Mitigation accident prone location on the BRT Trans Jateng Semarang District (Case Study: Soekarno Hatta Street KM 24+600 - KM 33+000)

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Abstract. The Route of Trans Jateng Bus Rapid Transit (BRT) Semarang Regency is one of the danger locations with 22 accidents involved BRT Trans Jateng in the period January-December 2018. This paper is to describe the results of road safety in quantitatively and qualitatively based on the results of safety deficiency measures on the road to become an evaluation model for road auditors. Data and information are compiled for analysing visual observations and measurement results of road infrastructure safety deficiencies on Soekarno Hatta Street KM 24+600-33+000. The results of the safetyness on this streets are shows there are 8 segments included the Dangerous category (B). The results of the categorization are arranged by risk management and anticipation of hazards in every segment in the form of travel safety map and safety handbook where location at risk of an accident is equipped with a QR Code that is connected to Google Maps.

1. Introduction
The Important transportation issues that are related to public transportation are become a very important things for the life of a city. Bus Rapid Transit (BRT) is one of type in public transportation that are not only provides you a much faster operation's speed and enhances greater services but also offering you a safe governance. Apart from this, the implementation of the Transjateng BRT poses a number of challenges. The year of accident reports at the Mulia Orda Serasi Transportation in 2018 stated that there were 22 accidents involved the BRT Trans Jateng on Jalan Soekarno Hatta with 22 situations in 15 accidents happened because of crashing into another vehicles above, 7 accidents occured because of crashing into public facilities and the risk of another accidents.

Potential accidents can be minimized by applying a Safety Management System. According to Permenhub No. 85 of 2018 regarding the Public Transportation Company Safety Management System states that what is meant by the public transportation company safety management system is the safety management in the field of public transportation which is carried out comprehensively and in a coordinated manner in order to realize the administration of safe public transportation and manage the risk of accidents.

In an effort to prevent a risk, one of important aspect is route management. In this aspect, the identification of hazards on each route is carried out, and then the results of the identification are informed to related parties, especially the driver. The management of this route is expected to be able to minimize the risks and potential hazard during the trip. Anticipation of hazard and risk management is very important for vehicle users to improve travel's safety and one of the bases for making safety guidelines for Trans Java Central BRT drivers. Guidelines as a reference for BRT Transjateng drivers.
to anticipate risks when traveling.

2. Methods

2.1 Methods of Data Collection

2.1.1 The Survey of Volume Traffic
The data collection was collected to determine the level of traffic density based on classified traffic volume that includes the type of vehicle and the vehicle direction, by making observations and enumeration directly in both directions.

2.1.2 The Audit Survey of Road Safety
Road Safety Audit are focused on parameters that are used as a basis for calculating deficiencies for road infrastructure that are geometric conditions and road equipment.

2.1.3 The Spotspeeds Survey
The survey was conducted manually using a stopwatch to calculate travel time at a predetermined distance with a length of 50 m.

2.1.4 The Moving Car Observer of Survey
This method is focussed to collect the data that includes the time of travel traffic in the same direction and in the opposite direction to the vehicle 10 times back and forth.

2.1.5 Road Inventory Survey Road
Inventory of road equipment is carried out to determine the completeness, condition and placement of suitable road equipment on Jalan Soekarno Hatta. the Target of data is traffic signs, road markings, street of lighting equipment, and supporting facilities for road traffic on the road and across the road.

2.2 Methods of Data Analysis

2.2.1 The division of Road Segments
The division is intended as the first step in data analysis. Segmentation of the Wujil to Bawen road is based on the geometrical characteristics of the road, traffic characteristics and the road environment.

2.2.2 Analysis of Accident Prone Locations
After being divided every 1 kilometer, a traffic accident prone location is determined by the Accident Equivalent Number (AEK) method. This method is one of the methods for calculating accident rates by weighting the accident equivalent numbers referring to the cost of traffic accidents.

2.2.3 85th Percentage Speed
The Calculation of the 85th percentile speed method (P85) is used to present the speed according to the conditions on the ground with 85% of vehicles using speeds below the speed point graph (P85), and 15% of vehicles are above the speed point (P85).

