Prioritising the Road Safety Programme

C. JAYASINGHE & L.L. RATNAYAKE *

ABSTRACT

All over the world, a large number of road accidents are occurring every year causing loss of life, injuries and loss of property. In a research study done in Sri Lanka, these losses had been quantified and it was shown that the total cost of traffic accidents in Sri Lanka is about 1% of the GDP of the country. Therefore, there is an urgent need to have a properly designed road safety programme to bring down the accident costs and save the lives. As the budget available for the road safety would be limited, especially in developing countries, it is vital to prioritise the road safety improvements. There are two such mechanisms identified in this research termed as Equivalent Accident Number (EAN) and the Weighted Accident Number (WAN). It is shown that the EAN is a better mechanism to rank an accident blackspots and the WAN, which is based on the collision type analysis, could be used to plan the road safety programme properly.

INTRODUCTION

Road traffic accidents cause a great economic loss to any country every year. The accident statistics clearly imply that there should be an urgent need to upgrade the road safety worldwide. Since the road safety improvements need a substantial amount of financial allocations, there should be a well-defined process to identify the locations where the improvements could be done on priority basis.

The safety management of a road network comprises of four interrelated components (Persaud et al, 1999):

- Identification of sites requiring safety investigations
- Diagnosis of safety problems

* *Mrs. Jayasinghe is Senior Lecturer, Institute of Technology, University of Moratuwa and Shri L.L. Ratnayake is Professor, Department of Civil Engineering, University of Moratuwa, Sri Lanka.*

- Selection of feasible treatments for potential solution
- Prioritisation of treatments within the limited budget.

It is important to have an efficient process for the identification of sites, which require safety investigations. If this is done in an improper manner, the resources can be wasted on sites that are incorrectly identified as unsafe, and sites that are actually unsafe being left out.

The overall economic loss due to road accidents to Sri Lanka could be evaluated as 1% of the Gross Domestic Product (Ratnayake & Jayasinghe 2001). According to the past accident records from year 1991 to year 2001, the number of accidents are on the increase. In year 2001, there were about 52,084 accidents, out of which 1961 were fatal, 3397 were grievous, 11,539 were non-grievous and 35,187 were vehicle damage accidents. There is an economic loss to the country from each accident. There were 21,858 casualties involved in road accidents in year 2001. This is about 0.12% of the population of the country.

Having considered various alternative approaches to prioritise the accident locations, this research has focused on the Equivalent Accident Number (EAN) and the Weighted Accident Number (WAN) at accident blackspots. The EAN and the WAN have been used as the mechanisms to prioritise the accident blackspots, which need road safety improvements. A detail study on EAN and WAN of the black spots revealed that, the Equivalent Accident Number (EAN) is a better tool than the Weighted Accident Number (WAN) to prioritise the road safety programme. However, when designing the road safety programme at a particular blackspot, the collision type analysis, which is used in WAN, could describe the necessary countermeasures properly. Therefore, both the EAN and the WAN evaluations are important for prioritising the road safety programme and for designing of countermeasures.

This paper describes a research study done in Sri Lanka, based on the past accident statistics which were obtained from the Computer Division of Police Department of Sri Lanka.

OBJECTIVES

The main objectives of this research can be identified as follows:

- Identification of magnitude of the economic problem due to road accidents

- Development of more suitable methods to identify accident blackspots
- Identification of prioritising techniques for road safety programmes.

METHODOLOGY

In order to achieve the above objectives, the following methodology was adopted:

- An overall analysis was carried out for the past accidents using the accident records in Sri Lanka from year 1991 to year 2001. This analysis was used to identify the magnitude and trends of road safety problem in Sri Lanka.
- A mechanism has been established in order to rank the accident blackspots. In this process ten locations, which could be considered as high accident-prone locations, were selected and ranked in the order of priority for the road safety improvements. The main mechanisms used in prioritising the accident blackspots are Equivalent Accident Number and the Weighted Accident Number.
- A comparison of EAN and the WAN has been done in order to select the better indicator.

IDENTIFICATION OF ACCIDENT BLACKSPOTS - DIFFERENT APPROACHES MADE IN OTHER COUNTRIES

Five methods were considered to identify the hazardous locations in a study done in Thailand. The methods are accident frequency method, the accident rate method, the quality control method, the accident severity method and a combination of several methods (Ratanavaraha V, 1999).

