THE ANALYSIS OF ROAD PERFORMANCE ON JALAN GAJAH MADA BATAM, INDONESIA

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ABSTRACT

Due to the country’s growing vehicle population, major cities in Indonesia are experiencing traffic congestion. Traffic congestion can result in driver delays, inconvenience, economic losses, and air pollution. This paper aims to analyze the road performance on Jalan Gajah Mada (Baloi Indah – UIB) Batam. The method that will be used to analyze the road performance on Jalan Gajah Mada (Baloi Indah – UIB) is MKJI 1997. The standard LOS value in determining the classification of roads in this study is D, or the starting current is unstable, the speed is low and varies, and the volume is close to capacity.

INTRODUCTION

Traffic is an issue that occurs all over the world. It can cause traffic congestion, vehicle noise, travel time, and travel costs, as well as have an impact on the environment. The primary cause is population growth, which has increased the number of vehicles on the road. Other factors contributing to traffic congestion include inadequate infrastructure, ineffective capacity management (for instance, poor traffic timing), work zones, special events, and unconstrained demand (Manthare, Kharat, & Patil, 2018).

Due to the country’s growing vehicle population, major cities in Indonesia are experiencing traffic congestion. For instance, DKI Jakarta’s current population density has reached 16,704 people per square kilometer, or 118 times the population density of Indonesia, which are only 141 square people. As a result, Jakarta was ranked 46th out of 404 cities on the list of the most congested cities. Congested levels vary by location and city, depending on the population density, road capacity, alternative modes of transportation available, and traffic management technologies in use (Metz, 2018). However, Jakarta’s traffic congestion level is at 34% (TomTom, 2022).

Batam is the capital of Indonesia’s Riau Islands province. In 2021, the population of Batam will be 1,193,088 people, with a population density of 1153 people/km². Despite being the largest city in the Riau Islands, traffic congestion in Batam is better than it is in Jakarta. This is because in Batam, it usually only happens during working hours. During daily peak hours, most metropolitan cities experience traffic congestion (Afrin & Yodo, 2020).
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Congestion occurs when the travel demand exceeds the supply or capacity of the transportation system (Lu, Tettamanti, Höcher, & Varga, 2020). Traffic congestion occurs when travel demand exceeds road capacity (Suryani, Hendrawan, EAdipraja, Wibisono, & Dewi, 2019, March). The location analyzed in this study is Jalan Gajah Mada (Baloi Indah – UIB) in Batam. During working hours, this road can be congested due to the large number of people who use it to get home after work or go to UIB College. Students and teachers who want to attend the college UIB must arrive early to avoid congestion.

The congestion on this road can cause a series of issues for everyone, especially students and teachers that are heading to the college. In addition, the drivers will face delays, inconvenience, and financial losses because of traffic congestion and air pollution (Afrin & Yodo, 2020). The purpose of this paper is to analyze the road performance of Jalan Gajah Mada (Baloi Indah – UIB) in Batam.

LITERATURE REVIEW

Indonesia is currently experiencing extremely rapid advancement in the field of transportation. As a result, it necessitates a transportation foundation, which is a road. Roads are the primary mode of transportation in any country, and as such, must be kept in good physical condition to provide a safe and continuous flow of people and goods (Elseicy, Alonso-Díaz, Rasol, & Santos-Assunção, 2022). Furthermore, the road is intended and provided as a means of transportation to move from the origin to the destination (Anwar & Rizal, 2018).

Road classification is a method of systematizing roads based on the road (Sutheeraakul & Kronprasert, 2019). Based on user rights, there are two types of roads: public roads and toll roads. A public road is one that everyone has the right to use and is legal (Public road or highway Definition | Law Insider, 2022). A toll road is a public road part of the road network system and requires users to pay a toll (Magfirona, Hidayati, & Sunarjono, 2018).

Based on the road functions, there are four types of roads: arterial roads, collector roads, local roads, and environmental roads (Rakhmatulloh & Dewi, 2019). Arterials are roads that are designed to carry large amounts of motorized traffic (McAndrews, Pollack, Berrigan, Dannenberg, & Christopher, 2017). Collector streets are critical for collecting and transporting traffic from local

Figure 1. Jalan Gajah Mada (Baloi Indah – UIB)
streets to arterial streets (Dehghanmongabadi & Hoşkara, 2022). Local roads connect districts to communities, have light traffic, and have the lowest speed limits (Andani, Geurs, & La Paix Puello, 2019). Finally, an environmental road is a public route dedicated to environmental mobility, with short travel distances and a low average speed (Suraharta, 2021).

