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Guideline on Accident-Prone Area Identification

for Automated Enforcement System (AES)

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Automated Enforcement System (AES) related department:

Road Transport Department (RTD)
Royal Malaysia Police (RMP)
Public Works Department (PWD)
Malaysian Highway Authorities (MHA)

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Abstract

The Automated Enforcement System (AES) is listed as one of the strategies employed under the Malaysian Road Safety Plan 2006–2010. The programme had been started since the year 2006, but only recently was the programme implemented at 14 pilot sites, in the year 2012. The programme has shown positive results in reducing the number of crashes related to speed and red light running. Studies have shown that the effectiveness of this programme is highly related to the accuracy and appropriateness of camera placement. Hence this guideline provides a guide in determining the accident-prone areas (Kawasan kerap kemalangan) that are to be installed with the Automated Enforcement System (AES).

This guideline is produced by taking into account all the comments and feedbacks gathered after the four months period of the AES pilot stage implementation. Guidelines or handbook as well as criteria used by other country in determining the camera placement for this safety camera programme are also reviewed to ensure the accident-prone areas determined for AES is accurate. The AES uses high-technology cameras to detect traffic offenders, including those who run against the red traffic light sign and exceed the speed limit. Subsequently it is hoped that the implementation of AES would not only detect these traffic offenders but to reduce the number of road crashes at the determined locations.

Finally from this guideline, two sets of accident-prone areas; the core sites and exceptional sites are produced. The accident-prone areas are determined by using the national accident data for the years 2008–2011, which was obtained from the Royal Malaysia Police (RMP). The ranking analysis, set conditions for accident data and prioritisation of accident-prone areas are discussed in this guideline so that it could be used as a guide to determine future locations for camera placement.

1.0 Introduction

For the past ten years the number of road traffic fatalities in Malaysia shows an upward trend and more than 6,000 cases recorded every year. In the year 2011 alone, 449,040 road traffic accidents occurred in Malaysia. From this figure, 6,260 fatal accidents which resulted in 6,877 fatalities due to road traffic accidents had taken place (RMP 2011). This situation needs to be taken seriously because each live lost due to road traffic crashes are estimated to be valued at RM 1.3 million; a great loss to the country.

Due to this alarming figure and to show that the government is committed in reducing the accident rate in this country, the government has launched the Road Safety Plan 2006–2010 in March 2006. The strategy of the effort is to focus on 5Es: Engineering, Enforcement, Education, Environment and Evaluation. In relation to this plan nine strategies were employed to achieve the objectives. These nine strategies contain one strategy related to the utilisation of technology for better and more effective enforcement. One of the programmes is the use of electronic or automated enforcement system. The implementation of automated enforcement has taken place widely in the developed countries namely Sweden, Switzerland, and Germany. Studies have shown that the implementation of this system has effectively reduced the number of accidents and fatalities; as well as increasing the compliance to the posted speed limit in the countries. The goal of automated enforcement is to complement conventional law enforcement by significantly increasing the objective and perceived chances of being caught, thereby creating a reduction in the act of speeding, which will in turn lead to a reduction in the number of crashes.

Looking at the local road safety situation, motorcyclists are a group with the biggest involvement in accidents and contribute to the biggest percentage of fatalities; nearly 60% of the overall road fatalities when compared to other road user groups. This is followed by car occupants and pedestrians. Based on an in-depth investigation conducted by the Crash Reconstruction Unit of MIROS; risky driving, speeding and fatigue are the main causes of traffic accidents. Similar findings can be found in the Statistical Report Road Accident Malaysia 2011, where analysis by collision type showed that out of control is the biggest contributor to the number of fatal accidents. The out of control can be associated with speeding behaviour. While in the same report it can also be found out that the number of accidents at signalised intersection is also high. Meanwhile in terms of the accident location, most of these accidents occurred on federal roads which constituted about 38.6% of the overall accidents.

Locations where road traffic crashes have historically concentrated on are called blackspots or accident-prone areas. A location can be considered as an accident-prone area when a sufficient number of accidents occurred and common factors are likely to be the susceptible treatment.

Close to the end of 2011, MIROS has produced a list of location for AES camera placement. The list contains 831 accident-prone locations with 566 locations related to speed and 265 locations at signalised intersection. Similarly the list was prepared using the national accident data obtained from the police but specifically applying the accident data for the year 2009. The list was also produced with the objective to fulfil the number of locations that had already been stipulated in the AES agreement. The list of location is part of the AES agreement between the government and the service providers.

