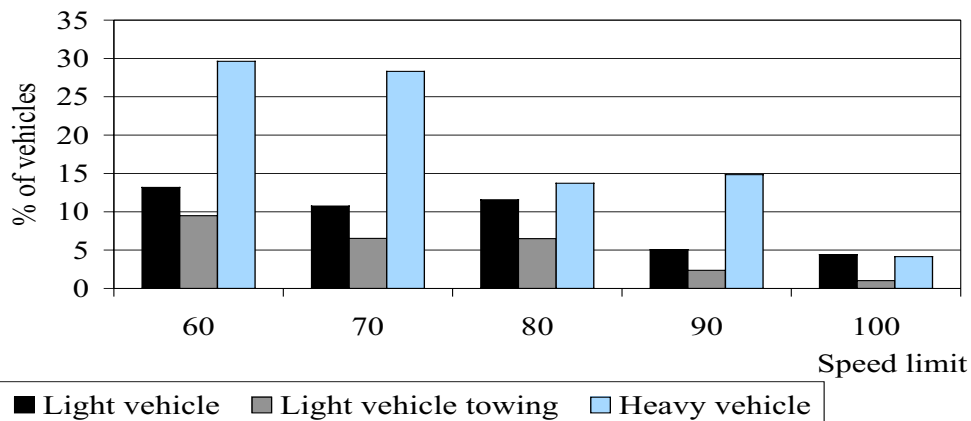


Figure 7. Proportion of vehicles exceeding enforcement speed limit by vehicle type and speed limit, Perth Metropolitan Area

Compliance rate to the enforcement speed limit in Rural Area had a different pattern to the one in Metropolitan Area. Light and heavy vehicle drivers had similar tendencies in exceeding the speed limit at 60 km/h road sections with non-compliance rate of 26-27% (see Table 1). Compliance rate at higher speed limits varied between the vehicle types. As expected, light vehicles on higher speed limit open roads had smaller compliance rate than the heavy vehicles. For all vehicle types, compliance rate was significantly better on higher speed limit roads than on 60 km/h Local Roads.

Mean speeds for all vehicle types on 60 km/h roads are not largely different from the mean speeds on 70 km/h roads. This finding points to an inference that driver speed behaviours on both road types are very similar with respect to perceived safe driving speeds.

Vehicle Type	Speed limit											
	60		70		80		90		100		110	
	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%
Light Vehicle	64.6	27.1	65.4	4.5	78.1	7.2	87.4	9.4	98.8	17.3	104.9	8.3
Light Vehicle Towing	63.4	27.2	61.6	1.9	74.4	2.9	80.3	2.8	90.0	4.2	93.8	1.6
Heavy Vehicle (Class 3+)	63.0	26.2	64.2	4.1	77.5	7.1	88.7	14.2	88.5	5.3	97.9	6.8

Table 1. Mean speeds and proportion of drivers exceeding the enforcement speed limit on Rural Area roads

3.6 Compliance with Speed Enforcement Limit by Day of Week

Analysis of driver compliance with enforcement speed limits at the network level across all speed limits showed relatively small differences between days of the week for both areas, Metropolitan and Rural. The maximum difference was about 3%, ranging between 11 and 14% in non-compliance rate (see Table 2). In both areas, drivers are more likely to exceed the speed limit on week-ends than on working days. In the Metropolitan Area, speed compliance on State Roads is remarkably high on Thursday and Friday, when compared to other days of the week. The compliance rate on these days is twice better than any other day.

Area	Day							Total
	Mon	Tue	Wed	Thu	Fri	Sat	Sun	
Rural	11.11	11.74	12.53	12.53	12.76	13.35	12.63	12.36
Metropolitan	11.43	12.96	13.51	11.64	12.06	13.24	13.93	12.69

Table 2. Proportion of drivers exceeding enforcement speed limit by Area

Non-compliance to the enforcement speed limit on 60 km/h Local Roads in Metropolitan Area is fairly consistent over the week, at about 15 %, while the rate on rural area Local Roads is significantly higher on Friday and Saturday when compared to days between Monday and Wednesday (30% vs 24%).

4. Conclusions

The results of this study suggest that driver speed behaviours in a “free” flowing traffic environment are largely dependent on a number of factors associated with: highly urban and rural areas, speed limit on roads, vehicle types, road types, state regions, times of day and days of week.

Both rural and metropolitan drivers tend to exceed speed limit and enforcement speed limits more frequently on 60 km/h roads than on higher speed limit roads. It has been shown that metropolitan drivers are more likely to comply with speed limits on higher speed limit roads than drivers in rural regions of WA. The higher the speed limit the higher the compliance will prevail among metropolitan drivers. In this instance, the decrease in percentage of drivers exceeding speed limit and enforcement speed limit is approximately three times less on 100 km/h roads than on 60 km/h roads.

Drivers in rural areas are twice as more likely to exceed enforcement speed limit on 60 km/h roads than drivers in the Perth metropolitan area on the same types of roads. Overall non-compliance with enforcement speed limit across all types of roads and speed limits is approximately 12% for each of the areas, metropolitan and rural.

Driver speed behaviour differences, measured in terms of average speeds and compliance with 9 km/h tolerance above the speed limit, vary between rural regions. For example, non-compliance of drivers in Kimberley is disproportionately high relative to mean speed and compliance in other regions of WA.

Although, in absolute terms, the number of non-compliant drivers is relatively small during night hours, the likelihood of exceeding speed limit during these periods is significantly large among metropolitan drivers than during the day time hours. This finding is contrary to the behaviours of drivers in rural areas who are more likely to speed during the day rather than during the night.

Slight differences in speed compliance between metropolitan and rural drivers were associated with days of week, when rural drivers are less likely to comply with speed limits on Local Roads on weekends than other days of the week, while metropolitan driver compliance is fairly consistent. At the network level of all roads and speeds, week-end driving results in significantly less compliance than on working days of the week.

5. Recommendations

It is recommended that the results of this survey be utilised as a component in defining traffic safety strategies related to speed enforcement on Western Australian road network. Speed enforcement strategies should incorporate regional, road type, speed limit, and temporal factors.

Further studies would be required to investigate relationship between speed compliance and traffic crashes, considering factors associated with driver speed compliance, as outlined in this study.

Furthermore, the results of this study should be used as a baseline in future evaluation of speed enforcement programs and monitoring of driver speed behaviours over time.

References

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