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Evaluation Of Daily Traffic Activities At Four-Way Intersection Of Cimencrang, Al Jabbar Mosque Are, Using PKJI 2023

Evaluation of Daily Traffic Activities At Four-Legged Intersection Of Cimencrang, Al Jabbar Mosque Area, Using PKJI 2023

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Abstract. *This study evaluates the impact of daily traffic activity at the four-legged intersection at the Cimencrang railway crossing, in the Al Jabbar Mosque area, using the Indonesian Road Capacity Guidelines (PKJI) 2023. The aim of this study is to assess the traffic performance affecting the efficiency of at-grade road and railway crossings in the area. This evaluation is essential to understand the traffic dynamics in the area, which will help the government in designing traffic and transportation management methods to reduce future congestion. Traffic data was collected through direct surveys during peak hours on weekdays, covering vehicle volume, vehicle types, and the geometric dimensions of the roads at the intersection. The evaluation results indicate that the intersection's Volume to Capacity Ratio (VCR) at the study site is 0.74. The findings also suggest that this four-legged intersection frequently experiences critical conditions, with Levels of Service (LOS) ranging from C to E during busy hours. The study recommends improving traffic management and infrastructure to enhance performance and traffic conditions, as well as road user safety in this area. It is hoped that these findings can serve as a foundation for local government in planning more effective traffic policies in the area, and provide insights into the processes and procedures of traffic evaluation at four-legged intersections.*

Keywords: *Traffic data; Traffic evaluation; Four-way intersection; PKJI 2023*

Introduction

Advances in transportation and urban mobility often lead to complex traffic issues in metropolitan areas. The increase in motor vehicles and the rapid growth of residential areas affect the intensity of travel, ultimately driving greater demand for direct access to city centers (Koenti and Risdiyanto, 2015). One critical point in traffic management is intersections near railway crossings, where traffic dynamics and delay times are often high. The Cimencrang railway crossing four-way intersection, in the area of Al Jabbar Mosque, is a clear example of such conditions. The presence of a railway crossing in this area adds to the challenges of managing traffic flow effectively and efficiently. This study examines the impact of daily traffic activities at this four-way intersection, using the Indonesian Highway Capacity Manual (PKJI) 2023 as the basis for analysis. The main objective of this study is to evaluate the traffic performance at the Cimencrang railway crossing four-way intersection, which affects the overall traffic flow on the roadway in this area. Traffic data were collected through direct surveys during peak hours, capturing vehicle volume, types of vehicles, and geometric dimensions of the intersection.

In studies and observations conducted by the Bandung City Government (Bandung City Government, 2024), significant challenges have arisen in addressing worsening congestion in the Gedebage area, especially following the operation of the Jakarta-Bandung High-Speed Rail Station (KCJB or KCIC) in Tegaluar. Access to this station through Gedebage has led to increased traffic, particularly on weekends. To anticipate congestion, which is expected to continue rising, the Bandung City Government has taken several strategic steps. One priority is to expedite repairs on Exit Toll KM 149 Gedebage. Reopening this toll exit is considered crucial, as it previously helped reduce congestion in the area. Additionally, the government is accelerating the construction and organization of access routes at South Gedebage Junction and Access 5 Summarecon, which lead to Al Jabbar Mosque. The West Java Provincial Government is also contributing by building a bridge over the Cinambo Lama River, which will eventually serve as a permanent bridge to divert some of the traffic flow towards South Gedebage.

Based on a global perspective, infrastructure and congestion issues like these have far-reaching impacts, affecting not only local urban life but also carrying broader economic and environmental implications. Additionally, according to the fact that rapid urban growth in various parts of the world and an expected urbanization rate reaching 66% by 2050 (United Nations, 2014), sustainable infrastructure planning becomes increasingly important. Cities worldwide face similar challenges in managing public transportation, improving accessibility, and reducing carbon emissions caused by congestion. Moreover, the quality of transportation services in an area has a feedback effect on land use choices and future development (Lubis, 2001; Nasution, 2010).