1.1 Scope

The purpose of this guideline is to provide instructions and reference in determining camera locations for Automated Enforcement System (AES) in Malaysia. It is intended to determine the AES camera location and the review of AES camera locations in the future, which will give a maximum impact to road users. The guideline also serves as a reference in the implementation process.

This guideline specifies criteria for selection of AES camera which will be one of enforcement approaches in Malaysia. The criteria are generic and are intended to be applicable in Malaysia. Where any criteria or requirements in this guideline cannot be applied due to the nature of the road environment or traffic operation characteristics, other better or equivalent guidelines should be referred to. In such cases, claims of conformity to this guideline are not acknowledged.

2.0 Literature Review

In preparing this guideline, practices adopted elsewhere have been reviewed. The current practice in Malaysia was reviewed and some improvements have been made to justify the need for AES camera placement. There are many ways used to determine a blackspot, from the traditional approach to a more scientific approach. One of them is verbal information from the local residents at the area who have observed the crash trend could also be taken as a recommendation. However, an analysis using the crash data collected by the police will be a more accurate and effective method in determining blackspot locations.

2.1 Blackspot Identification in Malaysia

In Malaysia, blackspot identification has been carried out since the early 1990s. The process of identifying was further simplified in the year 1992 when the Royal Malaysia Police started adopting the use of a standardised form called POL 27 to collect accident information. In the year 1998, a guide for accident blackspot identification and road safety countermeasures was introduced by the Road Engineering Association of Malaysia (REAM) and the Public Works Department. The guideline specified that a blackspot can be in the form of a single site, a section of a route or an area-wide phenomenon. The traditional approach of identifying a blackspot location is by identifying a site with a higher than average number of accidents.

A blackspot or accident-prone area could be determined and the list could be long, hence there is the need to prioritise and determine the spots that are critical. Below are some of the ways to prioritise the blackspot for engineering remedial or intervention.

a) Ranking by accident maps

This method displays the frequency of accidents at each blackspot as a dot or circle and the circle size is proportional to the frequency of accidents. The bigger the circle, the higher the number of accidents at the spot.

b) Nodal analysis

Nodal analysis displays the accidents within 20 m from major junctions. This method is appropriate in determining accident locations near junctions.

c) Analysis on link accidents

A link accident is defined as any accident that occurs between two major junctions. Prioritisation of the blackspot is determined by the frequency of accidents on the link and to be compared with the length of the link.

d) Analysis on cell accidents

A cell accident is an accident that occurs in areas bound by a series of links and node. In this method, accident rates in cells per unit area or per unit length or road network are used in blackspot prioritisation.

e) Ranking by accident point

The Highway Planning Unit (HPU) adopted an accident point system that is based on weightage to compute site priority. Under the earlier implementation of this method, a fatal accident is given 6.0 weightage points, while serious, slight and damage-only accidents are assigned 3.0, 0.8 and 0.2 points respectively.

f) Ranking by accident cost

Another way to obtain the priority list is by ranking the blackspot using the total costs of accidents. The figures proposed by the United Nations Economic and Social Commission for Asia and the Pacific in the year 1996 are RM 763,158, RM 76,316, RM 7,632 an RM 1,421 for each fatal, serious, slight and damage-only accident respectively.

g) Kilometre post analysis
   Ranking is done by using the information pertaining to the kilometre post provided by the police. The exact spot can be up to 100 m length.

h) Intervention level
   Intervention level is a cut-off level or point whereby actions are needed to remedy the blackspot locations. The cut-off point by frequency can be at five accidents per spot of about 50 m radius or three accidents of a similar type per spot of about 50 m radius. The prioritised location could also be based on the intervention level by HPU points which are 40 weighted points per kilometre per two years, or blackspots that rank in the top 200 worst points in the list.

Later in 1998, Ahmad Rodzi *et. al* supplemented the previous study by incorporating the use of Geographical Information System (GIS) in the accident data. The study came out with a system called SMKJ2 which is a GIS-based system with a function that displays tabulated number and visualised geographical outputs for treating accident problems.