In Australia, different policies have been established in order to make the expenditure on black spot treatment programme efficient and effective. Funds are divided between the states and territories on the basis of a weighting system (PEA, 2001).

The weights were calculated on the basis of average population and the number of casualty crashes in each territory in the three years before the programme started.

Although there are fewer crashes in regional areas relative to urban areas, regional crashes tend to be more severe. Motorists in regional areas generally face a higher risk of fatal and serious injury crashes than their urban counterparts. The blackspot programme is targeted at reducing death and injury, rather than minimising total estimated crash costs. Only locations that have had casualties are eligible under the crash criteria.

In Victoria, the blackspot programme is administered by the Transport Accident Commission (TAC) implemented by VicRoads, and evaluated by the Monash University Accident Research Centre (MUARC). It has been found that with the blackspot intersection treatments, casualty crash frequencies fell by an average of 33% (PEA, 2001).

The past research has shown that the number of accidents at a particular site will vary widely from year to year. When ranking the accident locations, comparisons between the number of accidents at particular sites must be made with respect to a fixed time period, typically one year. Ideally, several years data are required, from which a mean annual accident rate can be calculated. Three years is generally regarded as a practical minimum period for which a reasonably reliable annual average rate can be calculated. (Ross Silcock partnership, 1991).

In order to identify a location as an accident blackspot, the use of annual number of accidents at an intersection is a straightforward concept. When there is a road link with a higher number of accidents, the problem is expressed in terms of accident density i.e. accidents per kilometre.

The severity of accidents should also be taken into account, as accidents with fatal and grievous injuries are more costly in both social and economic terms. The severity can be measured in terms of accident costs (Ross Silcock partnership, 1991). When possible, the effect of traffic volume should also be considered. In simple terms, more traffic could be expected to lead to more accidents. If traffic flow data is available, the sites can also be compared in terms of accidents per million vehicles entering an intersection or accidents per million-vehicle kilometre on a link. This gives an indication of the relative safety of sites, given their traffic volumes (Ross Silcock partnership, 1991).

Although the traffic volume at a location plays an important role, the flow data is rarely available in sufficient quantity and accuracy to justify this approach. Therefore, it is recommended that effort be concentrated on collecting comprehensive and accurate accident data, and the blackspots be identified on the basis of annual number of accidents and weighted to reflect the severity.

ACCIDENT ANALYSIS FOR SRI LANKA

The accident statistics from year 1991 to year 2001 have been summarised for different severity classes in Table-1 and the casualties involved in accidents have been summarised in Table-2.

Table-1 : Number of Annual Road Accidents in Sri Lanka

Class of Accidents	Year										
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Fatal	1255	1302	1346	1414	1481	1560	1705	1874	1915	1983	1961
Grievous	1899	2112	2299	2554	2588	2615	3310	2393	2676	2292	3397
Non Grievous	9685	10386	11687	11992	12233	11510	10037	11417	11642	11756	11539
Damage	21305	23977	26163	27855	31837	32990	33481	35275	37281	37509	35187
Total	34144	37777	41495	43815	48139	48675	48533	50959	53514	53540	52084

Table-2 : Annual Road Accident Casualties in Sri Lanka

Class of Accidents	Year										
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Fatal	1532	1515	1421	1611	1681	1755	1835	2023	2038	2151	2062
Grievous	2153	2395	2652	3022	3316	3512	3621	3172	3607	3905	4211
Non Grievous	11542	12582	14530	15592	16726	17358	15903	15023	15770	15964	15585
Total	15227	16492	18603	20225	21723	22625	21359	20218	21415	24020	21858

Trends of Accidents in Sri Lanka

It is important to get an idea about the annual variation of road accidents. Therefore, the total number of accidents for each year is graphically presented in Chart-1.

