Crash Patterns in Western Australia

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Abstract

Examination of crash patterns is one way of identifying key factors on which focus should be directed for improving road safety. This paper has researched the current status of a number of selected crash patterns in Western Australia and compared this status where possible with that existing 10 or 20 years ago. The crash patterns examined are road type crash risks, speed, fatigue, night-time, severity and collision types. It is considered that the results should be useful not only to Western Australia but also to road safety agencies elsewhere.

The paper provides quantitative information on crash risks of various levels of road design ranging from unsealed country roads to freeways using a large sample of some 100 000 crashes. Quantitative estimates based on surrogate measures show that both speed and fatigue are major contributing factors in crash occurrence. In taking traffic into account it is shown that both the risk and severity of crashes is higher at night than daytime particularly in the open road environment.

In addition to numbers and risk values, patterns are also expressed in terms of crash costs. Crash costs are proposed and demonstrated as a method for the optimum allocation of resources directed towards road safety improvement.

Keywords : Road safety strategies, crash patterns, road safety funding, road design

1. Introduction

This study has analysed the current and past status of a number of specific crash patterns in Western Australia (WA). In this analysis a major distinction has been made between urban built up and rural open road environments. The key crash patterns examined are road type crash risks, speed, fatigue, night-time, severity and collision types.

The purpose of the study is to provide current information that can be applied in the development of road safety policies, action plans and programs. The results should not only be useful to road safety agencies in WA but also to agencies elsewhere in Australia.

2. General Approach

All crash patterns except road type crash risk have been researched for the year 2000 and where data is available comparisons made between this current status and that existing in the years 1980 or 1990. Road type crash risk data covered a 5 year period ending December 31 2000. The analysis itself is carried out at a high level only.

The crash data used is based on crashes reported to WA Police Services and held in the data base maintained by Main Roads WA (MRWA). All reported crashes are used in the analysis of the current patterns but only casualty crashes are used in past comparisons because of changes over the study period in the legal reporting level for damage only crashes.

Crash costs estimated in this study are based on crash type costs derived by MRWA (1) utilising the latest research of the Bureau of Transport Economics (2) and Hendrie et al (3). Crash costs are as of December 31 2000.

3. Road Type Crash Risk Patterns

3.1 Method

A study has been made of the current levels of crash risk on different types of road in WA. The measure of crash risk employed is crashes per vehicle kilometre of travel. Road types have been categorised by functional classification, operational classification and by road environment.

The study involved analysing all reported crashes over a 5 year period ending 31 December 2000. The crash sample includes both casualty and damage crashes and overall consisted of 112 000 crashes. The crash risk values exclude major intersection crashes. Traffic data was based on that collected on the road network by MRWA using roadside recording equipment.

Road environment classification is based on degree of access. In this instance open road is defined as having little or no property and side road access. Major Road refers to distributor roads and Local Road to local access roads.

3.2 Results

The study results are summarised in Table 1**.**

Table 1: Network average crash risks by road type expressed as crashes per million vehicle kilometres

	Built Up		Open	
Road Type	Major Road	Local Road	Major Road	Local Road
Unsealed			0.81	
One Way	2.85	7.78	0.70	
Undivided	2.35	2.68	0.49	0.73
Divided	1.55	1.74	0.74	
Freeway			0.72	
All Road Types	2.00	2.62	0.60	0.71

As a general conclusion major roads have lower crash risks than local roads over all road types probably because of their higher road design standards.

An important result for cost benefit applications is that in built up areas divided roads have lower crash risks than undivided roads for both major and local roads. This finding reflects the safety effects or reduced vehicle conflicts caused by reducing access opportunities from both property and minor side streets. The corresponding open road values are not comparable as the divided sample contains some metropolitan highways carrying significantly higher traffic volumes than the undivided sample, which mainly consists of low volume country roads.

As would be expected unsealed roads have a higher crash risk as a result of the hazard caused by the loose surface of these roads particularly in wet weather.