A more recent study (Law 2000) offers the possibility of raising and solving problems related to street segments and intersections by developing a Road Accident View (RAV) package. The package consists of two main modules which are Geo-referencing and Road Accident View. The geo-referencing module is used to obtain accident location coordinates and information for each link and node, while the Road Accident View module is used to capture and store accident locations and also to carry out accident analysis. This mode is also capable of carrying out area-wide analysis which includes distribution plots for overall, vehicle, collision type and accident prone location ranking and specific location analysis.

2.2 UK Experience

In the UK, enforcement by camera is organised by partnerships between police, local authorities and the court. Here the enforcement covers both speeding and red light offenders. To emphasise that the camera enforcement objective is to reduce death and serious injuries by reducing the level and severity of speeding and red light offences, the cameras in the country are called safety cameras. The programme is part of the UK government's Road Safety Strategy that seeks a 40% reduction in fatalities and serious injuries by 2010 and a 50% reduction in fatalities and serious injuries to children (compared to the average of 1994–1998).

To ensure that the implementation is carried out effectively, the Department of Transport UK has came out with a Handbook of Rules and Guidance for the National Safety Camera Programme and is updated regularly each year. The handbook specifies the programme background and aims, the national and local partnership setup, the site definitions and enforcement requirements; partnership operations, performance and on-going data monitoring and few more important items.

In the handbook, a site is defined as a stretch of road where safety camera enforcement takes place. Table 1 summarises the criteria used to determine the placement of the safety camera.

Table 1 Criteria for fixed, mobile camera and signalised intersections in the UK

Criteria	Fixed camera	Mobile camera	Signalised intersection
Site length	Between 400 to 1500 m	Between 400 m to 3 km	
Number of fatal and serious collisions	At least 4 per km in last 3 years	At least 2 per km in 3 years	At least 1 in last 3 years
Number of personal injury	8 per km in last 3 years	At least 4 per km in last 3 years	
Causation factor	Speed related	Speed related	
Distribution of collisions	Collisions are clustered close together along a single stretch of road	High density of accidents distributed evenly along a stretch of road	

2.3 Australian Experience

In the state of Victoria, the Australian Monash University Accident Research Centre and Victoria Police have developed a formula for prioritising sites for the camera placement. The formula uses crash statistics by allocating a weighting of 80% to crashes resulting in fatalities and/or serious injuries, and 20% to crashes resulting in minor injuries. Minor injuries are included to help identify trends in crash incidence. The formula also accords weightings to how recent the crashes are, with 60% allocated to crashes happening within the past three years, and 40% allocated to crashes that took place seven years prior to this three-year period. According to the formula, an intersection which has had serious crashes take place more recently will be ranked higher than an intersection which has had less serious crashes. The collaborating road safety specialists agree that this weighting represents an appropriate balance of these key road safety indicators.

Meanwhile in Queensland, the red light camera was introduced in the year 1990 and was followed by the mobile camera in the year 1997. Only in the year 2007 was the fixed camera adopted. The site selection is based on high risk areas with a high number of speed-related crashes and a high risk of speed-related crashes due to the environment. The analysis is conducted using a five-year crash data and the sites for the camera placement are based on five relevant accidents in five years for a kilometre radius.

Another study conducted by Champness *et. al* (2005) analysed the time and distance halo effects of a mobile camera. The study found out that there is a significant reduction in the mean, 85th percentile speed and the number of vehicles exceeding the speed limit adjacent to the camera operation area. The effects of the camera however dissipate 1,500 m downstream from the camera location.

2.4 Other Guidelines

In the United States, a Speed Enforcement Camera Systems Operational Guideline was produced by the US Department of Transportation Federal Highway Administration to ensure that the system is implemented effectively. The guideline indicates that the key important thing to ensure that the programme achieves the highest level of safety; and public safety is the top aim of the programme, appropriate site selection is essential. It is generally unwise to select sites where speeding is common but crashes are rare because the public is likely to perceive these locations as “speed traps”. However, exceptions may be made in locations with many pedestrians and in neighbourhoods where speeding adversely affects quality of life. The site selection is based on crash history data, crash patterns and other factors such as the percentage of vehicles that speed. The guideline also mentions that citizen complaints can be used to determine locations with speeding-related problems.

3.0 Methodology

This section will discuss in more details the method in producing the accident-prone area list for the AES.

3.1 Data

The Royal Malaysia Police (RMP) plays a major role in road accident data collection, and throughout the years there is an abundance of data available for analysis. For each crash incident, the police use a standardised form called POL 27 to collect the crash information throughout the country. There are 91 variables collected for each accident. The variables include information related to the road environment, vehicle and road users that are involved in the crash. The information could be utilised to better understand the crashes formation so that the right and effectives countermeasures could be determined.