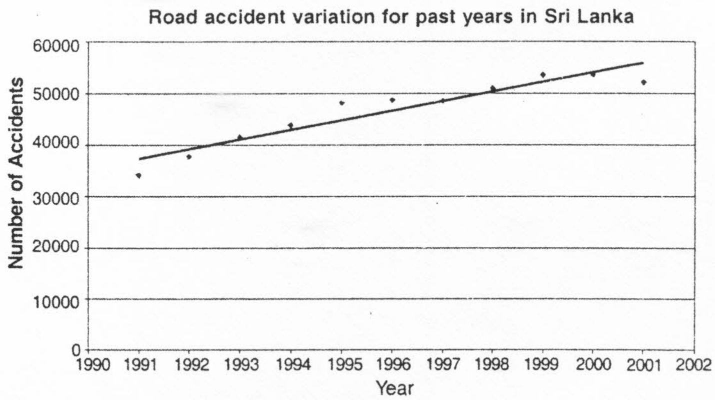

Chart-1: Annual Growth of Road Accidents in Sri Lanka

According to Chart-1, it is clear that there is a gradual increase in road accidents. The rate of increase in accidents is about 7% per year. If accidents increase at such a rate, after ten years there can be nearly 100,000 accidents occurring annually in Sri Lanka.

Fatality Rate per 100,000 Population

Since the most serious type of accident is the fatal, which causes a heavy impact to the economy of the country, the fatality rate has been expressed in Chart-2.

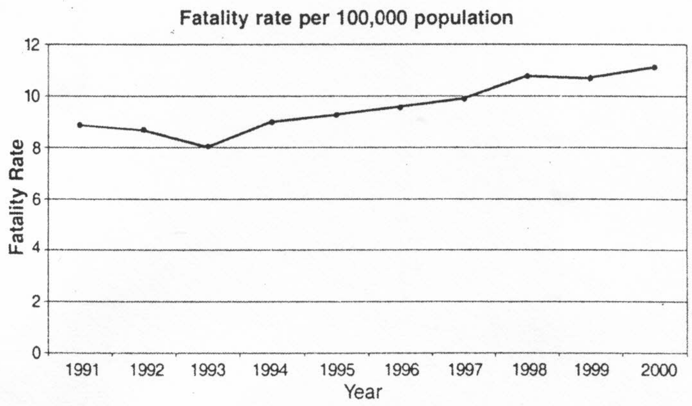

Chart-2 : Fatalities per 1,00,000 Population in Sri Lanka

Chart-2 explains the fatalities per 1,00,000 population in Sri Lanka. It can be inferred that starting from 1993, the fatal casualties have increased gradually. In 2001, fatalities per 100,000 population are 11. This value is much higher than that of the total fatality rate in developed countries, which is about 2 fatalities per 100,000 population (Wetteland and Lundebye, 1997).

Fatalities per 10,000 Operational Vehicles

Chart-3, indicates the fatalities per 10,000 operational vehicles. From year 1991 to 1993, there is a decrease in fatalities per 10,000 operational vehicles. But since 1993, it has not altered much. It is about 13 fatalities per 10,000 operational vehicles. This is a considerable value when compared to the developed countries, which has 2 to 5 deaths per 10,000 operational vehicle (Wetteland and Lundeby, 1997).

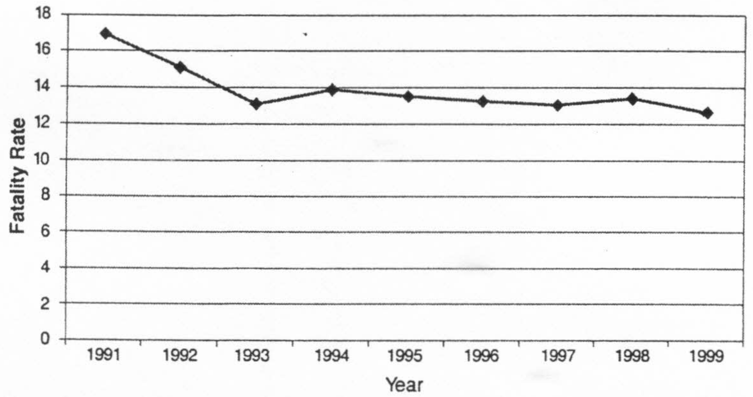

Chart-3 : Annual Variation of Fatalities per 10,000 Operational Vehicles

Economic Loss to Sri Lanka Due to Road Accidents

The cost of traffic accidents in Sri Lanka was evaluated using the net out put approach described in Lay (1986) by Ratnayake and Jayasinghe (2001). The cost components of accidents are given in Table-3 for year 2000. These costs could be used to determine the equivalent accident numbers (EAN). For this, the EAN of a damage only accident is considered as 1. The corresponding values for other types were obtained by dividing the accident cost by the cost of a damage only accident.

