Road engineering with traffic operating facilities at black spot for motorcycle on the road

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Abstract. Transportation cannot separate from the needs of roads and vehicles. Users of motorists and road accidents are increasing, one of them because it has ignored by road facilities that support blackspots. The purpose of the research is to identify blackspots for motorcycles and determine the completeness of road facilities in traffic operations. The research methods include handling the blackspot location based on the number of accidents using the Accident Equivalent Number method and the weighted method. The results can be five blackspots, namely Ngamplang, Ngamplangsari, Penclut, Cimaragas, Dan Sawahlega. Accident handling at the traffic operation facility by Installing signs and markings that refer to vehicle speed and visibility of vehicle downtime.

1. Introduction
The victim died around the world due to a traffic accident on pedestrians, riding motorcycles, and cyclists each year, almost half of 1.25 million people [1-3]. This statement based on statistical data, where more than 3000 people from around the world die every day due to road traffic accidents [4]. Accidents on the road can still occur even though road funding has been arranged in such a way with a safe, comfortable, and secure design, as it involves several factors, namely human, road and environment, as well as vehicles. To minimize accidents, there several ways to reduce the impact of traffic accidents on road and vehicle users [5].

Analysis of road traffic accident trends can identify the cause of accidents, including road traffic safety is an indicator of performance, risk, and identifying accident-prone areas (Blackspot area) [6]. Blackspot is part of the road, which is considered a high-risk location of repeated vehicle accidents at the same point/place [1,7]. Handling in the blackspot area, including by placing warning signs in blackspot areas, repairing and improving road and pedestrian facilities, makes regulations that can reduce the level of road traffic accidents [8-10].

Accident identification includes conditions, types of collisions, and local impacts that stand out among variables that determine the severity of accidents involving humans, roads, environments, and vehicles, especially motorcycles [11,12]. Motorcycles are particularly vulnerable to injuries and accidents [13-15]. Motorcyclists suffered the most severe accidents, and the rate of injuries per mile traveled from all groups of road traffic users [16,17].

The problem of road traffic accidents involving motorcycles is a prominent occurrence in all regions of Indonesia. Traffic accident in one of the streets in Garut district, in Garut Province Road-boundary
Garut/Tasikmalaya (Cilawu), generally due to the users of motorcycles. Based on these conditions, it is necessary to analyze the cause and distribution of traffic points that are prone to traffic accidents caused by motor vehicles in the region.

2. Methodology
The analysis used refers to the T-09-2004-B guidelines on The handling of blackspot traffic accidents [2,18]. Furthermore, research on the area of accident risk (blackspot area) based on Unmanned Aerial Vehicle (UAV) can describe the situation, causing a traffic accident in vehicles that passed two regions. Identifying these points makes it easy to know on some roads that are most vulnerable to disasters.

Field observations conducted to determine the distribution of accident-prone spots using UAV and Accident Equivalent Number/AEK methods. By collecting and analyzing traffic accident data along the provincial road of Garut-borderline Garut/Tasikmalaya (Cilawu), know the points that are prone to accidents for vehicles, including analyzing the dominant factors that cause motorcycle accidents that occurred at that location.

This research uses secondary data obtained from the Polres Garut province of West Java and the UPTD province of West Java, as well as primary data by conducting field surveys. The research flowchart can see in Figure 1.

![Flow chart](image)

**Figure 1.** Flow chart.

How to identify dangerous places [19,20]:
- The AEK (Accident Equivalent Number) method, which is a weighted grade for road traffic accidents. The standard weight value used:
  
  \[
  \text{Death (MD)} = 12, \quad \text{severe injuries (LB) and small injury (LR)} = 3, \quad \text{vehicle damage (K)} = 1.
  \]
  
  \[
  \text{AEK} = 12 \text{MD} + 3 (\text{LB} + \text{LR}) + \text{K}
  \]
- The weighted method, the location of road traffic accidents, is determined based on the weighted victims due to traffic accidents. The method of a weighted by (1) Method of Directorate General of Bina Marga, (2) Method of Philip Jordan (consultant Bina Marga and AU SAID). Weight value based on the impact of the victim's severity of traffic accidents.