2.2.4 Research value and risk categories
The results of the calculation of every aspect of road geometry and road equipment will be assessed for risk value and calculated on average every one kilometer in each segment. The results will be categorized as risk values in each segment as stated in Mulyono et al (2009) as the following Table 1.

| Analysis Risk | Level of Handling **
---|---
| Risk Value * | Non-hazardous (TB) |
| Risk Category ** | Routine monitoring with scheduled road safety audits at points potential for accident accidents |

Table 1. Value and Category of Risk along with the Level of Handling Road Infrastructure Safety Deficiency
| Risk Value * | Risk Category ** | Level of Handling ** |
|-------------|------------------|----------------------|
| 125-250     | Hazardous Enough (CB) | Need unscheduled technical handling based on the results of road safety audits at the scene and surrounding areas |
| 250-375     | Dangerous (B) | Needs scheduled technical handling a maximum of 2 (two) months since the results of the road safety audit are approved |
| > 375       | Very Dangerous (SB) | Needs total technical handling with relevant stakeholders a maximum of 2 (two) weeks from road safety audit results approved |

*Source: *) DGH (2007a; 2007b) and **) Mulyono et al (2009b; 2009c)*

In this study, the categories obtained from these methods are not used to determine the level of importance were used but it used as a reference to arrange risk management for drivers on the journey that will be traversed so that it can be estimated to produce risks that can be minimized.

### 3. Result and Discussions

The results of the study were obtained in 4 steps, namely division of road segments, consideration of risk points, categorization of risk in road segments and risk management of road segments with the following explanation are:

#### 3.1 The division of road segments

The division are the first step in data analysis. The division of segments on road sections based on the characteristics of the road geometry, traffic characteristics and road environment the Roads with geometric characteristics of road, traffic characteristics and relatively similar to road environment will be divided into the same road segment because it will be determine the results of the analysis of each of the road segments. The results of the division on the road segments obtained the results of the Soekarno Hatta road segment divided into 7 road segments, namely the Wujil segment (STA 24 + 600 - 25 + 200), Karangjati (STA 25 + 200 - 27 + 000), Bergas Kidul (STA 27 + 000 - 28 +000), Jatijajar (STA 28 + 000 - 29 + 000), Randugunting (STA 29 + 000 - 30 + 000), Harjosari (STA 30 + 000 - 32 + 000), Bawen (STA 32 + 000 - 33 + 000)

#### 3.2 The Identification of Problem

The problem identification is works by analyzing accident locations and carrying out an inventory of road equipment from real conditions and conditions must be. the results of tracing accident-prone locations in 2014-2018 was used the Accident Equivalence Rate (AEK) method, the following results were obtained
Table 2. Analysis Jalan Soekarno Hatta EAN Year 2014-2018

| Segment            | MD  | LB  | LR  | PDO | EAN  | BKA | Explanation      |
|--------------------|-----|-----|-----|-----|------|-----|------------------|
| Wujil              | 7   | 0   | 31  | 26  | 203  | 245.7| Not Blackspot    |
| Karangjati         | 10  | 0   | 48  | 42  | 306  | 245.7| Blackspot        |
| Bergas Kidul       | 4   | 0   | 26  | 21  | 147  | 245.7| Not Blackspot    |
| Jatijajar          | 5   | 0   | 13  | 16  | 115  | 245.7| Not Blackspot    |
| Randugunting       | 8   | 0   | 50  | 46  | 292  | 245.7| Blackspot        |
| Harjosari          | 4   | 1   | 31  | 27  | 174  | 245.7| Not Blackspot    |
|                    | 7   | 0   | 40  | 43  | 247  | 245.7| Blackspot        |
| Bawen              | 1   | 1   | 6   | 6   | 42   | 245.7| Not Blackspot    |
|                    | 5   | 2   | 44  | 38  | 242  | 245.7| Not Blackspot    |

Source: Analysis Results, 2019

From the analysis of report, it was found that the data’s accidents in 2014-2018 STA with 3 blacksite namely STA 24 + 600 - 25 + 200 (Wujil) with an EAN value of 247 292, STA 29 + 000 - 30 +000 (Randugunting) with EAN value and STA 31 + 000 - 32 + 0000 (Harjosari) with EAN value of 247. Furthermore, an audit of the condition and availability of road equipment is needed to identify potential dangers from road equipment. The availability of road equipment will be a warning for drivers to get an attention to the arrangements indicated by the road equipment with the following result:

![Recapitulation of Road Equipment Deficiency](image)

From these results it can be identified that the most risk points are caused by the unavailability of street lighting along this path. This is very dangerous, especially at night.