Because the purpose of the road is to facilitate transportation and logistics, road users’ safety must be prioritized (Handayani, Setyowati, & Firdaus, 2019). Road safety is a global issue with significant implications for personal safety, the economy, and public health (Abdullah, 2021). The most commonly used measures to define road safety are the number of road crashes, road casualties, and associated negative consequences (Wegman, 2017). Road safety is critical because we must know whether or not the road is safe to prevent road users from being killed or seriously injured.

The Road Performance

Road performance is the ability of roads to serve the needs of traffic flows according to their functions, and it can be measured and compared to the level of road service standards (Ginting & Widyaningisih, 2022). Therefore, the level of road service is used as a road performance parameter. According to the US-HCM, road performance or service level is a qualitative measure used in the United States that describes how traffic flows operate and are rated by road users (Rifai, Surgiarti, Isradi, & Mufhidin, 2021). Speed, congestion, comfort, freedom of movement, travel time, and safety are all factors to consider in calculating road performance (MKJI, 1997).

One of the parameters of road performance is road capacity. Capacity is defined as the maximum number of cars, people, or similar things that may be accommodated per unit of time under certain conditions with a reasonable expectation of occurrence (Moses, Sudharsanamurthy, & Madhivadhani, 2021). Because a lack of road capacity is the most common cause of persistent congestion, increasing road capacity is the most commonly proposed solution (Planning and the Complicated Causes and Effects of Congestion, 2022). The number of vehicles crossing the urban road network has expanded fast as social and economic growth has occurred. However, road capacity has remained constant, resulting in a progressive reduction in the level of road service (Wadu, 2020).

Road roughness can be used to estimate road performance. Road roughness must be continuously monitored to accurately understand the road infrastructure's condition (Bajic, et al., 2021). Knowledge of "road roughness" has long been acknowledged as a crucial measure of road performance in terms of safety and ride quality, automobile working conditions, and pavement deterioration (Cruz, Mendoza, & Lopez, 2021). There are many ways to quantify road roughness. However, most of them measure the road surface's vertical deviation along the bike path's longitudinal driveline, known as the profile (Behera, Pradhan, & Das, 2021).

There are numerous indicators of poor road performance. For example, high traffic density and the formation of queues indicate poor road performance (Sugari, Kusuma, & Purnomo, 2022). Another indicator of poor road performance is observed by observing whether or not the road is likely to be congested.

The Traffic Management

To improve traffic management, developing urban areas face challenges such as collecting, analyzing, sharing, traffic density, and predicting real-time travel times on the road’s routes (Chavhan & Venkataram, 2020). Traffic management is the process of maximizing the effectiveness of the existing infrastructure to ensure the safe and reliable operation of traffic (Hanumappa, Mulangi, & Kudachimath, 2018). Its purpose is to ensure safe, orderly, efficient passenger and freight transportation, to protect, and where possible, improve transportation
facilities and the local environment near them (Nayak & Katakiya, 2019). A traffic management system consists of a set of applications and management tools aimed at improving traffic efficiency and safety in transportation systems (De Souza, et al., 2017).

The term “traffic” does not only refer to the movement of goods and people. It also refers to the transportation of trains, people, and ships from one location to another. The movement usually occurs along a specific facility or pathway known as a guideway (Jovanis & Hobbs, 2021). All these movements require proper management (De Souza, et al., 2017).

The connection between driving and CO2 emissions is perfect, allowing people to estimate better how traffic management policies can help mitigate climate change (Makhloga, 2022). A vehicle, an accident, or a lack of pedestrian safety contribute to high emissions. Many of these are the root causes of the congestion problem. In this situation, where space is frequently inaccessible, traffic management is required.

The level of danger on the road is directly proportional to the road environment. There are numerous environmental issues on the road, such as noise, dust, and vibrations. The state of traffic infrastructure is critical to the development of transportation and its environmental impact (Mavrin, Magdin, Shepelev, & Danilov, 2020). Adequate infrastructure facilities can significantly reduce environmental pollution caused by traffic flows (Mavrin, Magdin, Shepelev, & Danilov, 2020).

METHOD

The quantitative method was applied in this study. Quantitative research is the act of gathering and evaluating numerical data that may be used to develop statistics and identify patterns in the study (Hadista, Suyadi, & Aisyah, 2021). Data is one of the most potent forces in compiling a research and scientific model (Rifai, Hadiwardoyo, Correia, Pereira, & Cortez, 2015). Therefore, the systematic process can begin with identifying the problem (Rifai, Hadiwardoyo, Correia, & Pereira, 2016). The primary data is the data that will be observed. The primary data is the number of vehicles on the road and the geometry data of the road. We will use the map location and population data as the secondary data. The method used in this research is MKJI 1997 to find the level of services on the road.

