

# Analysis of Accident-Prone Areas in Bekasi City

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## Abstract

The most highlighted transportation problem at this time is traffic safety. In Bekasi City, traffic accidents often occur, ranging from minor accidents, serious accidents to accidents that cause casualties due to various factors. The objectives of this study are: To determine the characteristics of accident-prone areas, the factors causing accidents and to analyze the locations where accidents often occur in those areas. The location of this research was conducted on Jalan Raya Narogong Bekasi City. The data used in this study are primary data and secondary data. The primary data used includes the volume of passing vehicles, vehicle speed, is the road geometry, namely the absence of road markings, road capacity, land use and traffic signs. The author divides 10 segments on this road based on coordinate points. The coordinate point with the highest AEK and EPDO values is at the coordinate point -6.280222 to -6.28175 with AEK 103 and EPDO also 103 which caused 8 deaths, 0 serious injuries, 0 minor injuries and with material loss of Rp. 5,000,000. The most types of accidents are front - front with 17 victims, the number of accident victims and material losses is obtained from IRSMS data provided by Bekasi City traffic officers.

## Keywords:

Accident, AEK, Characteristics, EPDO

## 1. Introduction

Transportation is a very important part of life, especially transportation by vehicle, both for human needs and for the transportation of goods. The population in Bekasi City has increased every year, thus of course the need for transportation facilities will also increase every year due to travel or transportation activities that increase along with population growth. In line with this, the number of vehicles will increase rapidly. This will require an increase in the quality of transportation facilities and infrastructure and a growth in the number of vehicles per day (Andri et al., 2016).

One of the most highlighted transportation problems is regarding traffic safety. In Bekasi City, traffic accidents often occur, ranging from minor accidents to accidents that cause casualties caused by various factors, such as human factors, road factors, environmental conditions and vehicle factors. Human factor is the most dominant factor in accidents. Almost all accidents are preceded by violation of traffic signs. Violations can occur due to deliberately violating, ignorance of the meaning of the applicable rules or not seeing the provisions that are applied or pretending not to know. In addition, humans as road users are often negligent and even reckless in driving a vehicle (Muhammad Fakhuriza Pradana et al., 2019).

To overcome this, it is necessary to conduct a study of the analysis of accident-prone areas that often occur in Bekasi City. Referring to several previous studies that analyzed traffic accidents in several other areas which can produce things that are used as evaluation materials in reducing the accident rate, such as what has been done by the government, by the police or the transportation agency that studied this matter. With the hope that this examination can be carried out analysis and identification of the things that cause the accidents that occur, which in the end can be found the right solution and carried out according to the study of the traffic accident problems that occurred. (Ramadhon & Arliansyah, 2019).

## 2. Methodology

This discussion will explain the methods or work steps of research on the Analysis of Accident-Prone Areas in Bekasi City. The objective of this research method is to determine the characteristics of accident-prone areas, their causative factors and to analyze the locations where accidents often occur. The method used in this research is to use primary data and secondary data.