For the analysis to determine accident-prone areas (3K) for AES, the most important bits of information from the POL 27 that are to be used are the location information, collision type and control type. The analysis uses a four-year accident data set from the years 2008 to 2011. For the analysis, all levels of accident severity data is used inclusive of fatal accidents, serious accidents, slight accidents and property damage accidents. To ensure that the analysis is accurate and valid, the most important info from the accident dataset is the accident location information. The accident location information could be in terms of kilometre post or coordinate. For a year, the dataset is about 400,000 and for the four years the dataset is about 1.5 million.

3.2 Ranking Analysis

The analysis to determine the accident-prone areas is done using the ranking function in the MIROS Road Accident Database System (MROADS) application. Figure 1 shows the interface of MROADS. To ease the analysis process, the analysis will be carried out by state. Analysis for each state is then focused on districts, followed by ranking analysis by route, and finally ranking analysis by locations. The analysis of ranking for each state is shown in Figure 2.

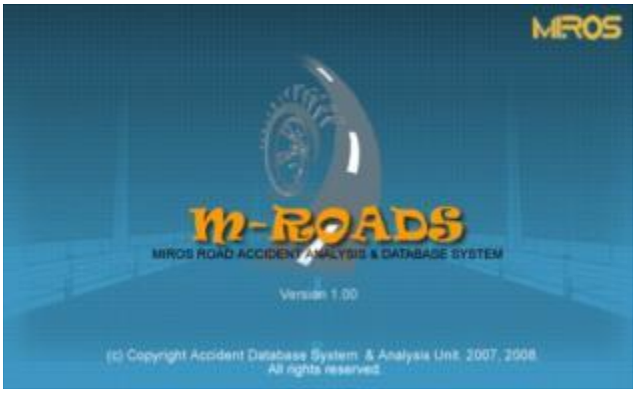

Figure 1 MIROS Road Accident Database System (MROADS)

Figure 2 Process of ranking the locations

The rank is based on the weightage point system to compute the location priorities. Using this weightage system, a fatal accident which involves at least one fatality is given 6 points, while 4, 2, and 1 points are assigned to serious, slight and damage-only accidents as shown in Table 2. This weightage system is adopted from 'A Guide for Accident Blackspot Identification and Road Safety Countermeasure' (Road Engineering Association of Malaysia 1998). The similar weightage system is also used by the HPU to determine blackspot locations in Malaysia.

Table 2 Weightage point for accident severity

Accident severity	Weightage points
Fatal	6
Serious	4
Slight	2
Damage only	1

3.3 Set Condition for Accident Data

3.3.1 Speeding

The locations for speed-related crashes are determined by a condition which is loss of control from the variable collision type in the POL 27 form. Loss of control is the best indicator which can be associated with speed-related crashes occurrence. Each year, loss of control constitutes about 24% of all fatal accidents. Figure 3 shows the data set and condition used for determining the accident-prone areas for speeding offence for AES. The output from the analysis in Section 3.2 will be tabulated in table format as per Figure 5, while the output in terms of geographical will also be produced.

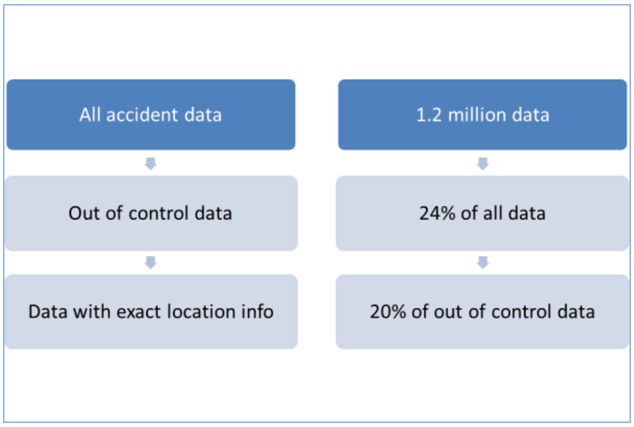

Figure 3 Data set and condition for speeding

3.3.2 Traffic Light

To determine accident-prone areas for camera placement at traffic lights, the condition used is the signalised intersection in the POL 27 form. Each year, the police data indicates show that about 3.7% of accidents occur at signalised intersections. The data set and conditions for determining the locations for red light AES cameras are shown in Figure 4.