In built up areas one way roads have higher crash risks than other road types. These roads are largely located in Central Business Districts and commercial retail areas. The high rates probably reflect parking, pedestrian and driveway conflicts. The open road one way sample consists mainly of freeway ramps, which explains the low crash risk of this type of road.

Freeways, although defined as open road for the purpose of the study, are located in the metropolitan area. Excluding on and off ramps, freeways have the lowest crash risks of road types in the metropolitan area.

3.3 Discussion

The WA network average road type crash risks are considered important nationally as they could be applicable in other States as the latter have generally similar road environments, weather conditions and driving cultures as distinct from those in other countries.

Crash risk is important for the identification and ranking of black spots as well as for the evaluation of proposed treatments. With respect to the former, network average crash risks act as benchmarks for identifying locations with crash risks significantly different from that expected on average. High-risk locations are signaling a possible road problem and it is considered that such a location is more amenable to successful treatment than a low risk location even when the latter has high traffic volumes. Low risk locations can be treated by reducing traffic volumes, for example, grade separation.

Preliminary ranking lists can also be obtained by calculating the expected crash number and cost savings if the location crash risk was reduced back to the network average.

Network average crash risks can also be used in cost benefit analysis of proposed road improvements involving changes in road type.

4. Speed Crash Patterns

4.1 Method

It is generally acknowledged that speed is a major contributing factor in road crashes. However, it is difficult to place a quantitative value on the size of this problem. The main reason for this is that only a relatively small proportion of crashes are Police attended. In the absence of Police assessment of speed as a crash factor, recourse has to be made to a surrogate measure based on crash characteristics held in the crash data base.

In developing a definition of a surrogate measure an attempt has been made to take into account two perspectives of speed, namely, excessive speed and speed too fast for prevailing road conditions. For the purpose of this study a speed related crash is

(1) a crash where speed has been assessed as a contributing factor by an attending Police Officer
    or if not assessed then
(2) a single vehicle crash involving a vehicle leaving the road while negotiating a curve or corner or
(3) any crash involving an out of control vehicle while negotiating a curve or corner or
(4) a crash involving a vehicle leaving the road and losing control while traveling on a wet road or
(5) a mid-block rear end collision.

Excluded are crashes involving road condition, vehicle failure, medical condition (heart attack, etc), swerving maneuvers (other vehicle, animal, object, etc), side wind and headlight glare.

Rear end collisions at mid-block locations have been included as they are considered to be mainly due to 'tailgating' behavior. Drivers who are adopting this type of behavior are not allowing sufficient braking distance for emergency stopping and are therefore traveling too fast for the prevailing traffic conditions.

Urban area in this section and following sections is defined as the Perth metropolitan area plus major country towns and cities. Open road represents the remaining area.

Crash risk estimates are measured in terms of crashes per vehicle kilometre of travel. For this purpose vehicle kilometres of travel have been estimated using data from the ABS Motor Vehicle Use Surveys.

4.2 Results

The speed related crash definition was applied to WA reported crash data for the year 2000. A total of 38 100 crashes were reported in this year. The results of the analysis are displayed in Table 2.

Table 2: Percentage of speed related crashes at each crash severity level by road environment.

Area	Fatal	Hospital	Medical	Damage	Total
Urban	40	24	20	20	21
Open	31	23	20	17	19
State	35	24	20	20	20

Speed related crashes represent approximately 20% of reported crashes both in the urban and open road environments. The risk is about the same over all severity levels except fatal crashes. In this instance, speed is assessed as a contributing factor in 40% of urban fatal crashes and 31% in open road fatal crashes. The overall results indicate that speed is a problem statewide.

The study also found that open road speed crashes are some 4 times more severe than those in the urban area based on the relative differences in serious crash proportions. That is, although the risk of being involved in a speed crash relative to a non-speed crash is about the same in both types of road environment, once involved in such a crash the consequences are more severe on the open road due to the higher operating speeds. Serious crashes are defined as the sum of fatal and hospital admission crashes.