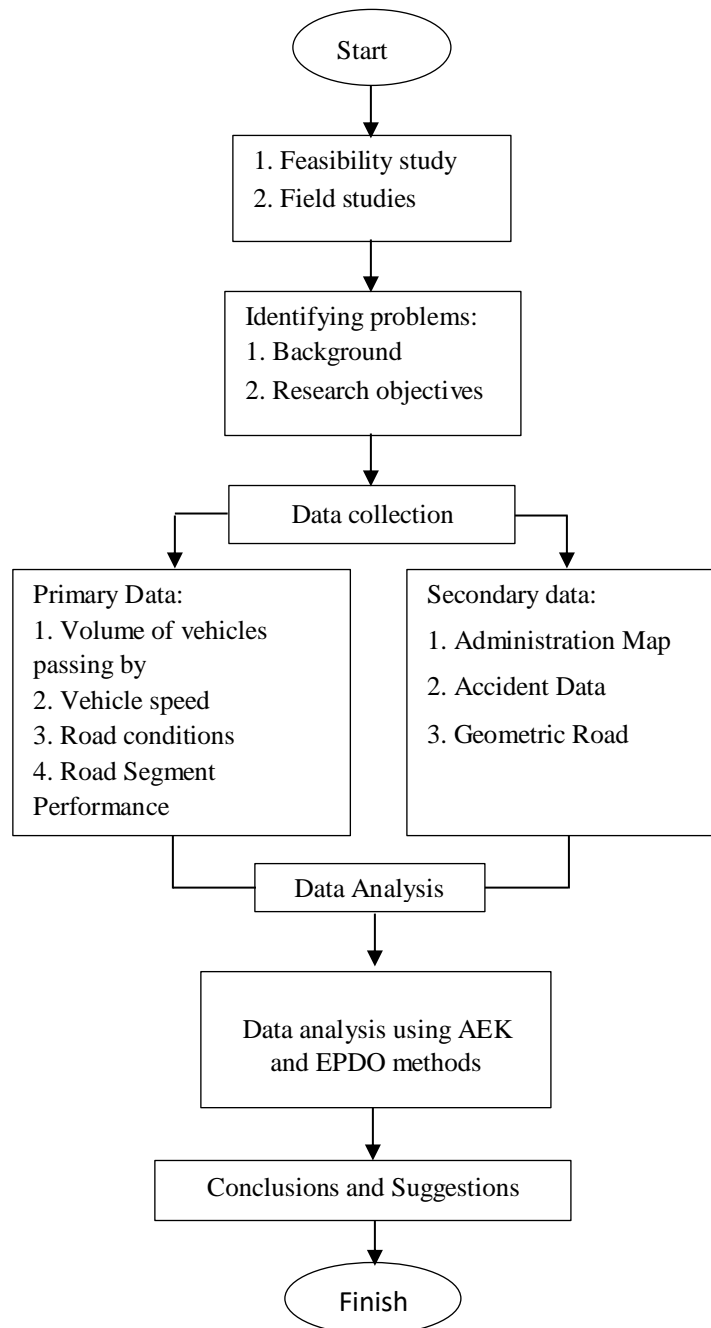


Figure 1. Research Flow Framework

The research was conducted in Bekasi City, namely on Jalan Raya Naragong. The first step the writer took was collecting secondary data, namely accident data in Laka Lantas, Bekasi City. The data that will be used are data for 3 years, namely 2016, 2017 and 2018. After obtaining the data, the data will then begin to be grouped according to research needs, based on location, time, types of victims and accident losses. Of all the roads in Bekasi City, the writer chose to take Jalan Raya Naragong because it has the highest number of accident victims.

The next data is road condition data, namely primary data. In this study, there is 1 road segment which will later be divided into 10 segments which are divided based on the level of coordinates. The data of the road conditions that will be taken are road geometric, traffic volume data and traffic signs conditions at the research location.

### 3. Result and Discussion

#### 3.1 Characteristics of Accident-Prone Areas

The characteristics of traffic accident-prone areas at this black spot or black spot are influenced by the large number of accidents involving humans with vehicles, besides that it is also seen from road conditions, road

slope, vehicle volume, road capacity, and road geometry which includes road width, length, roads and road medians. From these data, it is used as an illustration of the tendency of accidents that occur on Jalan Raya Narogong.

### 3.2 Accident Type Data

Data on the number of accidents will focus on the death toll that often occurs on Narogong Highway.

Table 1. Accident Types of Death Victims

Accident Type	Year			amount
	2016	2017	2018	
Single	2	3	0	5
Front - Front	3	6	1	10
Front back	9	5	3	17
Front - Side	3	0	0	3
Sides- side	0	1	0	1
Hit Humans	4	3	1	8
amount	21	18	5	44

Source: IRSMS data

Table 2. Number of Deaths and Losses

Year	MD	Total Events	Amount of Material Loss
2016	21	21	IDR 23,000,000
2017	18	18	IDR 7,700,000
2018	5	5	IDR 3,000,000
Amount	44	44	IDR 33,700,000

Source: IRSMS data

### 3.3 Segment Division Data

The coordinate segment on Jalan Raya Narogong extends from the coordinate point -6,368.858 to -6,360.083. The segment will be divided into 10 to be included in the AEK and EPDO calculation methods.

