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THE ANALYSIS OF ROAD SERVICE LEVEL DUE TO RAIL CROSSING: A CASE OF RAILWAY CISAUK STATION AREA, TANGERANG INDONESIA

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ABSTRACT

Transport is the key to any country's development; thus, roads, railways, airways, and waterways have been developed for rapid urbanization and mobility. Nevertheless, many cities in the world are facing uncontrolled growth in traffic volumes, one of which is congestion. Traffic congestion is one of the most severe problems in many cities worldwide. This problem is even more pronounced in developing countries due to the rapid population and economic growth. Population and economic growth promote the expansion of urban areas and the use of cars, which leads to traffic jams. The level of road service, delays, and queue length cause congestion. Therefore, this study aims to determine the level of road service due to crossing a railway plot. The method used in this study is a direct observation or survey method, which directly calculates the volume of the vehicle, the length of delay, and the actual queue length of the field. Based on the results of research conducted on the Cisauk Highway regarding the level of road service due to the closure of the train door bars, it was concluded that the Cisauk Highway obtained a Level of Service (LoS) value of 1,674, categorized as F with the definition of forced current conditions, low speed, volume above capacity, and long queues (traffic jams). The researchers also obtained the results of the most comprehensive delay survey at 18.23 of 223 seconds, with the most extended queue length of 524 meters for the Serpong direction and 267 meters for the Cisauk direction.

INTRODUCTION

Transportation is the key to any country's development. Thus, roads, railways, airways, and waterways have been developed for rapid urbanization and mobility (Bari, Chandra, Dhamaniya, Arkatkar, & Navandar, 2021). Transportation is one of the media to connect people with specific goals. Transportation provides convenience for humans in carrying out daily activities, meeting the needs of life, and interacting with humans. Transportation makes people more productive because it can move quickly from one place to another, which impacts time efficiency (Andika, Rifai, Isradi, & Prasetijo, 2022). The transport system has become a fundamental basis for the economic growth of all nations.

Nevertheless, many cities worldwide are facing uncontrolled growth in traffic volumes. The rapid development in major cities of the world, especially in developing countries, has resulted in increased community activity. This increase is also directly proportional to the community's need for traffic, causing traffic jams that result in longer travel times. In addition, congestion also results in increased air pollution, fuel wastage, and reduced comfort levels in traffic (Guerrero-Ibáñez, Zeadally, & Contreras-Castillo, 2018); (Rifai & Arifin, 2020).

Traffic congestion is one of the most severe problems in many cities worldwide. This problem is even more pronounced in developing countries due to the rapid population and economic growth. Population and economic growth promote the expansion of urban areas and the use of cars, which causes traffic jams (Nafila, 2018). Traffic congestion has a direct and indirect impact on the economy of a country and the health of its population Congestion (Akhtar & Moridpour, 2021). It often occurs in large cities, especially where public transport is inadequate or system irregular traffic and is also unbalanced between traffic volume and road capacity or density. Traffic congestion can be caused by several factors, including the comparison of the volume of vehicles with available road sections is not suitable, the number of vehicles that continues to increase every day, the lack of optimal use of public transportation, illegal parking, and traffic accidents. Congestion also often occurs around the station area, especially on roads adjacent to the railroad tracks, due to the closure of door bars if trains pass by, causing delays and congestion that are pretty long around the road section. The same is true in Cisauk. In terms of rapid population growth and the movement of people from other places to the area, traffic jams occur, especially on the Cisauk station road section, because there are delays due to the closure of the train door bars, which causes long traffic jams to occur.

Geographically, Cisauk is included in the administrative area of Tangerang Regency. Tangerang Regency is a lowland regency with an altitude of 0-85 meters above sea level, located at 6°00' - 6°20' South Latitude and between 106°20'-106°43'East Longitude. The area of Tangerang regency is 959.61 km2, inhabited by a population of 3,293,533 people, so the population density of the Cisauk district is 3432.16 / km^2. The northern boundaries border the Java Sea, the south bordering Bogor Regency, the west bordering Serang and Lebak Regencies, and the east with South Tangerang City and West Jakarta City. This research is expected to determine the level of road service, delays, and queue length at a plot crossing due to the closure of the fire gate bar on the Cisauk station road section and can provide advice and solutions to interested parties regarding the level of road service due to the closure of the train door bar (Central Statistics Agency of Tangerang Regency, 2022).