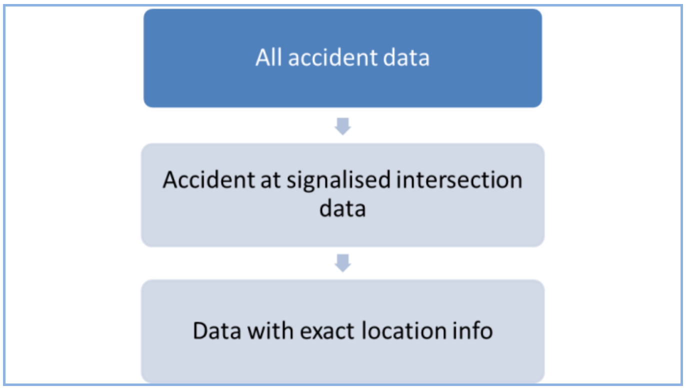

Figure 4 Data set and conditions for red light AES

3.4 Prioritisation of Accident-Prone Areas

After analysis using procedures in Section 3.2 and Section 3.3, a list of accident-prone areas is produced as in Figure 5. The list could be lengthy if no prioritisation is made. Based on the literature and experience in other countries, this guideline will prioritise the accident-prone areas for AES camera placement.

The additional analysis in this section includes the effects of other accidents within 5 km for each location. The weightage within a 1-km radius will be the highest, followed by a 3-km radius and finally the 5-km radius. Then, for every kilometre the scores will be added and the location with the highest score will be prioritised for AES camera placement.

Route Number : F0003

AE	AF	AG	AH	AI	AJ	AK	AL	AM
							Analysis based on 5km radius	
KM	Fatal	Serious	Slight	Damage Only	Total Cases*	Total Point **	Score Based on Total Cases	Score based on Total Points
60	0	0	0	2	2	2	61	133
61	3	0	0	6	9	24	108	270
62	0	1	0	0	1	4	72	165
63	0	0	0	0	0	0	85	173
64	0	0	0	1	1	1	93	150
65	0	0	0	5	5	5	145	232
66	0	1	0	8	9	12	166	271
67	2	1	0	7	10	23	178	340
68	1	0	0	1	2	7	118	237
69	0	0	0	3	3	3	101	181
70	0	0	0	0	0	0	59	116
71	0	0	0	1	1	1	59	103
72	1	0	0	2	3	8	59	123

Figure 5 Example of prioritising AES camera placement at F003
**Summation of total accidents per km*
*** Total points based on HPU weightage*

Figure 5 shows the example of this analysis for federal route 3 in Kemaman, Terengganu. Based on this figure, KM 67 has the highest score, followed by KM 61, so these two sites could be considered. However these two sites are not very far apart. Hence another factor for prioritising the sites is based on the distance of each AES camera placement. The guideline suggests that the minimum distance between each AES camera for speeding should be within a 30-km radius. Therefore for the example in Figure 5, only KM 67 will be selected for AES camera placement.

This guideline will produce two lists of accident-prone areas; the accident-prone areas for core sites and exceptional sites. The following section will explain in detail these two lists.

3.4.1 Accident-Prone Areas – Core Sites

The accident-prone areas for core sites are determined based on the following criteria, as shown in Table 3.

Table 3 Criteria for accident-prone areas at core sites

Speeding	Traffic light
• ≥ 200 points **and** ≥ 2 fatal accidents **OR equivalent** • ≥ 200 points **and** ≥ 2 injury accident **and** total cases ≥1 0	• 1 fatal accident **OR** • 3 injury accidents

The list from the core sites are deemed suitable for AES camera installation except if the site verification indicates that the sites are not suitable due to road engineering limitations. An example of the list of accident-prone areas for the core sites is in Appendix A.

3.4.2 Accident-Prone Areas – Exceptional Sites

Accident-prone areas that are considered exceptional sites are based on the following criteria, shown in Table 4.

Table 4 Criteria for accident-prone areas at exceptional sites

Speeding	Traffic light
• < 200 points **and** ≥ 1 fatal accident **OR equivalent** • < 200 points **and** ≥ 1 injury accident **and** total accidents ≥ 6	• 2 injury accidents

The locations based on this list are to be used as a bottom up approach for consideration of AES camera placement for the locals. An example of the list of accident-prone areas for the exceptional sites is in Appendix B. If the site verification conducted by the local verification team found out that the sites are essential for AES camera placement, the site is accepted for AES camera placement.