As Indonesia aspires to become a developed nation, the commitment outlined in the Paris Agreement to achieve zero carbon emissions by 2050 should serve as a guiding benchmark (United Nations, 2015). Rapid and effective policy implementation in Bandung could set an example for other cities facing similar challenges in creating transportation solutions that are not only efficient but also environmentally friendly and sustainable.

A prior study (Nurutami, 2023) outlined previous findings in this area, where projected traffic volumes were calculated using the compounding factor method and linear trends, based on the growth of motor vehicles in Bandung. At that time, the performance of Cimencrang Street was still categorized as Level of Service B, as the analysis indicated that this road had stable traffic flow, with an average speed of about 40 km/h, a V/C ratio of 0.24, and moderate traffic density due to internal obstacles. This study recommended that, to improve the performance of Cimencrang Street, traffic engineering with three different scenarios should be implemented. The calculations from the study showed a traffic volume growth rate of 4%. However, this study did not conduct specific research on the Cimencrang four-way intersection near the level railway crossing.

Research Methodology

This research was conducted at the four-way intersection connecting Cimencrang Road with SOR GBLA (Gelora Bandung Lautan Api) Road. The location of this intersection is at a railway crossing. The intersection comprises two major roads: East SOR GBLA Road, which leads to an alternative route toward the Summarecon Mall area via Bulevar Utama Road, and West SOR GBLA Road, which directly leads to the GBLA Football Stadium. Additionally, there are two minor roads, namely North Cimencrang Road and South Cimencrang Road. According to the Indonesian Highway Capacity Manual (PKJI) 2023, this intersection is categorized as type 424M, meaning it has four legs, with two lanes on the minor roads and four lanes with a median on the major roads.

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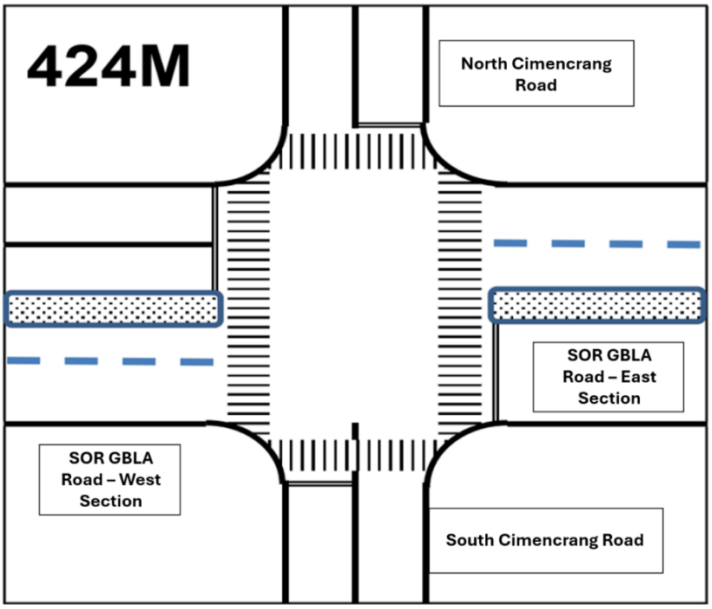

Source: Author's Design Image (Modified Original Image from PKJI 2023), 2024

Figure 1. Layout of The Cimencrang Four-Way Intersection

Results And Discussions

1. Road And Traffic Conditions

This intersection often experiences significant congestion during peak hours on weekdays, specifically from 6:30 – 8:30 AM, 11:00 AM – 1:00 PM, and 4:00 – 6:00 PM. The evaluation of the intersection's conditions through traffic surveys aims to understand the actual state of the road by analyzing its operational traffic capacity. Surveys during these peak hours are also implemented to assess the Level of Service (LOS) according to the latest conditions. Figure 1 above shows the layout of the Cimencrang four-way intersection, which is the location of this study.