3. Results
Total Road traffic accidents in Garut Provincial Road section-the the border of Garut/Tasikmalaya (Cilawu) from 2015-2018 due to motorcycles as much as 132 events, caused by 60% human factor, 16% vehicle, 24% road and environment. Crash Data based on causal factors can see in table 1.
Table 1. Number of road traffic accidents in 2015 -2018.

| No | Factors causing accidents | Condition          | Number of accidents | Amount |
|----|---------------------------|--------------------|---------------------|--------|
| 1  | Human                     | 1. Off guard       | 19                  | 77     |
|    |                           | 2. Sleepy          |                     |        |
|    |                           | 3. Undisciplined   | 18                  | 81     |
|    |                           | 4. The influence of alcohol | 4         |        |
|    |                           | 5. Speed limit     |                     | 33     |
| 2  | Vehicle                   | 1. Brake failure   | 14                  |        |
|    |                           | 2. The steering is broken | 7       | 21     |
| 3  | Road and environment      | 1. Potholes        | 9                   | 30     |
|    |                           | 2. Alignment       |                     | 21     |
|    | Total                     |                     | 132                | 132    |

Based on identification along with the road and traffic accident data for 2015-2018, the area divided into 14 villages. Using the AEK method, Ngamplang village is an area with the highest number of road traffic accidents, as in Table 2.

Table 2. Observation of black spot by accident in 2017.

| No | Village                  | Frequency | MD, LB, LR | MD, LB | MD | AEK | INDII-Aus Ald | Bina Marga | KSI |
|----|--------------------------|-----------|------------|--------|----|-----|---------------|------------|-----|
| 1  | Ngamplang                | 7         | 4          | 2      | 44 | 39  | 47            | 4          |     |
| 2  | Gandasari                | 3         | 3          | 0      | 10 | 12  | 18            | 3          |     |
| 3  | Cimaragas                | 7         | 4          | 1      | 38 | 29  | 37            | 4          |     |
| 4  | Pasanggrahan             | 3         | 3          | 0      | 10 | 12  | 18            | 3          |     |
| 5  | Tankolot                 | 1         | 0          | 0      | 3  | 1   | 1             | 0          |     |
| 6  | Ngamplangsari            | 7         | 4          | 2      | 43 | 39  | 47            | 4          |     |
| 7  | Sawah Lega               | 6         | 4          | 0      | 21 | 18  | 26            | 4          |     |
| 8  | Genteng                  | 4         | 0          | 0      | 15 | 4   | 4             | 0          |     |
| 9  | Pasanggrahan Tongghoh   | 1         | 1          | 0      | 4  | 4   | 6             | 1          |     |
| 10 | Penclut                  | 4         | 2          | 0      | 17 | 10  | 14            | 2          |     |
| 11 | Cigasong                 | 4         | 0          | 0      | 14 | 4   | 4             | 0          |     |
| 12 | Cigadog                  | 4         | 0          | 0      | 12 | 4   | 4             | 0          |     |
| 13 | Citela                   | 2         | 0          | 0      | 6  | 2   | 2             | 0          |     |
| 14 | Cisaat                   | 1         | 1          | 0      | 3  | 4   | 6             | 1          |     |
|    | Total Black Spot         | 234       |            |        |    |     |               |            |     |

The speed of vehicles is observed directly in the field, the areas with the most severe accidents in the villages Ngamplangsari and Ngamplang. Stop view distance (Jh) used for the distance placement of the mark before the starting point of the mark or hazard point [21]. The calculation results can see in Table 3.