The local verification team is also free to suggest any sites as long as the sites fulfil the criteria in Table 3 and Table 4. The local verification team can suggest the sites nevertheless the data is yet to be verified by the local police. The report from the site verification is to be submitted to the RTD at central level and the suggested list of location from the local verification team is once again needs to be verified at the central level. Once RTD, RMP and MIROS verify the sites at the central level, the sites will be accepted for AES camera placement and the finalised list of exceptional sites should be updated accordingly.

4.0 Stakeholders Engagement

Based on the experience of the implementation of AES during the pilot phase, MIROS has taken the initiative to come out with evidence-based and strategic approach of identifying the accident-prone areas for AES. MIROS has a series of engagement with related road safety authorities. Table 5 shows some of the engagement activities conducted for AES accident-prone area identification.

Table 5 Engagement activities

No	Date	Activity
1	4 December 2012	MIROS discussion with MHA DG
2	21 December 2012	MIROS discussion with RMP Traffic Chief
3	26 December 2012	MIROS discussion with RTD DG
4	3 January 2013	MIROS Presentation to pre-cabinet meeting
5	15 January 2013	MIROS discussion with RMP
6	17 January 2013	MIROS discussion with MHA
7	18 January 2013	MIROS discussion with local road safety expert
8	22 January 2013	MIROS discussion with RMP
9	25 January 2013	MIROS discussion with RSD DG
10	28 February 2013	MIROS presentation to RTD, MHA, PWD
11	6 March 2013	MIROS presentation to RTD
12	2 April 2013	MIROS presentation to AES Steering Committee
13	10 April 2013	MIROS discussion with MOT Land Division
14	31 May 2013	MIROS meeting with stakeholders; RMP, RTD, PWD, MHA, RSD. All of the representatives agreed to accept this guideline

With this process, feedbacks from the relevant stakeholders were used to further improve the process of identifying accident-prone areas.

5.0 Conclusion

The identified accident-prone areas will be further subject to site verification for exact location identification which is suitable to install AES camera. The finalised locations are subject to approval by the relevant authorities.

The guideline serves as a general guide in determining accident-prone areas for AES installation. The guideline could be used in the future to help identify locations for AES camera placement if the current locations have successfully reduced the number of crashes. The guide can be improved on in the future to make the use of AES even more efficient.

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Appendix A

An Example of Accident-Prone Areas for Core Sites

Speed

Sarawak

Bil	District	Route no	Route name	KM	Fatal	Serious	Slight	Damage only	Total cases	Total point	Score	Score
1	Sarikei	F0001		422	1	1	1	70	73	82	976	1077
2	Kota Samarahan	F802	Jalan Dato Mohd Musa	13	1	0	0	10	11	16	279	361
3	Kota Samarahan	Q0002		13	1	0	0	16	17	22	271	322
4	Serian	F0001		16	1	2	0	4	7	18	107	222

Traffic Light

Kedah

No	District	Route number	KM	Route name		Fatal	Severe	Slight	Damage only	Total cases
1	Kuala Muda	F0001	36			0	1	2	0	3
2	Kuala Muda	F0001	54			3	3	7	1	14
3	Kuala Muda	F0067	5			2	2	1	0	5
4	Baling	F0067	20			0	0	3	0	3
5	Kuala Muda	K0010	1			0	1	0	0	1

Appendix B

An Example of Accident-Prone Areas for Exceptional Sites

Speed

Melaka

Bil	District	Route no	Route name	KM	Fatal	Serious	Slight	Damage only	Total cases	Total point	Score	Score
1	Jasin	M0014		28	1	0	0	6	7	12	106	196
2	Jasin	M0008		35	1	0	0	2	3	8	90	144
3	Jasin	M0125		60	1	0	0	3	4	9	68	119
4	Jasin	M0167		69	0	0	1	9	10	11	109	119
5	Jasin	M0013		34	0	0	2	4	6	8	97	118
6	Jasin	M0129		39	1	0	0	2	3	8	66	116
7	Jasin	M0015		48	1	0	0	2	3	8	62	113
8	Jasin	M0108		20	1	0	0	1	2	7	31	86
9	Jasin	M0112		42	1	0	0	0	1	6	14	64

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