LITERATURE STUDIES

Road Service Level

In general, road service is a facility provided by the road. These can be road surface conditions, traffic and pedestrian lane width, the neighborhood around the road, road crossing facilities, security, safety, public toilets, refreshment facilities, parking facilities, lighting, road signs, and emergency services—any service, whether road infrastructure or otherwise, the quality

of that service has more impact on satisfaction. Service quality is one of the performance indicators included in the effectiveness category. It consists of accessibility, convenience, comfort, convenience, and security. The level of road service consists of the quantity of service, quality of service, comfort, safety, convenience, and others (Hasan, Alam, Mim, & Das, 2020).

The level of road service is related to the road's capacity and traffic volume. Road capacity is the maximum hourly flow rate at which people or vehicles can be expected to cross a point or uniform part of a lane or highway over a while under prevailing road and traffic conditions. Capacity is the maximum current that goes through a point on the road that can be maintained per unit hour under certain conditions. For two-way two-lane roads, the capacity is determined for two-way currents (two-way combinations), but for roads with many lanes, the current is split per direction, and the capacity is determined per lane. Traffic volume is expressed as the rate of flow passing through a section of the road, usually by units of vehicles per hour (vehicles/hour). Then the calculation on the road is carried out for one day to get the value of vehicles per day (vehicles/day). For twelve months of the year, it is often changed to Average Daily Traffic (ADT) and Annual Average Daily Traffic. Traffic volume can also be interpreted as the number of vehicles passing through a section of road at a certain level at a suitable time. Traffic volume research is carried out to determine the number, movement, and classification of road vehicles in a particular location to determine the critical time flow period and the influence of heavy vehicles or pedestrians on the traffic flow of vehicles. Because the traffic volume is not always stable, calculating the continuous traffic volume is very important for the smooth functioning of vehicles. If the traffic volume is measured continuously, the transport system can succeed, and the country's economic system can also face difficulties. (Jayaratne & Pasindu, 2020); (MKJI, 1997); (Salisu & Oyesiku, 2020); (Bhat & Gupta, 2018).

Delays and queue lengths due to delays also affect the level of road service. A delay is an obstacle or additional travel time required to go through an intersection compared to a track without going through a meeting. Procrastination consists of traffic delays and geometry delays. Traffic Delay is the wait time caused by interaction with conflicting traffic movements. Geometry delays are caused by the deceleration and acceleration of vehicles that turn intersections or are stopped due to stopping. Queue length is the length of the vehicle queue, in short, that occurs due to a delay and is expressed in meters. The movement will control the vehicle's movement in the queue before it, or other traffic system components will stop it. The service time depends on many factors, such as toll rates, traffic characteristics, driver behavior, and even the closure of train door bars. Variations in service time affect road performance, resulting in additional delays for users waiting in queues. For example, the increase in queues caused by delays in the train door bars results in inconvenience and inconvenience for road users and also causes fuel combustion in ignited conditions that can cause greenhouse gas emissions (Kuncoro, Ratih, & Primantari, 2022); (Kuncoro, Ratih, & Primantari, 2022); (Bari, Chandra, Dhamaniya, Arkatkar, & Navandar, 2021).

Plot Crossing

Transportation makes people more productive because it can move quickly from one place to another, which impacts time efficiency. Guaranteeing economic growth and the convenience of road users are two conditions for developing a country, which is only possible with smooth traffic flow. With developments in the transport sector by collecting traffic information, the authorities pay more attention to monitoring traffic congestion. One mode of transportation currently crucial for the Jabodetabek community is the train because trains can make workers' mobility quickly and at low prices. Rail transport is a mode of transportation of people and goods through wheeled vehicles operating on rails. It is a safe, fast, and cost-effective transportation for long and short distances.

