



THE ROAD PERFORMANCES ANALYSIS IN JALAN LAKSAMANA BINTAN, BATAM-INDONESIA

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ARTICLE INFO	ABSTRACT
Published: December 20th, 2022 Keywords: Road Performance, Peak Hour, IHCM 1997 This work is licensed under CC BY-SA 4.0 	Jalan Laksamana Bintan is a secondary arterial road with high vehicle intensity. They are located in industrial and schooling areas, causing traffic congestion due to many road users. This study aims to determine the performance of the road during adequate working time. This study used the IHCM 1997 method and field surveys to collect data directly. Data was taken at Jalan Laksamana bintan, Batam (Kenki Intersections – Frenkie). The results obtained from the traffic analysis on Thursday, November 10, 2022, 06.30 AM – 07.30 AM with the degree of saturation = 0.5, actual speed = 47.95 km/hour, volume = 3069.45 pcu/hour, capacity = 6082.56, and Level of Services = C. This condition indicates that Jalan Laksamana Bintan is still comfortable and suitable for use by traffic users

INTRODUCTION

Transport no doubt plays a pivotal role in every society's overall development and continuous existence. Transportation in the form of public vehicles or private vehicles has a tangible impact on the community. Private vehicles are part of human efforts to facilitate movement from one place to another. In addition to the use of private vehicles that help, the increase in private vehicle ownership also needs to be considered. With the rapid growth of private vehicle ownership, the corresponding transportation infrastructure is insufficiently supplied, and traffic congestion has become more serious, affecting people's travel, and limiting the city's economic stable development. It has been identified as a significant concern, especially in highly urbanized cities. The urbanized city is a high influx of people and vehicles regularly without a corresponding expansion in the road infrastructure nor any other reliable artificial mechanisms to contain such rapid influxes (Salisu & Oyesiku, 2020), (Zhou, Chen, Chen, Liu, & Jiang, 2021), (Nwankwo, Olayinka, & Ukhurebor, 2019).

Indonesia is a developing country where most people work as laborers or employees in a company. In Indonesia, two modes of transportation are often used for daily needs, namely cars and motorbikes. These two vehicles have different characteristics and behaviors when on the road. The number of motorcycle riders is greater than that of car drivers because these factors affect traffic performance. The problem of motorcycle riders who tend not to behave in an orderly manner and the growth in the number of motorcycle users that continues to increase every year makes the

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level of road service strongly influenced by the presence of motorcycle users. This condition can lead to the vulnerability of traffic congestion and accidents in Indonesia (Sari & Latifa, 2019).

Known as an industrial city, therefore there are also many workers who work in Batam. This industrial city, of course, causes the attraction of vehicles. Traffic intensity is the main parameter that determines the category of roads and all other road design and construction requirements. Batam encounters a high-intensity vehicle at adequate work time, namely, going to work and coming home. Therefore, there is often prolonged traffic congestion at certain points. In addition, the narrow path of the road and the number of works such as road widening and maintenance roads are also often encountered. Traffic flow multiplication is an option that is often taken so that construction activities can still be carried out. The obstruction of traffic flow causes vehicles in an area, which eventually causes congestion (Volkova & Stepanenko, 2020).

Jalan Laksamana Bintan (Kenki Intersection-Frankie Intersection), Batam, is one of the roads with high vehicle intensity, especially during effective working hours. Because of the increased traffic volume, the number of conflicts near the intersections between pedestrians, bicycles, and motorized transportation modes is more significant. During working hours, there is severe traffic congestion due to in and out of vehicles going to work and crossroads. Coupled with driving that tends to be disorderly, causing more severe traffic congestion. In addition, the changing of road width, from two lanes one-way to a lane in the opposite direction, caused obstacles. By widening the one-lane road in the opposite direction into a two-lane road, the traffic flow may have been better performance (Gonçalves & Ribeiro, 2020).

The purpose of this study is to analyze road performance on Jalan Laksamana Bintan (Kenki intersection-Frankie Intersection). Analysis of road performance parameters in speed, density, and road volume. Does the intensity of the vehicle only cause poor road performance, or are there other factors involved? The results will be obtained in the form of road performance data.

LITERATURE REVIEW

Road Performance

Transportation infrastructure such as roads may impact regional productivity through their effect on employment, private investment, and the returns to schooling. Roads are the primary medium used to move places on land. Therefore, good road flow is the main requirement for motorists in using the road as a medium of transportation. Various types of vehicles pass through the road, this causes various kinds of behavior in traffic situations, especially heavy vehicles passing through roads that are also passed by conventional vehicles (Agrawal, Galasso, & Oettl, 2017).