Table 3. Segment Division

No.	Segment		GPS coordinates - Latitude	GPS Coordinates - Longitude	Accident Rate	M D	L B	L R	Total	Material Loss
1	-6.27766	-6.27957	-	107.006217	1	1	0	0	1	500000
			-	106.991708	1	1	0	0	1	5000000
			-	106.991483	1	1	0	0	1	1000000
			-	106.99125	1	1	0	0	1	500000
			-	106.991042	1	1	0	0	1	1500000
			amount					5	0	0
2	-6.28022	-6.28175	-	106,99075	1	1	0	0	1	1000000
			-	106,990656	1	1	0	0	1	1000000
			-	106,990533	1	1	0	0	1	1000000

			-	6,280783	106,990497	1	1	0	0	1	0
			-	6,281369	106,990236	1	1	0	0	1	500000
			-	6,281869	106,990164	1	1	0	0	1	500000
			-	6,281706	106,990089	1	1	0	0	1	500000
			-6,28175	106,990067	106,990067	1	1	0	0	1	500000
			amount				8	0	0	8	5000000
			-	6,283819	106,989075	1	1	0	0	1	200000
3	-6,28382	6,28382	-	6,283819	106,989075	1	1	0	0	1	300000
			amount				2	0	0	2	500000
			-	6,284203	106,988597	1	1	0	0	1	3000000
4	-6,2842	-6,2846	-	6,284492	106,988497	1	1	0	0	1	500000
			-6,2846	106,988406	106,988406	1	1	0	0	1	500000
			amount				3	0	0	3	4000000
			-	6,315728	106,987142	1	1	0	0	1	500000
			-	6,286303	106,987069	1	1	0	0	1	500000
5	-6,31573	6,31765	-	6,287339	106,986286	1	1	0	0	1	500000
			-	6,317394	106,986075	1	1	0	1	2	200000
			-6,31765	106,986025	106,986025	1	1	0	0	1	1000000
			amount				5	0	1	6	2700000
			-	6,319828	106,985386	1	1	0	0	1	500000
6	-6,31983	6,31107	-	6,289408	106,985181	1	1	0	0	1	500000
			-	6,311067	106,985144	1	1	0	0	1	1000000
			amount				3	0		3	2000000
			-	6,298117	106,984669	1	1	0	0	1	1000000
			-	6,322447	106,984556	1	1	0	0	1	1000000
7	-6,29812	6,30942	-	6,298744	106,984528	1	2	0	0	2	500000
			-	6,322908	106,984406	1	1	0	0	1	500000
			-	6,309422	106,9842	1	1	0	0	1	500000
			amount				6	0	0	6	3500000
8	-6,32469	6,30763	-	6,324689	106,983789	1	1	0	0	1	200000

			-	106.983669	1	1	0	0	1	500000
			6,307156							
			-	106.983586	1	1	0	0	1	1000000
			6,308122							
			-	106.983517	1	1	0	0	1	500000
			6,302008							
			-	106.983347	1	1	0	0	1	500000
			6,307633							
			amount			5	0	0	5	2700000
			-	106.981464	1	1	0	0	1	500000
			6,328578							
			-	106.978667	1	1	0	0	1	500000
			6,342469							
9	-6.32858	-6.3454	-	106.978639	1	1	0	0	1	1500000
			6,342258							
			-	106.978169	1	1	0	0	1	500000
			6,345403							
			amount			4	0	0	4	3000000
			-	106.977472	1	1	0	0	1	500000
			6,348056							
			-	106.976878	1	1	0	0	1	1000000
			6,350161							
10	-6.34806	6.36008	-	106.976586	1	1	0	0	1	300000
			6,360083							
			amount			3	0	0	3	1800000

Source: IRSMS data

### 3.4 Accident Equivalent Rate Analysis (AEK)

Accident Equivalent Rate (AEK) is calculated by the formula of adding up the incidence of accidents in one kilometer or one segment of road length then with the weight value according to the severity. Below is the calculation of the Accident Equivalent Value (AEK) value on the Narogong Highway (Segment 1):

$$\begin{aligned}
 \text{AEK} &= 12\text{MD} + 3\text{LB} + 3\text{LR} + 1\text{K} \\
 \text{AEK} &= 12(5) + 3(0) + 3(0) + 1(5) \\
 \text{AEK} &= 65 \\
 \text{AEK average (C)} &= 65/10 \\
 &= 6.5
 \end{aligned}$$