This area is an intersection of roads classified as Secondary Collector Roads (Jalan Kolektor Sekunder), in accordance with Bandung City Regulation No. 10 of 2015 on the Detailed Spatial Plan and Zoning Regulations for Bandung City 2015–2035 (Peraturan Daerah Kota Bandung Nomor 10 Tahun 2015 tentang Rencana Detail Tata Ruang dan Peraturan Zonasi Kota Bandung Tahun 2015 – 2035). Furthermore, based on Presidential Regulation of the Republic of Indonesia No. 34 of 2006 on Roads (Peraturan Presiden Republik Indonesia Nomor 34 Tahun 2006 tentang Jalan), Secondary Collector Roads must be designed with a minimum speed of 20 km/h and a minimum road width of 9 meters. These roads must also have a capacity that exceeds the average traffic volume, and fast traffic flow on these roads should not be disrupted by slower traffic flows. Table 1 below provides the specifications of the road sections at the Cimencrang intersection survey location, Al Jabbar area.

Table 1. Specifications of Road Sections at Cimencrang Intersection, Al Jabbar Area

The Width of Each Lane on Major Road (SOR GBLA Road – East Section and SOR GBLA Road – West Section	5,8 meters
The Width of 2 Lanes on Major Road	11,6 meters
The Road Median Width on Major Road	0,9 meter
The Curb Height on Major Road	0,2 meter
The Sidewalk Width on Major Road (SOR GBLA Road – West Section)	2,5 meters
The Width of 2 Lanes on Minor Road	4,3 meters
The Curb Height on Minor Road	0,15 meter
The Sidewalk Width on Minor Road (South Cimencrang)	1,1 meters

Source: Primary Survey Data, 2024

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Table 2. Summary Of Vehicle Volume Survey Results During Morning, Noon, and Evening Hours at Cimencrang Intersection, Al Jabbar Area

The Origin Direction of Vehicle Movement	Vehicle Volume (Units)	The Destination of Vehicle Movement	Proportional Ratio of Total Vehicle Volume Based on Origin Direction
South Cimencrang (CS)	4145	North Cimencrang	0,881
	330	SOR GBLA Road – West Section	0,070
	227	SOR GBLA Road – East Section	0,048
North Cimencrang (CU)	4003	South Cimencrang	0,742
	1319	SOR GBLA Road – West Section	0,244
	73	SOR GBLA Road – East Section	0,014
SOR GBLA Road – East Section (GB)	825	North Cimencrang	0,512
	504	South Cimencrang	0,313
	283	SOR GBLA Road – West Section	0,175
SOR GBLA Road – West Section (SUM)	89	South Cimencrang	0,106
	579	North Cimencrang	0,696
	164	SOR GBLA Road – East Section	0,197

Source: Primary Survey Data, 2024

Based on the provisions of PKJI 2023, Chapter 6 on Intersection Capacity, in Table 6-2 regarding Intersection Type Codes, it can be concluded that the survey location is an intersection with Type Code 424. This code indicates that the intersection has 4 legs, with 2 minor roads, each having 2 lanes, and 2 major roads, each having 4 lanes. Thus, this area has 12 movement behaviors from all the legs. The summary of the survey results over 6 days during peak morning, noon, and evening hours shows the traffic calculation order as follows: first, South Cimencrang; second, North Cimencrang; third, SOR GBLA Road – East Section; and fourth, SOR GBLA Road – West Section, as shown in Table 2 above.

2. Determining The Capacity of The Cimencrang Intersection

Intersection Capacity (C) is calculated for the total flow entering from all legs of the intersection and is defined as the product of the base capacity (C_0) and correction factors that account for environmental conditions relative to ideal conditions. Equation (1) below is the formula for calculating the intersection capacity:

$$C = C_0 \times F_{LP} \times F_M \times F_{UK} \times F_{HS} \times F_{BKi} \times F_{BKa} \times F_{Rmi} \quad (1)$$

where: C is the intersection capacity, in PCU (SMP/Satuan Mobil Penumpang)/hour; C_0 is the base intersection capacity, in PCU/hour; F_{LP} is the correction factor for the average approach width; F_M is the correction factor for the median type; F_{UK} is the correction factor for city size; F_{HS} is the correction factor for side friction; F_{BKi} is the correction factor for the left-turning flow ratio; F_{BKa} is the correction factor for the right-turning flow ratio; F_{Rmi} is the correction factor for the flow ratio from the minor road.