Maximum efficiency can be achieved mainly by transferring mass quantities of people and goods. Rail transport is more organized than car travel because of its well-established routes and schedules, and it allows economic progress. In addition, rail transport increases investment and attracts foreign investors due to efficient and fast service, cost savings, improved traffic safety, and reduced pollution. Train travel includes airport rail connections, cable rail lines, heavy rail, Light Rapid Transit, and Mass Rapid Transit. However, because in Indonesia, the supporting structure for railways is not yet like abroad, there are still many train lines that intersect road sections or so-called plot crossings (Andika, Rifai, Isradi, & Prasetijo, 2022); (Akhtar & Moridpour, 2021); (Suhaimi, Maimun, & Sa'at, 2021).

The crossing of a plot of railway tracks is a place of intersection of rails and highways with each other at the same level. Approaching trains have a higher priority to pass first than road vehicles and pedestrians approaching railway crossings. There are many plot crossing types, but they can be divided into three main types: controlled, automatic and passive railways. At railway crossings, the opening and closing of crossings to railroad tracks or roads are controlled by railway signals or crossing guards who are members of the railway staff. The crossing operation is almost always interlaced with the railway signal, so it is only possible to remove the railway signal once and when the crossing proves closed to road users. Modern railway-controlled crossings have lifted full barriers, either operated by on-site signallers or remotely supervised by CCTV. However, due to the closure of train door bars, there is often congestion around the area of the road closing the train door bars.

Traffic congestion is a widespread global phenomenon due to high population density, the growth of motor vehicles and their infrastructure, and the proliferation of rideshare and delivery services. The most common definition of congestion in a traffic flow state is when the travel demand exceeds the capacity of the road. From the perspective of travel delay time, congestion occurs when normal traffic flow is disrupted by high vehicle density resulting in excessive travel time. Various reasons are responsible for creating congestion in most urban areas. Depending on these different reasons, congestion can be classified into repetitive and non-repetitive. Traffic congestion also impacts the individual level. Loss of time, especially during rush hour, mental stress, and additional pollution to global warming are also some of the essential factors caused due

to traffic congestion (Evans & Hughes, 2019); (Singhal, et al., 2020); (Afrin & Yodo, (2020); (Akhtar & Moridpour, 2021).

METHOD

Research methodology is a way or technique to obtain information and data sources used in research. Data is one of the leading forces in compiling scientific analysis and modeling. To get information, it is necessary to carry out A systematic scientific research process that must begin with identifying the right problem. Research is carried out using quantitative methods, namely the exact values (numbers) in the analysis and discussion process to meet research objectives. Data collection is carried out using direct field surveys in the morning and evening. The calculation of vehicle volume is carried out every 15-minute interval and is divided into three categories: bicycles, light vehicles, and heavy vehicles. The location of this study was carried out on the Cisauk Lapan highway around the Cisauk station road section, which experienced delays due to the closure of the train door bars. The Geometric Condition of the (Rifai, Hadiwardoyo, Correia, & Pereira, 2016)(Rifai, Hadiwardoyo, Correia, Pereira, & Cortez, 2015). Cisauk road section that is the place of study is an urban road type with a classification of 2/2 UD with a lane width of 6 m, a Kerb barrier distance of ≤ 0.5 m, and also a high class of side obstacles and with a total population of Tangerang Regency with a total population.

Figure 1. Location of research

RESULTS AND DISCUSSION

The traffic volume survey was conducted on Saturday, November 19, 2022, in the morning at 06.00 – 08.00 and in the afternoon at 17.00 – 19.00. with a coefficient or equivalent of a support car of 1.2 for heavy vehicles and 0.25 for motorcycles (MKJI, 1997).