![Figure 2. Location of research](image-url)
The Analysis of Road Performance on Jalan Gajah Mada Batam, Indonesia

The research was conducted for one day during the morning rush hour on Monday, November 28, 2022. The research took about 1 hour, and the time used for the research was 06:15 – 07:15. The location of this research was conducted at Jalan Gajah Mada (Figure 2).

RESULT AND DISCUSSION

The location of this research was conducted at Jalan Gajah Mada (Baloi Indah – UIB). The Jalan Gajah Mada (Baloi Indah – UIB) is a road with type 4/2 D. Each lane is 3 meters wide and is divided by a median width of 1.5 m. Batam will have a population of 1.685.000 in 2022 (MacroTrends, 2022).

There are 3 types of vehicles that were used in this research which are LV (Light Vehicle), HV (Heavy Vehicle), and MC (Motorcycle). The emp factor that’s going to be used is 1.00 for LV (Light Vehicle), 1.2 for HV (Heavy Vehicle), and 0.25 for MC (Motorcycle). The traffic data was collected from a 1-day in-person survey at the survey site on Monday, November 28, 2022. The findings showed that the heaviest traffic volume occurred at 07:00 – 07:15 at 1277 pcu / hour.

<table>
<thead>
<tr>
<th>Time</th>
<th>Type of Vehicle</th>
<th>Total Per Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LV per Hours</td>
<td>HV Per Hours</td>
</tr>
<tr>
<td>06:15 – 06:30</td>
<td>543</td>
<td>7</td>
</tr>
<tr>
<td>06:30 – 06:45</td>
<td>787</td>
<td>3</td>
</tr>
<tr>
<td>06:45 – 07:00</td>
<td>742</td>
<td>2</td>
</tr>
<tr>
<td>07:00 – 07:15</td>
<td>747</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>10,392</td>
<td>4728.4</td>
</tr>
</tbody>
</table>

Table 1. Traffic Volume Data

Road Capacity

Capacity is the maximum traffic flow that can be sustained under certain conditions (traffic flow, environment, and geometric), and the total capacity across arms is the base of this capacity under certain conditions (ideal), and it is a multiplication of capacity, and adjustment factor considering field conditions (Isradi & Pratama, 2020). Therefore, the capacity can be calculated using the formula (MKJI, 1997):

\[ C = C_o \times FC_w \times FC_{SP} \times FC_{SF} \times FC_{CS} \]

\[ C = 6600 \times 0.92 \times 1.00 \times 0.98 \times 1.00 \]

\[ C = 5950.56 \]

Table 2. Road Capacity
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### Degree of Saturation

The degree of saturation value is used as a key factor by which the level of services (LOS) of a road can be determined, as well as whether the analyzed road has capacity issues (Rifai, 2021). The formula below can be used to calculate the degree of saturation (MKJI, 1997):

\[
DS = \frac{Q}{C}
\]

\[
DS = \frac{4727.2}{5950.56}
\]

\[
DS = 0.79 \text{ pcu/hour}
\]

### Level of Services

Level of service (LOS) is a qualitative description of a roadway's operating conditions based on speed, travel time, maneuverability, delay, and safety (Mohammed Ali, Hasan, Mohammed, & Qadr, 2019). The level of services that will be used to determine the level is in table UHCM 1985. The level of services of Jalan Gajah Mada (Baloi Indah – UIB) can be calculated using the formula (MKJI, 1997):

\[
LOS = \frac{V}{C}
\]

\[
LOS = \frac{4727.2}{5950.56}
\]

\[
LOS = 0.79 \ (D)
\]

Road segment performance is a quantitative measurement describing certain conditions on a road segment. Generally, a road's performance can be seen from the capacity and degree of saturation (DS) through a study of road performance. A qualitative measure that describes the operational conditions in the traffic flow and the driver's perception of driving quality is expressed by the service level of the road section.

Level of Service is a measure used to determine the quality of a particular road section in serving the traffic flow that passes through it. The level of road service describes the operational conditions of traffic flow and motorists' perception in terms of speed, travel time, comfort, freedom of movement, security, and safety. By calculating the LOS value, the road classification or the level of service on a particular road segment can be seen. The standard LOS value in determining the classification of roads in this study is D, or the starting current is unstable, the speed is low and varies, and the volume is close to capacity.

### CONCLUSION

Some conclusions can be drawn from the field survey results and data analysis calculations. First, Jalan Gajah Mada (Baloi Indah – UIB) has the heaviest traffic volume in the morning, which is 4728.4 pcu/hour. By calculating the LOS value, the road classification or the level of service on a particular road segment can be seen. The standard LOS value in determining the classification of roads in this study is D, or the starting current is unstable, the speed is low and varies, and the volume is close to capacity.
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