Table 3. Vehicle speed and stop distance.

| Village     | Distance (m) | Time (m) | Speed (Km/hr) | Speed (%) | Response distance Jsa (m) | Breaking distance Js (m) | Total distance (m) |
|-------------|--------------|----------|---------------|-----------|----------------------------|--------------------------|--------------------|
| Ngamplang   | 100          | 7,32     | 52            | 46,4      | 36,11                      | 26,61                    | 62,72              |
| Ngamplangsari| 100          | 6,08     | 60            | 53,6      | 41,67                      | 35,43                    | 77,1               |
| Total       |              |          |               |           | 77,78                      | 62,04                    | 139,82             |
In the calculation using the AEK method, blackspot for the accidental accident occurred in Ngamplang, Ngamplangsari, Cimaragas, Penclut, and Sawahlega. In the area, it recommended to plan and install traffic signs and road markings to prevent traffic accidents.

Regional recommendations in Ngamplang include the placement of warning signs and winding road warning signs, while road markings are using longitudinal lines in solid lines and dashed lines. Pay attention to the average speed of 52 km/h, placement of the order signs around 36 m before dangerous places, and the prohibition mark is about 15 m. High mark about 175-265 cm; The leaf size is diameter 40 cm. The road markers use solid and dashed longitudinal lines, so the driver is forbidden to overtake other vehicles at that location. Application signs and markers can see in Figure 2.

![Figure 2](image_url)

**Figure 2.** Application of markings and signs on the ngamplang road section.

The road around Ngamplangsari has average speed of 52 km/h, hence the placement of signs around 36 m before dangerous places, the winding road signs, and warnings. The mark height is about 175-265 cm, and the leaf size is 40cm in diameter, using an elongated line mark and dashed line. The sign is a ban for drivers to overtake other vehicles on site. Sketch the implementation of signs and markers can see in Figure 3.

![Figure 3](image_url)

**Figure 3.** Inclusion of markings and signs on the ngamplangsari road section.

The recommendation is at Penclut with an average speed of 52 km/h, a planned command sign of about 36 meters before a dangerous place. Height marks around 175-265 cm, with leaves with a diameter of 40 cm. Dashed lines and dashes used, prohibiting the driver from overtaking other vehicles at that location. The proposed application can see in Figure 4.

Along the streets of Cimaragas (Astro) with an average speed of 60 km/h, the placement of the road command line is about 42 meters before dangerous places with a prohibition sign of about 15 meters. This type of signposts mounted on uphill road and speed limit of 40 km/h. For the height of the mark, approximately 175-265 cm. Size mark diameter 40 cm. The road markings using a solid longitudinal line and dashed line are guidelines for drivers to overtake other vehicles on site. The sketch app can see in Figure 5.
Figure 4. Inclusion of markings and signs on the Penclut road section.

Figure 5. Inclusion of markings and signs on the Cimaragas road section.

Placement of signs and markings in Sawahlega with an average vehicle speed of 160 km/h, the warning signs crossed the forbidden road about 15 meters with a high sign of about 175-265 cm, and leaves with a diameter of 40 cm. Some road markings use a longitudinal-dotted marking. The presence of signs expected. The driver reduces the speed of vehicles to anticipate accidents, as it is a residential area, so many pedestrians pass by or cross. The sketch app can see in Figure 6.

Figure 6. Inclusion of markings and signs on the Sawahlega road section.

4. Conclusion
Based on the results and discussions from the previous section, the results are:

- With the Accident Equivalent Number (AEK) method, the road segment that has the highest traffic accident rate is Ngamplang with AEK 44 people.
- Blackspot using the AEK method and reviewed by UAV obtained five points of an accident, namely: Ngamplang, Ngamplang Srawa, Penclut, Cimaragas, and Sawahlega.
- The cause of traffic accidents on Cilawu Road in five years involving vehicles is due to the human factor of 60%, vehicle factor 16%, street actors, and environment 24%. So, besides
analyzing the road and environmental factors, it is also necessary to see it from a human viewpoint.

- To minimize traffic accidents at the prone points on Jalan Cilawu, including using signs and markers, to safeguard traffic safety.

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