It is somewhat difficult to quantify the cost reflecting pain, grief and suffering caused to relatives and friends of the accident victims. In a study of evaluating accident costs in India, the quantifiable costs have been increased by 20% to take account of pain and grief (Fernando and Fernando, 1994). Hence when evaluating the accident cost, the quantifiable cost has been increased by 20% in order to take account of cost reflecting pain and grief.

Evaluation of Equivalent Accident Number

The accident cost can be used to calculate the Equivalent Accident Numbers (EAN). If the vehicle-vehicle damage only accident cost is taken as 1.0 unit, the EAN for other types of accidents can be evaluated as given in Table-3.

Table-3 : Equivalent Accident Numbers

Type of Accident	Cost per accident in Sri Lankan Rupees	EAN Evaluation	EAN
Fatal	1,312,326	1,312,326 / 89752	14.6
Grievous	707,443	707,443 / 89752	8
Non grievous	102,755	102,755 / 89752	1.14
Damage only	89,752	89,752 / 89752	1.0

The cost figures should be considered as approximate only since a number of assumptions were made in the cost analysis. However, any error in these values could be in the same order of magnitude, thus not affecting EAN values very much.

DETERMINATION OF WEIGHTED ACCIDENT NUMBER (WAN)

Another index called weighted accident number was developed which could identify the type of accident. This is based on the type of accidents given in the accident form used by the police. When the accidents are reported to the police, an accident form, which gives as much information as possible, is filled up. This could be subsequently used to make a computerised database for the accidents. For example, if the accident is a head-on collision, it is recorded as an approaching collision. Fourteen such collision types are identified in the police accident form. The types are as stated below :

- Approaching collision
- Angle collision
- Rear end collision
- Sideswipe
- Turning vehicles coming from different directions
- Turning vehicles coming from same direction
- Single motor vehicle/Parked car
- Single motor vehicle
- Pedestrian
- Vehicle passenger
- Cyclists
- Animal
- Fixed object
- Other

Table-4 shows the number of accidents falling into different collision types in year 2000. The collision types were extracted from the accident database maintained by the police. It was found that no accident had fallen into the category of "vehicle passengers". Therefore, it has not been included in the collision type table with year 2000 data.

Table-4 : Collision Type Distribution in year 2000

Collision type	Accident distribution for 2000				
	Fatal	Grievous	Non Grievous	Damage only	Total
Approaching	210	473	1104	2472	4259
Angle	4	5	30	175	214
Rear end	31	102	399	5460	5992
Side-wipe	3	6	31	486	526
Turning, different direction	0	1	9	45	55
Turning, same direction	0	3	11	51	65
SMV/parked car	5	17	39	604	665

Collision type	Accident distribution for 2000				
	Fatal	Grievous	Non Grievous	Damage only	Total
SMV	48	36	188	786	1058
Pedestrian	863	1102	4773	0	6738
Cyclist	331	396	1755	321	2803
Animal	6	11	71	789	877
Fixed object	25	10	44	566	645
Other	457	130	3302	25754	29643
Total	1983	2292	11756	37509	53540

It is important to find out the seriousness of the collision type of accidents. This can be quantified using the accident costs. In order to quantify the severity of each collision type, the average cost of an accident for a particular year will be considered as unity. The severity of different collision types has been measured on the basis of the average cost of an accident. This is called the severity factor of each collision type.

The Average Cost of an Accident

The average cost of an accident can be defined as follows:

$AC_{avg} = TC / N$ .... equation (1)

Where, AC_{avg} – average cost of an accident

TC – Total cost of accidents in one year

N – Total number of accidents in that particular year

In year 2000, there were 1983 fatal accidents, 2292 grievous accidents, 11756 non-grievous accidents and 37509 damage only accidents. This costs Rs. 8,798,281,331. The total number of accidents was 53540 and hence the average cost of an accident:

AC_{avg} = 8,798,281,331/53540

AC_{avg} = Rs. 164330.99

Severity Factor

The severity factor is a measure of severity on the basis of the average cost of an accident. For example, according to the accident database, in year 2000 for the head-on collisions (approaching accidents) there were 210 fatal, 473 grievous, 1104 non-grievous and 2472 damage only accidents. Specimen calculation of severity factor for approaching accidents for the year 2000 is given in Table-5.