Although speed crash severity is higher on open roads, most speed crashes (90%) occur in the urban areas. This is a dilemma for road safety agencies in recommending resource allocation for combating the speed problem. It is considered that the best approach for resource allocation is to use crash costs as they take into account both crash severity and crash numbers.

The annual cost of speed crashes has been estimated to be $222M for the urban area and $105M for the open road area. A recommended allocation of resources for combating the speed problem would therefore be 70% to the urban area and 30% to open roads.

The current speed problem has been compared to that existing 10 years ago in 1990. In order to assess any real change in the speed problem changes in the amount of vehicle travel have to be taken into account. Consequently, crash risks for the years 2000 and 1990 have been estimated and compared. Results of the analysis are provided in Table 3.

Table 3: Changes in speed and non-speed casualty crash risk from 1990 to the year 2000

Road Type	Percent Change of Crash Risk from 1990	
	Speed Crashes	Non-speed Crashes
Urban	-8	-10
Open	-24	-28

Speed crash risk has decreased since 1990 with open road showing the greatest rate of change. However, this rate of change is lower than the crash risk reduction experienced by crashes in general.

Although the speed crash risk has improved since 1990, speed is still a major contributing factor in current crash patterns and is a problem that requires priority attention.

5. Fatigue Crash Patterns

5.1 Method

It is generally acknowledged that fatigue is a major contributing factor in open road crashes. However, it is even more difficult to place a quantitative value on the size of this problem than for the speed factor. Even with Police attended crashes it is difficult to make an assessment as there is no objective measure of fatigue. As with speed, recourse has to be made to a surrogate measure based on crash characteristics held in the crash data base in order to arrive at an estimated quantitative value.

For the purpose of this study a fatigue related crash is
(1) a crash where fatigue has been assessed as a contributing factor
or if not assessed then
(2) a head-on collision not involving overtaking or
(3) a single vehicle crash involving a vehicle leaving or out of control on a straight section of road or
(4) a single vehicle crash involving a vehicle leaving an outside curve

5.2 Results

The study estimated that in the year 2000, fatigue as defined, was a contributing factor in about a third (32%) of open road crashes. With respect to fatal open road crashes about half (48%) were estimated to have fatigue as a contributing factor.

Appropriate data was not available to analyse changes from 1980 or 1990.

6. Night Crash Patterns

6.1 Method

Night-time is regarded as a high-risk time for crashes and therefore presents a specific problem that requires addressing. Crashes per vehicle kilometre has been used to quantify the relative risk between day and night. With respect to crash data, night/dawn/dusk as reported was used as the definition of night. With respect to traffic data, the 7.00pm –7.00am period was used as a definition of night.

The first step in estimating travel was to estimate the network average day/night proportional traffic splits by road environment from traffic data collected at MRWA's statewide continuous count sites. These proportional splits were then applied to the total travel estimates from the motor vehicle usage surveys to estmate night/day travel.

6.2 Results

The risk analysis based on amount of travel found that the night-time crash risk on the open road is about 3 times greater than that of day light hours. Even though the night affect is not as great in the urban area the night-time crash risk is still much higher being 16% above that of day light hours.

The severity of crashes at night is higher than that during the day both in the urban and open road environments. In the urban area serious crashes represent 6% of night crashes as compared with 3% for the day period. Corresponding figures for the open road are 17% and 13% respectively. These results indicate that higher night speed is a contributing factor to the high night-time crash risk.

In the open road environment the annual cost of night-time crashes was estimated to be $108M being 46% of total open road crash costs. This suggests that half of open road safety resources should be directed at night-time treatments. In urban areas the annual cost of night-time crashes was estimated to be $291M being 35% of total urban crash costs. In this case the results suggest that a third of urban road safety resources should be directed at night-time treatments.

Current night and day crash risks have been compared with those existing 20 years ago in 1980. The results are summarised in Table 4.