Table 5. Calculation of the Accident Rate using the AEK method

Segment	Coordinate		Victim				AEK value				Total AEK	C (Average)
			MD	L B	L R	K	MD *	LB *	LR *	K *		
							12	3	3	1		
1	6.277664	6.279572	5	0	0	5	60	0	0	5	65	6.5
2	6,280222	-6.28175	8	0	0	7	96	0	0	7	103	10.3
3	6.283819	6.283819	2	0	0	2	24	0	0	2	26	2,6
4	6,284203	-6,2846	3	0	0	3	36	0	0	3	39	3,9
5	6.315728	-6.31765	5	0	1	5	60	0	3	5	68	6.8
6	6.319828	6.311067	3	0	3	3	36	0	9	3	48	4,8
7	6,298117	6.309422	6	0	0	5	72	0	0	5	77	7,7
8	6.324689	6.307633	5	0	0	5	60	0	0	5	65	6.5
9	6.328578	6.345403	4	0	0	4	48	0	0	4	52	5,2
10	6.348056	6.360083	3	0	0	3	36	0	0	3	39	3,9

Source: IRSMS data

### 3.5 Analysis of Equivalent Property Damage Only (EPDO)

To determine accident-prone areas, you can use Equivalent Property Damage Only (EPDO) by knowing the weight of the accident rate with the ratio of death times 12, serious injuries multiplied by 6, minor injuries multiplied by 3 and material losses multiplied by 1. Below is the calculation of the Equivalent value. Property Damage Only (EPDO) from Jalan Raya Narogong (segment 1):

$$EPDO = 12M + 6B + 3R + 1K$$

$$EPDO = 12 (5) + 6 (0) + 3 (0) + 1 (5)$$

$$EPDO = 65$$

Table 6. The calculation of the Accident Rate uses the EPDO method

Segment	Coordinate		Victim				EPDO value				Total EPDO	Rating
			MD	LB	LR	K	M *	B *	R *	K *		
							12	6	3	1		
1	-6.277664	6.279572	5	0	0	5	60	0	0	5	65	4
2	-6,280222	-6.28175	8	0	0	7	96	0	0	7	103	1
3	-6.283819	6.283819	2	0	0	2	24	0	0	2	26	8
4	-6,284203	-6,2846	3	0	0	3	36	0	0	3	39	7
5	-6.315728	-6.31765	5	0	1	5	60	0	3	5	68	3
6	-6.319828	6.311067	3	0	3	3	36	0	9	3	48	6
7	-6,298117	6.309422	6	0	0	5	72	0	0	5	77	2
8	-6.324689	-6.307633	5	0	0	5	60	0	0	5	65	4
9	-6.328578	-6.345403	4	0	0	4	48	0	0	4	52	5
10	-6.348056	-6.360083	3	0	0	3	36	0	0	3	39	7

Source: IRSMS data

### 3.6 Field Survey Data

Based on the results of the field survey for safety indicator data, the authors summarize in table form:

Table 7. Safety Indicator Survey Data

No.	Safety Indicator	Completeness		Information
		There is	Not	
1	Road signs	√		There are road signs but not in some areas The sign is blocked by a tree Red light not working
2	Road markings		√	There are no road markings
3	Safety Fence / Sidewalk		√	There are no safety fences or walkways
4	Road Damage	√		Many roads are potholed and cracked There was no notice of any potholes Bumpy road
5	Street Lighting	√		There was some street lighting but it was blocked by a tree, turning off and starting to dim

Source: Observation Results 2021

### 3.7 Road Condition and Land Use

Road conditions on Jalan Raya Narogong.

1. Roadway Width : 8 m
2. Side Track Width : 4 m
3. Street Type : 2 Lines / 2 Directions
4. Roadside : There is
5. Drainage : There is
6. Road markings : There is no
7. Traffic signs : There is

Land uses on Jalan Raya Narogong include shops, factories, minimarkets, gas stations (petrol stations). However, this road is dominated by factories, food stalls and tire repair shops for trucks.

### 3.8 Traffic Volume

The author conducted a survey on Friday, February 5, 2021 in order to see the peak of the highest traffic flow (Morning, Day and Night) in the area. The condition of the field at the time of the survey was drizzling. After knowing the peak traffic flow, the Passenger Car Equivalent (EMP) value is obtained and this road uses the type 2 lane 2 undivided direction (2 / 2UD):