Table-5 : Cost of Approaching Accidents

Collision type	Fatal	Grievous	Non Grievous	Damage only	Total
No. of Approaching Accidents	210	473	1104	2472	4259
Cost of approaching Accidents	275,588,250	334,620,066	113,440,416	221,866,944	945,515,676

The severity factors have been evaluated as follows:

Total accident cost of approaching collision type = Rs. 945,515,676

Total number of accidents of approaching collision type = 4259

Cost of an approaching accident, $AC_{approaching}$ = 945,515,676 / 4259

$AC_{approaching}$ = Rs. 222,004

Severity factor $_{approaching} = S_{f\ app} = AC_{approaching} / AC_{avg}$

$= 222{,}004/164{,}330.99 = 1.35$ (year 2000)

The severity factors have been evaluated for all the collision types for five years as given in Accident report form and summarised in Table-6. The average severity factors have also been evaluated in the Table-6. The average severity factors for different collision types are presented in graphical form in Chart 4 for the period of 1997 to 2001.

Table-6 : Severity factors for different collision types calculated for Sri Lanka

Collision Types	Severity Factor					Average Severity Factor
	2001	2000	1999	1998	1997	
Approaching	1.39	1.35	1.31	1.16	1.08	1.26
Angle	0.72	0.78	0.74	0.68	0.72	0.73
Rear End	0.61	0.65	0.63	0.65	0.62	0.63
Sideswipe	0.58	0.64	0.56	0.59	0.51	0.58
Turning, Different Direction	0.51	0.63	0.71	0.55	0.56	0.59
Turning, Same Direction	0.77	0.73	0.66	0.71	0.51	0.68
SMV/Parked Car	0.65	0.70	0.72	0.66	0.55	0.66
SMV	0.95	1.03	1.02	1.05	1.05	1.02
Pedestrian	2.02	2.17	2.01	1.97	1.70	1.97
Cyclist	1.85	2.01	1.90	1.71	1.56	1.80
Animal	0.69	0.65	0.68	0.63	0.61	0.65
Fixed Object	0.76	0.90	0.84	0.70	0.67	0.77
Other	0.73	0.69	0.74	0.76	0.89	0.76

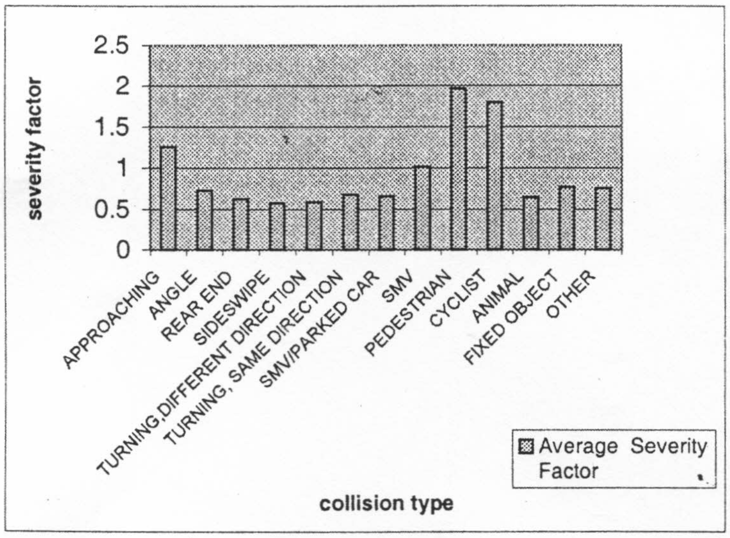

Chart-4 : Average Severity Factors for Collision Types

According to Chart-4, the pedestrian collision type category has got the highest severity factor - about 1.97. The other collision types with high severity factors are cyclist, approaching and single motor vehicle type.

Weighted Number of Accidents

Using the known severity factor, S_f the actual number of accidents occurred at a blackspot can be transformed to the weighted Accident Number, considering the collision type analysis of the location. The weighted accident number (WAN) at a particular location can be evaluated as follows:

$$WAN = (An_{approaching} \times S_{f\ approaching}) + (An_{angle} \times S_{f\ angle}) + \text{..........} \quad \text{equation (2)}$$

Where, WAN = weighted accident number

$An_{approaching}$ = Number of approaching accidents

$S_{f\ approaching}$ = Severity factor for approaching accidents

The number of accidents at selected blackspots, given in Table-7 has been transformed to weighted accident numbers. The weighted accident number at a location reflects the accident severity and its monitory impact to the society.