Table 1. Traffic survey data volume

Traffic Volume Survey Form				
Location: Jalan Stasiun Cisauk			Day: Saturday	
Direction: 2 Direction			Date: November 19, 2022	
Time	Types of Vehicles			Weather
	Motor	Light Vehicles	Heavy Vehicles	
06.00 - 06.15	570	116	26	Bright
06.15 - 06.30	603	151	37	Bright
06.30 - 06.45	921	243	61	Bright
06.45 - 07.00	1239	334	84	Bright
07.00 - 07.15	1337	383	103	Bright
07.15 - 07.30	1384	402	107	Bright
07.30 - 07.45	1286	352	91	Bright
07.45 - 08.00	1231	332	81	Bright
17.00 - 17.15	1192	315	80	Bright
17.15 - 17.30	1266	336	86	Bright
17.30 - 17.45	1411	423	113	Bright
17.45 - 18.00	1556	510	138	Bright
18.00 - 18.15	1337	402	132	Bright
18.15 - 18.30	1155	305	78	Bright
18.30 - 18.45	1355	407	135	Bright
18.45 - 19.00	1574	517	145	Bright

Calculation of road performance requires vehicle flow data and road geometry data. The flow that passes on a road section consists of various types of vehicles, including passenger cars, city buses, and motorcycles. To calculate the classification of traffic flow is to state traffic not in vehicles per hour but in passenger car units (PCU) per hour. Therefore, a conversion value is needed so that traffic flow becomes more precise when expressed in standard vehicle types, namely passenger cars. The conversion factor of these various types of vehicles into passenger cars is

known as pce (passenger car equivalent). PCU is a unit of vehicle in traffic flow which is equivalent to a light vehicle or passenger car, the amount of PCU is influenced by the type and type of vehicle, vehicle dimensions, and maneuverability. While the equivalent of a vehicle with a passenger car depends on the size and speed of the vehicle, the larger the vehicle, the higher the emp value, the higher the vehicle speed, the lower the emp value.

Table 2. PCE Conversion of traffic survey volume data

Time	Types of Vehicles			Sum
	Motor	Light Vehicles	Heavy Vehicles	
06.00 - 06.15	142,5	116	31,2	289,7
06.15 - 06.30	150,75	151	44,4	346,15
06.30 - 06.45	230,25	243	73,2	546,45
06.45 - 07.00	309,75	334	100,8	744,55
07.00 - 07.15	334,25	383	123,6	840,85
07.15 - 07.30	346	402	128,4	876,4
07.30 - 07.45	321,5	352	109,2	782,7
07.45 - 08.00	307,75	332	97,2	736,95
17.00 - 17.15	298	315	96	709
17.15 - 17.30	316,5	336	103,2	755,7
17.30 - 17.45	352,75	423	135,6	911,35
17.45 - 18.00	389	510	165,6	1064,6
18.00 - 18.15	334,25	402	158,4	894,65
18.15 - 18.30	288,75	305	93,6	687,35
18.30 - 18.45	338,75	407	162	907,75
18.45 - 19.00	393,5	517	174	1084,5

Based on Table 2. It can be known that the busiest total traffic flow on the Cisauk Highway section is at 17.15 – 18.15, with a traffic flow volume (Q) of 3626.3 pcu/hour. With the Geometric and Environmental Conditions of the Cisauk Highway following what has been described, the essential capacity (C_O) is 2900 pcu / hour; road lane width factor (FC_W) is 0.87; road divider correction factor (FC_{SP}) is 1.00; side resistance factor (FC_{SF}) 0.78; city size correction factor (FC_{CS}) 1.04. To determine the capacity of the Cisauk highway is obtained through calculations:

$C = C_O \times FC_W \times FC_{SP} \times FC_{SF} \times FC_{CS}$ ..... (1)

C = 2900 x 0.87 x 1.00 x 0.78 x 1.04

C = 2046.66 pcu/hour

Table 3. Level of service value

Service Level	Traffic Characteristics	V/C Scope Limits
A	Conditions of free traffic flow with high speed and low traffic volume without obstacles	0,00 - 0,20
B	The current is stable, but the operating speed begins to be limited by traffic conditions	0,21 - 0,44
C	The current is stable, but the speed and motion of the vehicle are controlled	0,45 - 0,74
D	The current is close to unstable, the speed is still controllable, and V/C is still tolerable	0,75 - 0,84
E	Unstable current speed sometimes stops; demand is already approaching capacity	0,85 - 1,00
F	Forced current, low speed, volume above capacity, long queue (jammed)	≥ 1.00