The speed of vehicles on certain roads is an indicator of the flow of the road. A road that is not obstructed will undoubtedly spur the driver to increase driving speed. A driver's reaction time in a situation such as a traffic light will also affect road performance. The smaller the delay, the higher the road capacity and the smoother the traffic flow. This condition will undoubtedly increase the efficiency of the road (Makridis, Mattas, & Ciuffo, 2019).

The forecasting of traffic intensity is a topic of considerable importance for the daily activity of a person in urban areas. It is possible to distinguish particular areas and zones in the street and road network where the traffic reaches maximum level. In contrast, the intensity in the other areas is several times lower. Furthermore, traffic intensity is very closely related to a particular time and period. For example, during effective working hours, road intensity increases, causing road congestion (Popov, Shterev, Baeva, & Hinov, 2021); (Afanasyev & Panfilov, 2017).

Traffic signs also affect the performance of a road. The signs will instruct the driver to allow and what is not to be done while on the road. However, sometimes, drivers do not care about traffic signs, especially when the weather is not convenient for driving. Therefore, making enhancement initiatives, like increasing driving safety and improving automatic detection and road sign recognition systems, is becoming indispensable to help decrease road death toll (Saadna & Behloul, 2017).

Intersections

An intersection is a meeting of two or more road segments that meet to connect. In an intersection without traffic lights, there will be conflict because vehicles meet each other from various directions to enter one of the available roads. Therefore, handling intersections involves planning under uncertainty concerning driver behavior. However, in certain circumstances, such as signalized intersections, this is not a problem that needs to be considered because the traffic system has been regulated by traffic lights (Bouton, Cosgun, & Kochenderfer, 2017).

Signalized intersections are indispensable parts of urban traffic networks. At signalized intersections, vehicles will stop, queue up, and then accelerate during the green and amber signals. The signalized intersection has the advantage of a more regular traffic situation, which prevents vehicles from coming together at a saturation point. However, this system also has a weakness where if the traffic conditions on one of the roads are congested, it will cause congestion in one segment. Furthermore, the timing of the use of traffic signals also affects the existing traffic conditions. Therefore, time management by considering roads with a higher intensity will be prioritized compared to other roads (Zheng & Liu, 2017); (Bokare & Maurya, 2017).

Unsignalized intersections are usually found on low-volume roads or when traffic lights cannot be installed. This type of intersection challenges drivers to pass through these obstacles. Here the character of the driver becomes one of the indicators that ensure the smooth and safe crossing of the intersection. Unfortunately, in this situation, the driver will tend to be selfish, and one party will succumb to the other (Tian, Kolmanovsky, Yildiz, & Girard, 2020).

Each driver's behavior is different, depending on the type of vehicles used and the current traffic conditions. The driver's attitude is demanded in the intersection, whether on unsignalized or signalized intersections. The driving habits of drivers, vehicle following behavior, lane changing habits, regional factors, and the precision of traffic rules are some important elements that influence the signalized intersection capacity. Therefore, the driver's awareness of traffic signs is essential for traffic flow and traffic safety (Çalışkanelli & Tanyel, 2018)

Traffic Management

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Traffic management is needed so that traffic can be carried out regularly according to planning. Moreover, in urban areas with high vehicle intensity, this will significantly help traffic. To improve traffic management, the growing metropolitan areas are facing challenges, such as real-time traffic collection, analysis, sharing, traffic density, and travel time predictions on routes. However, these things certainly benefit drivers because of the regularity of the system on the road (Chavhan & Thakare, 2017).

Creating an orderly traffic atmosphere can improve the performance of a road. Applying road lines and warning signs can improve driver discipline. Lane discipline can be measured in terms of its effect (i.e., the lateral position), and its importance lies in the extent to which it weakens or strengthens vehicle traffic's efficiency and safety risk perception. Therefore, orderly traffic conditions allow drivers to choose safety or efficiency (Delpiano, 2021).

Efficiency in driving is one of the points of traffic management. One of the traffic management roles in determining and finding the best solution to the traffic congestion problem. Suggesting and computing alternative routes to avoid traffic hazards are better ways to improve overall traffic efficiency. This also reduces and prevents the driver from danger while traveling on certain roads (Astarita, Festa, & Giofrè, 2018).

Road traffic safety is the central aspect of road transport planning activities. Good traffic can also add safety value in the form of adequate facilities. The use of signs can also increase the level of safety on the road. This includes traffic management which improves road safety without compromising the value of the environment (Sakhapov & Nikolaeva, 2017).

METHOD

Data is one of the leading forces in developing scientific research and modeling. However, very large datasets are only information without meaning if not interpreted accurately and translated into accurate predictions. Therefore, data collection in big data is necessary to produce a sound and sustainable pattern. Also, the process of systematic scientific research must begin with the identification of the right problem. (Rifai A. I., Hadiwardoyo, Correia, & Cortez, 2015); (Rifai, Latief, & Rianti, 2018); (Rifai, 2022); (Rifai A. I., Hadiwardoyo, Correia, & Pereira, 2016).