MECHANISM FOR PRIORITISING THE SAFETY IMPROVEMENTS

In order to determine the usage of number of accidents, EAN and WAN, a case study was performed at ten locations identified as accident blackspots. The number of accidents were determined by considering the past accident records from year 1998 to 2000 (the average values were used in the study). These records are given in Table-7. It describes the junction type, the average number of accidents per year and severity. Since average values are used, some accidents are presented with decimal points. The equivalent accident numbers have been evaluated on the basis of severity classes and the cost of accidents.

Table-7 : Number of Accidents at Selected Blackspots

ID No.	Location	Junction Type	Division	Urban/ Suburban	Average No. of accidents Per year	Severity (Average No. of accidents)				EAN
						Fatal	Grievous	Non Grievous	Damage	
1	Dehiwala Junction	4-Leg	Mt. Lavinia	Urban	57.33	1.00	0.33	4.67	51.33	73.85
2	Rawattawatta (Moratuwa) junction	4-Leg	Mt. Lavinia	Urban	57.89	3.89	2.11	10.44	41.44	126.58
3	Duplication Road Bullers Road Intersection	4-Leg	Colombo	Urban	62.33	0.33	1.00	4.67	56.33	74.32
4	Castle Street Baseline Road	4-Leg	Colombo	Urban	149.88	2.78	1.00	12.33	133.78	196.19
5	James Peries Opposite Nawaloka	4-Leg	Colombo	Urban	111.65	1.56	1.00	7.33	101.78	141.00
6	Yakkala Junction	4-Leg	Gampaha	Urban	63.55	2.11	0.78	18.22	42.44	100.10
7	Havelock Road Thummulla Junction	5-Leg	Colombo	Urban	84.33	1.67	1.33	5.33	76.00	116.80
8	Nalluruwa	3-Leg	Panadura	Suburban	39.00	5.00	4.00	14.00	16.00	136.00
9	Egoda-Uyana	Link	Mt. Lavinia	Suburban	34.67	3.67	3.67	10.33	17.00	110.91
10	Wnnapuwa town to Thbarawila	Link	Chilaw	Urban	27.33	5.33	5.33	5.00	11.67	136.83

The collision types occurred at each location of the sample have been extracted and presented in Table-8, after analysing data for three-year records (year 1998 to 2000).

Table-8 : Collision Type Analysis at Blackspots

ID	Location	Number of accidents													
		Approa-ching	Angle	Rear End	Sidewipe	Turning	SMV/ Parked Car	SMV	Pedes-trian	Passen-gers	Cyclist	Animal	Fixed object	Other	Total Accidents
1	Dehiwala Junction	1.333	0.333	6.333	4.000	1.667	0.667	1.667	3.667	0.000	0.333	0.333	0.333	36.667	57.33
2	Rawattawatta Junction (Moratuwa)	0.333	0.333	7.667	1.333	1.667	0.000	0.333	10.000	0.000	2.333	0.000	1.000	32.888	57.89
3	Duplication Road Bullars Road I/S	1.667	3.333	8.667	0.333	0.667	0.333	1.333	1.667	0.000	1.000	0.000	1.000	42.333	62.33
4	Castle Street Baseline Road	1.333	0.333	9.000	1.000	0.667	0.333	9.667	9.667	0.000	1.667	0.000	3.000	113.223	149.89
5	James Peries opposite Nawaloka	4.333	1.333	10.333	2.667	1.000	0.000	9.000	5.333	0.000	0.667	0.000	2.667	74.332	111.67
6	Yakkala Junction	2.667	0.000	2.000	1.000	0.333	1.000	0.000	8.000	0.000	2.000	0.000	2.333	44.221	63.55
7	Havelock Road Tummulla Junc.	1.667	3.000	10.000	3.000	2.667	0.333	2.333	4.333	0.000	0.333	0.000	1.000	55.667	84.33
8	Nalluruwa	0.333	0.333	4.000	1.333	0.000	0.333	1.333	9.333	0.000	6.667	0.333	0.667	14.333	39.00
9	Egoda Uyana	0.333	0.333	4.000	0.333	0.000	0.333	1.333	8.333	0.000	1.333	0.000	0.333	17.993	34.66
10	Wennapuwa Town to Thabarawila	1.667	0.667	0.667	0.000	1.000	0.000	2.667	4.333	0.000	4.667	0.333	2.000	9.333	27.33