Source(US-HCM, 1985)

The calculation of the level of *service* can be known by comparing the volume of traffic flow (Q) with the road capacity (C). Based on the data that has been obtained, then:

$$LOS = \frac{Q}{C} \quad \text{..... (2)}$$

$$LOS = \frac{3626,3}{2046,66}$$

$$LOS = 1,674$$

Based on the calculation results, *the LOS* value of 1,674 was obtained and referred to in Table 3. So, the Cisauk highway is categorized as F with conditions of forced current, low speed, volume above capacity, and long queues (traffic jams). In addition to knowing the level of road stewards (*LOS),* researchers also conducted research on Delay and Queue Length. Based on the field survey results, the most prolonged delay at 18.23 was 223 seconds, with the most extended queue length of 524 meters for the Serpong direction and 267 meters for the Cisauk direction.

Table 4. Delay and queue traffic survey data

Delay Survey Form and Queue Length		
Location: Jalan Stasiun Cisauk	Day:	Saturday
Direction: 2 Direction	Date: November 19, 2022	
Closing Time	Queue Length (m)	

	Closing Duration/ Delay (seconds)	Serpong Direction	Cisauk Direction
06.08	115	115	74
06.16	126	98	56
06.25	158	134	84
06.32	134	146	94
06.39	122	123	80
06.46	180	201	63
06.57	145	245	104
07.06	162	183	74
07.12	134	254	148
07.20	169	312	189
07.27	115	256	154
07.37	189	387	234
07.48	174	376	117
07.57	154	224	107
17.09	124	249	118
17.15	107	240	114
17.22	214	347	136
17.28	133	255	129
17.36	185	386	153
17.42	118	223	122
17.51	105	202	107
17.58	115	174	98
18.07	107	232	114
18.15	121	371	188
18.23	223	524	267
18.31	208	476	237
18.40	103	416	184
18.47	114	356	158
18.52	101	234	137
18.58	120	258	115

It is hoped that with accuracy in analyzing the performance level of a crossing, it will reduce losses for road users caused by inappropriate policies. To be able to make decisions to overcome crossing problems, the parameters used in analyzing road performance must have high validity. The validation of the pce value with ICHM 1997 can be measured from the delay time directly in the field. The results of direct measurements in the field serve as the basis for comparing them with calculations carried out using the 1997 IHCM based on several variables adjusted for a location. In subsequent research, the variables that can be used from ICHM 1997 are the Linear Regression Method and the Headway Ratio.

The existence of delays from passing trains adds to the travel time of vehicle drivers with varying durations. In addition, the railroad track has a higher elevation than the normal road elevation, causing a decrease in vehicle speed when passing through it. In addition, there are frequent problems with traffic violations around railroad crossings, for example motorbikes crossing, merging, turning around or breaking into the road near the crossing which in turn becomes an operational delay that adds to the duration of the total delay.

CONCLUSIONS

Based on the results of research conducted on the Cisauk Highway regarding the level of road service due to the closure of the train door bars, it was concluded that the Cisauk Highway obtained a *Level of Service* (LoS) value of 1,674, categorized as F with the definition of forced current conditions, low speed, volume above capacity, and long queues (traffic jams). The researchers also obtained the most comprehensive delay survey results at 18.23 of 223 seconds, with the most extended queue length of 524 meters for the Serpong direction and 267 meters for the Cisauk direction. According to researchers, short-term handlers can be done by ordering shops or street vendors so that the space belonging to the street (Rumija) can be used for road widening. Moreover, according to researchers, a flyover can be made *for long-term handling* to reduce congestion/delay due to the closure of the train door bar (crossing a plot).

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