3.3 Risk Categories of Road Segment

From the results of the analysis by categorizing risks by calculating the opportunities for road infrastructure safety deficiency against accident incidents and the impact of the severity of accident victims based on the level of fatality and handling interests stated by Mulyono et al., 2009 the following results are obtained:
Table 3. The Value of Risk Recapitulation and Risk Categories Jalan Soekarno Hatta

| Segment     | STA          | Value Risk | Category Risk   |
|-------------|--------------|------------|----------------|
| Wujil       | 24 + 600-25 + 200 | 287        | Dangerous (B)   |
| Karangjati  | 25 + 200-26 + 000 | 300        | Dangerous (B)   |
|             | 26 + 000-27 + 000 | 28         | Not Dangerous (TB) |
| Bergas Kidul| 27 + 000-28 + 000 | 280        | Dangerous (B)   |
| Jatijajar   | 28 + 000-29 + 000 | 253        | Dangerous (B)   |
| Randugunting| 29 + 000-30 + 000 | 267        | Dangerous (B)   |
| Harjosari   | 30 + 000-31 + 000 | 293        | Dangerous (B)   |
|             | 31 + 000 - 32 + 000 | 307       | Dangerous (B)   |
| Bawen       | 32 + 000 - 32 + 600 | 273        | Dangerous (B)   |
|             | 32 + 600 - 33 + 000 | 247        | Quite Dangerous (CB) |

Source: Results of Analysis, 2019

Figure 2. The Recapitulation from the Categorization of Road Segments

Jalan Soekarno Hatta available 8 STA with the Dangerous (B) categories, namely STA 24 + 600 - 25 + 200, STA 25 + 200 - 26 + 000, STA 27 + 000 - 28 + 000, STA 28 + 000 - 29 + 000, STA 29 + 000 - 30 + 000, STA 30 + 000 - 31 + 000, STA 31 + 000 - 32 + 000, and STA 32 + 000 - 32 + 600. For the Dangerous Enough (CB) category there is one STA, namely STA 32 + 600 - 33 + 000. While for one other STA is categorized as Harmless (TB) at STA 26 + 000 - 27 + 000. Visualization of risk categories as follows:
3.4 The Risk Segment of Road Segmentation

From the results of risk categorization, a risk management was formed to provide the knowledge about the anticipation that must be done by motor vehicle drivers in each risk with the following layout in Appendix B.

The risk management design that will be applied on Transjateng BRT Semarang Regency on the Soekarno Hatta Road (STA 24 + 600 - 33 + 000) was made to improve the safety on the way by informing the driver about the potential hazards that will be faced during the trip and solution to minimize the consequences which arise from the hazards. The guidebook contains a travel points using national road kilometers that are expected so that the driver can easily recognize the danger risk points and estimated travel minutes from the first segment, Bawen. In the next column is a description of the potential hazards that will be faced by the driver. In addition there are images of recommendations for handling and barcode location of Google Maps for road segments.

4. Conclusions

- The Locations of risky accidents in the Semarang Regency Transjateng BRT with an analysis of all vehicle accident events using the Accident Equivalence Rate (EAN) method was found that roads with blackspot criteria at STA 24 + 600-25 + 200 (Wujil), STA 29 + 000-30 + 000 (Randugunting), and STA 31 + 000-32 + 000 (Harjosari). From the results of road safety audits and inventory of road equipment there are 52 points of potential danger caused by the minus of road equipment which are dominated by the lack of warning signs, marking and safety devices such as delineators or guardrails.

- The results of risk categorization in the Transjateng BRT line in Semarang Regency exactly on Jalan Soekarno Hatta (STA 24 + 600 - 33 + 000) there are 8 STAs with the Dangerous category (B), namely STA 24 + 600 - 25 + 200 (Wujil), STA 25 + 200 - 26 + 000 (Karangjati), STA 27 + 000 - 28 + 000 (Bergas Kidul), STA 28 + 000 - 29 + 000 (Jatijajar), STA 29 + 000 - 30 + 000 (Randugunting), STA 30 + 000 - 31 + 000 (Harjosari), STA 31 + 000 - 32 + 000 (Harjosari), and STA 32 + 000 - 32 + 600 (Bawen). For the Dangerous Enough (CB) category there is 1 (one) STA, namely STA 32 + 600 - 33 + 000 (Bawen). The Harmless (TB) category is found at STA 26 + 000 - 27 + 000 (Karangjati). From the results of the categorization above, risk management and hazard anticipation have been compiled.
in every segment and each deficiency has been prepared in the form of a travel safety map and a safety handbook on the Transjateng BRT route Semarang Regency

5. Appendices

Appendix A. The Distribution of Soekarno Hatta Road Segments (STA 24 + 600 - 33 + 000)

Appendix B. Risk Management Layout The risk

6. References

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