Table-9 : Weighted Accident Numbers at Blackspots

ID No.	Location	Weighted Accident Number													
		Approa-ching	Angle	Rear End	Sidewipe	Turning	SMV/ Parked Car	SMV	Pedes-trian	Passen-gers	Cyclist	Animal	Fixed object	Other	WAN
1	Dehiwala Junction	1.679	0.243	3.989	0.773	1.058	0.440	1.700	7.223	0	0.599	0.216	0.256	27.866	46.047
2	Rawattawatta Junction (Moratuwa)	0.419	0.243	4.830	0.193	1.058	0	0.339	19.7	0	4.199	0	0.77	24.994	56.748
3	Duplication Road Bullars Road I/S	2.100	2.433	5.460	0.58	0.423	0.219	1.359	3.283	0	1.8	0	0.77	32.173	50.603
4	Castle Street Baseline Road	1.679	0.243	5.67	1.546	0.4235	0.219	9.860	19.043	0	3.00	0	2.31	86.049	130.047
5	James Peries opposite Nawaloka	5.459	0.973	6.509	0.58	0.635	0	9.18	10.506	0	1.200	0	2.053	56.492	93.589
6	Yakkala Junction	3.360	0	1.26	1.74	0.2114	0.66	0	15.76	0	3.6	0	1.796	33.607	61.996
7	Havelock Road Tummulla Junction	2.100	2.19	6.3	0.773	1.693	0.219	2.379	8.536	0	0.599	0	0.77	42.306	67.868
8	Nalluruwa	0.419	0.243	2.52	0.193	0	0.219	1.359	18.386	0	12.00	0.216	0.513	10.893	46.964
9	Egoda Uyana	0.419	0.243	2.52	0	0	0.219	1.359	16.416	0	2.399	0	0.256	13.674	37.508
10	Wennapuwa Town to Thabarawila	2.100	0.486	0.420	0	0.635	0	2.720	8.536	0	8.400	0.216	1.54	7.093	32.149

From Table-8, it is clear that the accidents categorised under the category "other" (not clearly known) dominates the exclusive types. This highlights the importance of improving the recording of accident information since the usefulness of the computerised databases will depend on the accuracy of the data included. The evaluation of WAN is described in Table-9, with the weightage given to each collision type (A_n x S_f) (equation 2). Table-9 presents the WAN values for the selected accident blackspots.

Selection of the Most Suited Prioritising Mechanism

In Table-10, all three indicators are presented for comparison. In addition to the number of accidents, EAN and WAN the last two columns of Table-10 gives the EAN per accident and WAN per accident at the selected blackspots.

Table-10 : Prioritising Mechanisms

ID No.	Location	No. of Accidents	EAN	WAN	EAN/ accident	WAN/ accident
1	Dehiwala Junction	57.33	73.85	47.60	1.28	0.83
2	Rawattawatta Junction	57.87	126.58	57.34	2.18	0.99
3	Duplication road Bullars road	62.33	74.32	50.22	1.19	0.80
4	Castle Street Baseline Road	149.89	196.19	129.08	1.30	0.86
5	James Peries opposite Nawaloka	111.67	141.00	94.56	1.26	0.85
6	Yakkala Junction	63.55	100.10	60.84	0.96	0.95
7	Havelock Road Tummulla Junction	84.33	116.80	68.85	1.89	1.12
8	Nalluruwa	39.00	136.00	47.55	3.49	1.22
9	Egoda Uyana	34.67	110.91	37.70	3.19	1.09
10	Wennapuwa Town to Thabarawila	27.33	136.83	32.15	5.00	1.18