According to the provisions of PKJI 2023, the base capacity (C_0) for Type 424M (and 424) intersections is 3400 PCU/hour as shown in Table 3 below.

Table 3. Visualization of Base Capacity Table (C_o)

Intersection Type	C_o, PCU/hour
322	2700
324	3200
344	3200
422	2900
424	3400

Source: Indonesian Highway Capacity Manual (PKJI) 2023, 2023

Based on the road specification data from the survey, the approach calculation for the average approach width of the major road ($L_{RP\ SUM\text{-}GB}$) and the minor road ($L_{RP\ CU\text{-}CS}$) is determined as follows, according to PKJI 2023: The lane on one section of the major road, with a width of 2.2 meters on SOR GBLA Road – West Section, is often used for on-street parking during weekend events, so the average approach width is calculated as (5.8-2.2) + (5.8) divided by 2, which

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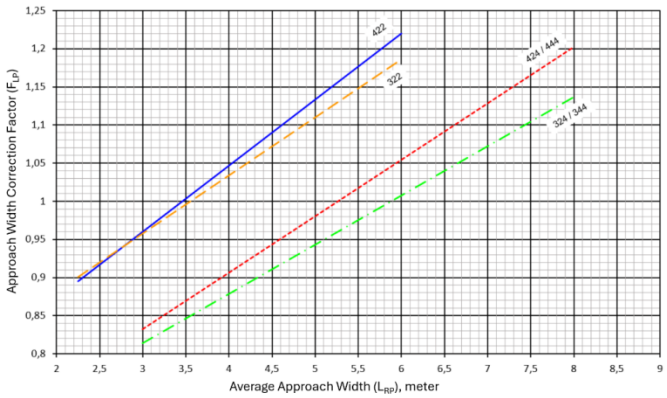
equals 4.7 meters. This is the average approach width for the major road ($L_{RP\ SUM-GB}$). The average approach width for the minor road ($L_{RP\ CU-CS}$) is 2.15 meters, taken from the average width of a single lane on the North and South Cimencrang sections. For a type 424 intersection like the location of this study, the Average Approach Width Correction Factor formula is used: F_{LP} = 0.61 + 0.0740 * LRP = 0.61 + 0.0740(4.7) = 0.9578. This result can also be obtained from the correction factor chart for approach width in PKJI 2023, as shown in Figure 2 below.



Source: Indonesian Highway Capacity Manual (PKJI) 2023, 2023

Figure 2. Visualization of The Approach Width Correction Factor (F_{LP})

After determining the value of the Approach Width Correction Factor, it is also necessary to know the value of the Median Correction Factor on the Major Road (F_M). The median on the major road at the survey location, with a width of less than 3 meters, is categorized as a narrow median with a correction factor of 1.05, as shown in Table 4 below.

Table 4. Visualization of The Median Correction Factor (F_M)

Intersection Condition	Median Type	Correction Factor, F_M
No median on the major road	None	1,00
Median on the major road with width < 3 m	Narrow median	1,05
Median on the major road with width >= 3m	Wide median	1,20

Source: Indonesian Highway Capacity Manual (PKJI) 2023, 2023

Additionally, the size of the city also affects driver behavior, which can increase road capacity. Therefore, F_{UK} (City Size Correction Factor) becomes a reference variable, with values that vary depending on population size. According to the 2023 data from the Central Statistics Agency of Bandung City, the population of Bandung is approximately 2.469 million people. According to PKJI 2023, the city size correction factor for the Cimencrang intersection area in Bandung City is 1.00. The Cimencrang intersection area, which was previously a residential area and is projected to become a commercial and religious tourism area, shows changes in land use and accessibility. This transformation is making the Al Jabbar area evolve into a commercial road environment.

Side friction in this area is categorized into three levels: high, moderate, and low. Each category reflects the impact of activities around the intersection area on traffic flow from the approaches, such as pedestrians crossing the street, public transportation stopping to pick up or drop off passengers, and vehicles entering and exiting driveways or parking areas off the roadway. Based on field observations, the Cimencrang intersection area does not experience significant side friction impacts, as commercial activities are located about 150 meters from the intersection area, in the South Cimencrang section. Therefore, the low category is considered appropriate for the conditions at the Cimencrang intersection. These provisions are displayed in Table 5 and Table 6 below.