Table 8. Vehicle Volume

Naragong Highway									
Time	Hour	Vehicle			Total Kend / Hour	LV 1	EMP		Total EMP / Hour
		LV	HV	MC			HV 1,2	MC 0.25	
Morning	07.00 - 07.15	100	43	255	398	100	51.6	63.75	215.35
	07.15 - 07.30	110	31	295	436	110	37.2	73.75	220.95
	07.30 - 07.45	170	75	310	555	170	90	77.5	337.5
	07.45 - 08.00	187	60	396	643	187	72	99	358
	Total	567	209	1256	2032	567	250.8	314	1131.8
Noon	13.30 - 13.45	70	75	265	410	70	90	66.25	226.25
	13.45 - 14.00	80	90	200	370	80	108	50	238
	14.00 - 14.15	105	46	190	341	105	55.2	47.5	207.7
	14.15 - 14.30	95	64	325	484	95	76.8	81.25	253.05
	Total	350	275	980	1605	350	330	245	925
Night	21.00 - 21.15	125	94	319	538	125	112.8	79.75	317.55
	21.15 - 21.30	110	85	280	475	110	102	70	282
	21.30 - 21.45	98	68	205	371	98	81.6	51.25	230.85
	21.45 - 22.00	95	49	225	369	95	58.8	56.25	210.05
	Total	428	296	1029	1753	428	355.2	257.25	1040.45

Source: Analysis Results 2021

From the traffic volume table on Friday, February 5, 2021 with drizzling field conditions, it can be seen that the largest number of vehicles passing Naragong Highway is in the morning, namely 07.00 - 08.00 with a total of 1131.8 Smp / hour.

### 3.9 Side Barriers

The side friction data below is obtained after conducting a direct survey by observing the types of side friction events along the 200 meter road segment in the vicinity are as follows:

 Table 9. Side obstacles of Naragong Highway  
 Jalan Raya Naragong

No.	Time	Weight Factor Resistance Type		Parking Vehicles Stop		Vehicle in and out		Slow Vehicle		Total Frequency Weight	Class Resistance Side
		PED	0.5	PSV	1	EEV	0.7	SMV	0.4		
		Freq. Gen / Hour	Freq. Weight	Freq. Gen / Hour	Freq. Weight	Freq. Gen / Hour	Freq. Weight	Freq. Gen / Hour	Freq. Weight		
1	Morning	32	16	26	26	85	59.5	56	22.4	123.9	L
2	Noon	19	9.5	32	32	89	62.3	79	31.6	135.4	L
3	Night	11	5.5	26	26	45	31.5	123	49.2	112.2	L

Source: Analysis Results 2021

### 3.10 Vehicle Free Flow Speed (FV)

Based on the MKJI 1997, the free flow speed of a vehicle has the following equation:

$$FV = (FV_0 + FVW) \times FFVSF \times FFVCS$$

1. Light Vehicle (LV)

$$FV = (44 + 3) \times 0.99 \times 1.03$$

- = 47.9 Km / hour
- 2. Heavy Vehicle (HV)  
 $FV = (40 + 3) \times 0.99 \times 1.03$   
 = 43.8 Km / hour
- 3. Motorcycle  
 $FV = (40 + 3) \times 0.99 \times 1.03$   
 = 43.8 Km / hour
- 4. All Vehicles / Average  
 $FV = (42 + 3) \times 0.99 \times 1.03$   
 = 45.8 Km / hour

### 3.11 Capacity of Roads

Based on (MKJI, 1997), the calculation can determine the capacity of a road section, at this time it will focus on the Naragong Highway by using the following formula (MKJI, 1997):

$$C = C_0 \times FCW \times FCSP \times FCSF \times FCCS \text{ (smp / hour)}$$

$$= 2900 \times 1.14 \times 1 \times 0.97 \times 1.03$$

$$= 3303,025$$

### 3.12 Road Service Level

The service level of the Naragong Highway is classified based on volume (Q) per capacity (C). Based on the Regulation of the Minister of Transportation Number: KM 14 of 2006, the level of service (LOS) can be seen from the formula for degree of saturation (DS) as follows:

$$DS = Q / C$$

Table 10. Road Service Levels

Time	Q smp / Hour	C smp / Hour	Q / C smp / Hour	LOS
Morning (07.00 - 08.00)	1131.8	3303,025	0.3426556	A
Afternoon (13.30 - 14.30)	925	3303,025	0.2800463	A
Evening (21.00 - 22.00)	1040.45	3303,025	0.3149991	A

Source: Analysis Results 2021

From the table above the service level on Friday, February 5, 2021 with drizzling field conditions, it can be concluded that in the morning, 07.00 - 08.00 has a service level of A, which means that in high-speed free flow conditions, the driver can choose the desired speed without a hitch. such as 2 duration of time after that, namely at noon at 13.30 - 14.30 and at night 21.00 - 22.00 which has service level A which means free flow conditions as before.