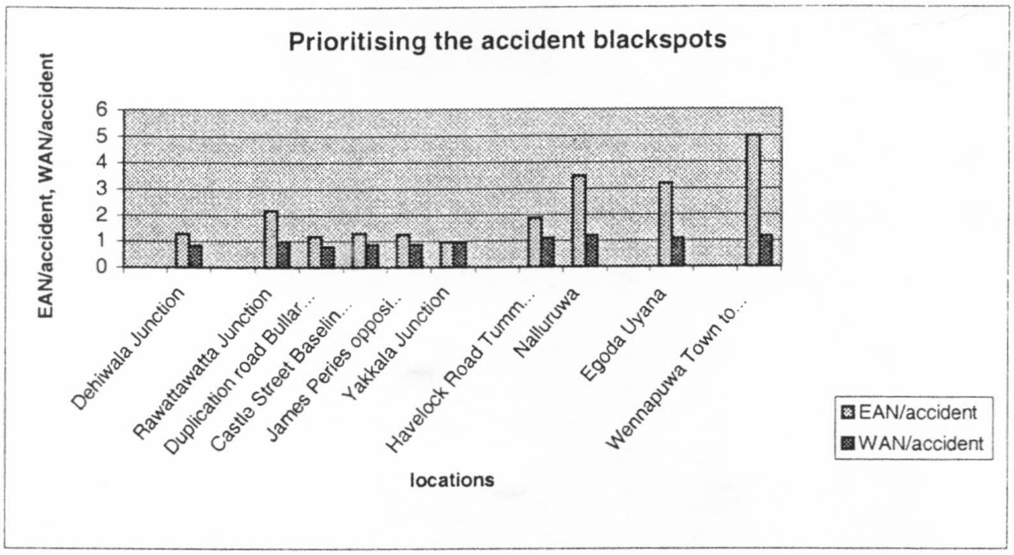

Chart-5 : Prioritising Mechanisms for Accident Blackspots

The two mechanisms described in the paper, such as EAN and WAN values are presented in Table-10 for the selected blackspots. The same table presents the EAN value per accident and WAN per accident as well. The measure of severity given by EAN per accident and WAN per accident are shown in Chart-5.

Locations 2,4,5,6,7,8,9 and 10 are having considerably high EAN values and locations 4,5,6 and 7 are having relatively high WAN values. Locations 4,5, and 7 are having higher number of accidents. These individual measures are giving some indication about the number of accidents and severity of the location.

A comparison of EAN per accident and WAN per accident is done in Chart-5. EAN per accident gives a considerable variation than WAN per accident. EAN per accident is higher at locations with high number of fatal and grievous accidents. Therefore, in order to select the location with the highest severity, EAN per accident has been selected. This gives the order of priority as given in Table-11. Therefore, it can be seen that the locations with higher number of fatal and grievous accident proportion are given priority using the established mechanism (EAN / accident).

However, the collision type analysis and the WAN are important to determine the appropriate safety measures that should be introduced at the selected blackspots. The collision type analysis properly identifies the problem at the accident blackspot, such as the proportion of rear end collisions, approaching, pedestrian and so on. Hence the road safety programme can be designed properly aiming the collision types occurred frequently, at the location.

Table-11 : Priority Order of Selected Blackspots

Order of priority	Location	EAN/ accident	Accidents			
			Fatal	Grievous	Non Grievous	Damage
1	Wennappuwa town Thabarawila	5.00	5.33	5.33	5.00	11.67
2	Nalluruwa	3.49	5.00	4.00	14.00	16.00
3	Egoda Uyana	3.19	3.67	3.67	10.33	17.00
4	Rawatawatta	2.18	3.89	2.11	10.44	41.44
5	Havlock Road Thunmulla junction	1.89	1.67	1.33	5.33	76.00
6	Castle street Baseline Road	1.30	2.78	1.00	12.33	133.78
7	Dehiwala Junction	1.28	1.00	0.33	4.67	51.33
8	James Peiris Opposite Nawaloka	1.26	1.56	1.00	7.33	101.78
9	Duplication Road Bullars Road	1.19	0.33	1.00	4.67	56.33
10	Yakkala Junction	0.96	2.11	0.78	18.22	42.44

CONCLUSIONS

It has been clearly shown in this paper that the road accidents cause a great economic loss to the country. Therefore, it is obvious that some money needs to be invested on road safety programmes. Since the money allocations for road safety is limited in developing countries, it is essential to prioritise the road safety programme.

There were two mechanisms identified and analysed in this research in order to prioritise the safety programme. The accident blackspots were identified by the number of accidents. Then the Equivalent Accident Number (EAN) of the blackspot was evaluated based on the accident severity and the cost. The second indicator was Weighted Accident Number (WAN), which takes the collision types into account and its severity. When the two indicators EAN and WAN were compared with the number of accidents, the EAN per accident gives a better indication about the severity of accidents. Therefore, the EAN per accident could be used to rank the blackspots in the order of priority for the safety improvements. Since the WAN and the collision type analysis give a better understanding about the type of accidents, this could be used when designing the safety programmes.

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