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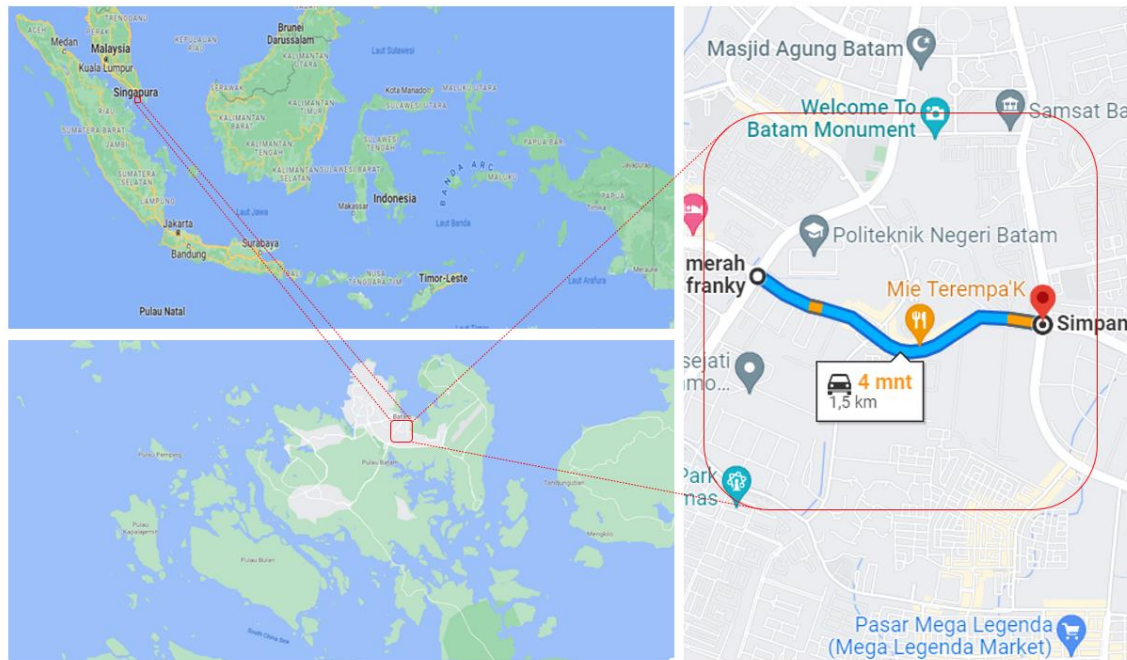


Figure 1. Research Location

This research will use the Indonesian Highway Capacity Manual (IHCM) 1997 method. The IHCM 1997 is a manual, used to calculate road performance but cannot be used to view or analyze by a network. Therefore, this research will use parameters based on IHCM 1997, which consists of primary and secondary data. Primary data consists of Road Geometry Data, Vehicle Volume, and Vehicle Speed. Meanwhile, the secondary data consists of Location Maps and Population Data. The research will be carried out on Thursday in the span of working hours (6.30 AM-8.30 AM). At these times, it can be seen the level of density and traffic conditions (Kusnandar, 2009).

RESULT AND DISCUSSION

Road Geometric Data

Table 1. Road Geometric Analysis of Jalan Laksamana Bintan

Road Type	4/2 D (4-lane 2-way divided)
Lane width	3.25 m
Roadside width	2.5 m
Median Width	3 m

Source: Author Survey Results (2022)

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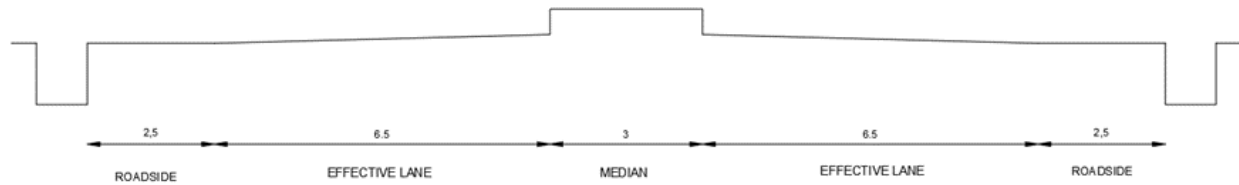


Figure 2. The section of Jalan Laksamana Bintan

Traffic Volume Analysis

Volume is the number of vehicles passing through at the current of the road at a certain period and is measured in vehicles per unit of time. From the survey conducted, the number of passing vehicles will be obtained, divided into LV (cars, vans, mini trucks), HV (big trucks, trailers, buses), MC (motorcycles), and UM (unmotorized vehicles). Based on IHCM 1997, volume is calculated using pcu/hour units, which are known as follows: LV: 1.0, HV: 1.2, MC: 0.25, and UM: 0.0. The volume obtained on Thursday, November 10, 2022, was 3069.45 pcu/hour.