## 4. Conclusion and Suggestion

### 4.1 Conclusion

Based on the research that has been done, the following conclusions can be drawn:

1. Characteristics that affect road sections identified as accident-prone areas on the Naragong Highway is a road geometry that does not have road markings, road capacity, land use and traffic signs.
2. The causes of accidents on the Naragong Highway include:
  - a. Inadequate traffic signs, present but not functioning properly and absence of road markings.
  - b. Lack of lighting on the road has resulted in several accidents.
  - c. There are several potholes and bumpy roads that make the driver unable to control the vehicle.
  - d. There is no road divider with the shoulder of the road which makes road users / pedestrians less safe.
3. Based on the results of the analysis of accident-prone locations on Jalan Raya Naragong for the period 2016-2018 using the Accident Equivalent Number (AEK) method and the Equivalent Property Damage Only (EPDO) value. And there are relatively high AEK and EPDO scores along this road. The author divides 10 segments on this road based on coordinate points. The coordinate point with the highest AEK and EPDO values is at the coordinate point -6.280222 to -6.28175 with AEK 103 and EPDO also 103 which caused 8 deaths, 0 serious injuries, 0 minor injuries and with material loss of Rp. 5,000,000. The most types of

accidents were front - front with 17 victims, the number of accident victims and material losses was obtained by the author from the IRSMS data provided by Laka then Bekasi City.

#### 4.2 Suggestions

Suggestions submitted based on the research results obtained include:

1. For accident-prone areas, warning signs for dangerous areas where accidents often occur should be installed. Usually the placement of these traffic signs can be installed at least 50 meters before the area that often occurs accidents. Adding road markings, Repairing traffic signs that are not functioning properly and adding zebra crossings.
2. Repairing bumpy roads and potholes, as this can cause a single accident and provide distraction tape or notification of any identified accident-prone locations.
3. Provide traffic safety education to the surrounding community so that they are always careful in driving and obey all traffic regulations.
4. It is necessary to provide education or outreach to the public regarding traffic safety regulations and always be careful when driving.
5. Further research is needed after the Covid-19 pandemic ends.

#### Reference

- Andri, O., Widodo, S., & Mayuni, S. (2016). Analysis of Traffic Accident Prone Locations on the Trans Kalimantan Road (Kuala Ambawang - Simpang Ampar). *Journal of University Civil Engineering Students Tanjungpura*, 3(3), 1–13.
- MKJI. (1997). Republic of Indonesia Directorate General of Highways, Directorate of City Roads (Binkot). In the public works department, "Indonesia's Road Capacity Manual" (pp. 1–573).
- Muhammad Fakhuriza Pradana, Intari, D. E., & D, D. P. (2019). Analysis of Traffic Accidents and Their Causes on Jalan Raya Cilegon. *Civil Engineering Studies*, 04(2), 165–175.
- Ramadhon, A. R., & Arliansyah, J. (2019). Analysis of Traffic Accident Prone Areas in the City of Bandar Lampung.

#### Biography

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**Muhammad Isradi.**, Born in Kandangan on August 18, 1972. He is secretary of the Civil Engineering study program at Mercu Buana University. Obtained a Bachelor of Civil Engineering degree from the University of Muhammadiyah Malang in 1998 with his thesis title One Way Flat Plate Planning at Ratu Plaza Madiun. Then obtained a Masters in Civil Engineering Concentration of Transportation from Brawijaya University in 2001 with a thesis title, Analysis of the Model of Family Movement Awakening in the Sawojajar Malang Housing Area. He also teaches several subjects such as Pavement Planning, Road Geometric Planning, Transportation Planning and Environmental Engineering.

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**Joewono Prasetyo.**, Was born in Pontianak on October 18, 1969. Obtained a degree in Civil Engineering at the University of Tanjungpura, Pontianak, Indonesia in 1993. Obtained a Master of Science in Road and Transportation Engineering from Delft University of Technology, the Netherlands in 1996. Obtained a Doctor of Ingenieur degree from Ruhr-Universität Bochum, Germany in 1996. Currently serves as Head of the Railway Transportation Engineering Technology Department, Faculty of Engineering Technology, Tun Hussein University in Malaysia.