Table 4: Changes in night and day casualty crash risk from 1980 to the year 2000

Road Type	Percent Change of Crash Risk from 1980	
	Night Crashes	Day Crashes
Urban	-35	18
Open	-62	-36

Night crash risk has shown substantial improvement since 1980 in both urban and open road environments. This improvement is greater than that experienced by day crashes. Urban day crashes have actually shown an increase in risk since 1980. This finding needs further investigation.

7. Severity Crash Patterns

Crash severity on the open road is on average 3 and a half times higher than that on roads in built up areas in terms of serious crashes as a proportion of all reported crashes. Serious crashes are defined as fatal plus hospital admission.

Although severity is higher on open roads only 11% of the States reported crashes in 2000 occurred on these roads. However, when costs are taken into account, some 31% of the States annual crash costs occur on open roads. A 70/30 split between urban and open roads is recommended for optimum allocation or resources directed to improving road safety.

Table 5 shows the crash severity in the year 2000 compared with that experienced 20 years ago in 1980. In this instance, severity is defined as serious crashes as a proportion of all casualty crashes. Over the last 20 years crash severity has declined in both urban and open road environments. In the urban area crash severity has been halved since 1980 and decreased by 20% on open roads.

Table 5: Changes in crash severity from 1980 to the year 2000

Year	Fatal Crashes	Serious Crashes as % of Casualty Crashes	Severity Percent Change From 1980
Urban 1980	137	33	0
2000	82	16	-53
Open 1980	130	62	0
2000	103	50	-20

8. Collision Crash Patterns

Table 6 provides a list of the major collision types in WA in terms of both crash numbers and crash costs. The costs are based on network average crash type costs derived by MRWA.

The list has been ranked in order of crash costs as being the most optimum method of allocating resources to road safety improvement.

Table 6: Collision type priority list for attention based on year 2000 crash numbers and costs

Collision Type	Percent of State Total	
	Crash Numbers	Crash Costs
Urban – rear end	36	17
Urban- right angle	9	16
Open road – single vehicle hit object	3	12
Urban – single vehicle hit object	8	12
Urban –right turn against	7	8
Open road – single vehicle no object hit	2	7
Urban - pedestrian	2	6

Detailed analysis of changes from 1980 or 1990 in collision types was not possible because of changes in definitions over the study period.

9. Conclusions and Recommendations

The study shows that crash risk varies with the level of road design. Of particular note are the benefits to be achieved from converting an undivided road in an urban environment to a divided road. The study also demonstrates that safety benefits can be achieved by road sealing and extending freeways.

Network average crash risks are recommended as benchmarks in the preliminary identification and ranking of black spots. In this instance, high risk locations are signaling a potential problem with the road environment. Any subsequent treatment will depend on a cost benefit analysis that takes into account both crash numbers and costs.

Although the speed crash risk is less than that it was in 1990, the study shows that speed is still a major contributing factor in crash occurrence and hence justifies the attention that it is currently getting by road safety agencies. It was found that speed contributed to some 20% of all reported crashes. This value was found to be higher for fatal crashes being 40% on the open road and 30% in the urban area.

Crash costs are recommended as a method for the optimum allocation of resources directed towards road safety improvement as they take into account both crash numbers and severity. For combating the speed problem this approach suggests a 70/30 split of resources between urban and open road.

Using a surrogate measure the study shows that fatigue is also a major contributing factor hence deserving special attention. About a third of open road crashes were assessed to be fatigue related rising to about 50% for fatal crashes.

When traffic is taken into account the night crash risk is higher than that of daytime particularly on the open road. Of special note for strategy planning is that the severity of night crashes is higher suggesting higher night operating speeds.

Crash severity is less now than it was in 1980. Using crash costs, the study suggests that the optimum allocation of the States current road safety resources should be a 70/30 split between urban and open road.

Urban rear end and right angle collisions have the highest proportions of the States crash costs having figures of 17% and 16% respectively. These types are followed by open road and urban hit object collisions.

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