Table 2. Traffic Volume Analysis on Jalan Laksamana Bintan

TIME	TOTAL VEHICLES							
	LV		HV		MC		TOTAL	
	<i>vhc/ hour</i>	<i>Junior/ hour</i>	<i>vhc/ hour</i>	<i>Junior/ hour</i>	<i>vhc/ hour</i>	<i>Junior/ hour</i>	<i>vhc/ hour</i>	<i>Junior/ hour</i>
06.30-06.45	337	337	8	9.6	1187	296.75	1532	643.35
06.45-07.00	524	524	3	3.6	1116	279.00	1643	806.60
07.00-07.15	526	526	0	0.0	931	232.75	1457	758.75
07.15-07.30	610	610	5	6.0	979	244.75	1594	860.75
TOTAL							6226	3069.45

Road Capacity

Capacity is the maximum number of hours per person or vehicle that will be able to pass a uniform point or section of a lane or lane during a specified period according to previous road conditions, traffic, and control. Road capacity can be calculated using IHCM 1997 road capacity formula.

$$C = Co \times FCw \times FCsp \times FCsf \times FCcs$$

Table 3. Road Capacity Data of Jalan Laksamana Bintan

Co.	6600
FCw	0.96
FCsp	1.00
FCsf	0.96
FCcs	1.00
C	6082.56

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The primary capacity (C_0) on Jalan Laksamana Bintan is 1650, obtained based on the IHCM 1997 table of basic capacity on urban roads. Because Jalan Laksamana Bintan is a 4/2 D type road, the basic capacity needs to be multiplied by 4 (the number of lanes). As a result, the basic capacity obtained is based on table 1. The width of Jalan Laksamana Bintan is 3.25. Therefore, based on the IHCM 1997 road width adjustment factor table, it was found that $FC_w = 0.96$. The direction separation adjustment factor (FC_{sp}) can be obtained by calculating the comparison of each lane width percentage. Based on the survey that has been done, it is concluded that Jalan Laksamana Bintan has a separation value of 50%-50%. Therefore, according to the IHCM 1997 direction separation adjustment factor table, Jalan Laksamana Bintan FC_{sp} value is 1.00. Based on table 1, the roadside width is 2.5 m. According to the IHCM 1997 table of side barrier adjustment factor, it can be determined that the FC_{sf} value is 0.96. Another factor that needs to be considered is the city population. Batam has a population of 1.2 million. Therefore, based on the IHCM 1997 table of city population factors, it can be obtained that the FC_{cs} value is 1.00. After determining all the factors, the load capacity can be obtained by inserting all the values into the IHCM 1997 road capacity formula. As a result, the road capacity value is $6082.56.1650 \times 4 = 6600$

Actual Speed

Actual speed is the average speed of vehicles passing through a road section, measured in km/hour. The average speed is obtained by taking a sample of several vehicles representing each type of vehicle (light, heavy, motorcycle). The samples that have been obtained are then processed, and the actual speed is obtained. The table shows that the actual speed of the vehicle on Jalan Laksamana Bintan is 47.95 km/hour.

Degree Of Saturation

The degree of saturation (DS) defines traffic behavior on a road section. With the degree of saturation value, many other factor values can be obtained, one of which is the Level of Service (LOS). It is obtained by dividing the volume (Table 2) by the road capacity (table 3). Through the calculations performed, the degree of saturation value for Jalan Laksamana Bintan is 0.50.

Level Of Services

Level of Service (LOS) is a value given to a road segment so that the quality of road service is known. According to IHCM 1997, LOS is divided into six levels (A-F): A is the best service quality, and F is the poorest service quality. The level of service can be determined by matching the degree of saturation value to the IHCM 1997 LOS table. Based on the survey and calculations that have been carried out, it is found that the LOS value for Jalan Laksamana Bintan is C (stable flow, speed is influenced by traffic, and volume according to the road city).

CONCLUSION

The research was conducted on Jalan Laksamana Bintan on November 10, 2022, from 06.30 AM to 07.30 AM. Based on the survey and research that has been carried out, the results show that the total volume = 3069.45 pcu/hour, road capacity = 6082.56, actual speed = 47.95 km/hour, Degree of saturation = 0.5, and Level of Services = C. From these data, it can be concluded that the Highway Laksamana Bintan is still comfortable and suitable for traffic players.

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