Table 5. Visualization of The City Size Correction Factor (F_{UK})

City Size	Population (million)	F_{UK}

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Very Small	< 0,1	0,82
Small	0,1 – 0,5	0,88
Medium	0,5 – 1,0	0,94
Large	1,0 – 3,0	1,00
Very Large	> 3,0	1,05

Source: Indonesian Highway Capacity Manual (PKJI) 2023, 2023

Table 6. Visualization of Road Environment Type

Road Environment Type	Criteria
Commercial	Land used for commercial purposes, such as stores/shops, restaurants, offices, with direct access for both pedestrians and vehicles.
Residential	Land used for residential purposes with direct access for both pedestrians and vehicles.
Limited Access	Land without direct or very limited access, such as due to physical barriers; access must be through side streets.

Source: Indonesian Highway Capacity Manual (PKJI) 2023, 2023

Table 7. Visualization of Side Friction Correction Factor Values at The Intersection Area

Road Environment Type	Side Friction	F_{HS} for R_{KTB} Values					
		0,00	0,05	0,10	0,15	0,20	≥ 0,25
Commercial	High	0,93	0,88	0,84	0,79	0,74	0,70
	Medium	0,94	0,89	0,85	0,80	0,75	0,70
	Low	0,95	0,90	0,86	0,81	0,76	0,71
Residential	High	0,96	0,91	0,86	0,82	0,77	0,72
	Medium	0,97	0,92	0,87	0,82	0,77	0,73
	Low	0,98	0,93	0,88	0,83	0,78	0,74
Limited Access	High/Medium/Low	1,00	0,95	0,90	0,85	0,80	0,75

Source: Indonesian Highway Capacity Manual (PKJI) 2023, 2023

Based on the summary of side friction factors collected during surveys on weekdays, it was found that the side friction correction factor at the Cimencrang Intersection must consider the ratio of non-motorized vehicles (R_{KTB}) to the base intersection capacity (C_0). It is assumed that the effect of non-motorized vehicles (KTB) is equivalent to that of passenger cars (MP), so the value of EMP_{KTB} = 1. From this comparison and referring to Table 7 above, the ratio of (1940/3400) = 0.57 (≥ 0.25), and the correction factor is 0.71.

The performance of the intersection is measured by including all traffic flows entering the intersection, expressed in vehicles per hour, which is then converted to PCU/hour according to PKJI 2023 guidelines. However, PKJI 2023 does not include categories for Heavy Trucks and Large Buses in intersection capacity specifications for urban areas, only including Passenger Cars (MP), Medium Vehicles (KS), and Motorcycles (SM). Heavy Trucks and Large Buses are considered insignificant due to minimal operation, particularly during off-peak hours, and are categorized as KS for practical capacity calculations.

From several traffic volume surveys conducted on weekdays, it was found that the highest traffic flow occurred from Cimencrang Utara to Cimencrang Selatan, with a volume of 819 vehicles per hour. Therefore, the EMPK values used are 1.0 (for MP), 1.3 (for KS), and 0.5 (for SM). For the correction factor for left and right turning traffic ratios at an intersection with 4 arms, PKJI 2023 sets values of 1.11 (from $F_{Bki} = 0.84 + 1.61R_{Bki}$) and 1.0. The correction factor for the minor road traffic ratio is derived from the comparison of the total minor road traffic flow to the total intersection

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traffic flow, yielding a value of 0.805. Additionally, the correction factor for a 424M type intersection is adjusted according to the total traffic flow ratio, resulting in a value of 0.935.

From the conversion and calculation based on the PKJI 2023 tables, the intersection capacity (C) is calculated as follows:

$$C = C_0 \times F_{LP} \times F_M \times F_{UK} \times F_{HS} \times F_{BKi} \times F_{BKa} \times F_{Rmi}$$

$$C = 3400 \times 0{,}9578 \times 1{,}05 \times 1{,}00 \times 0{,}71 \times 1{,}11 \times 1 \times 0{,}935$$

$$C = 2.519{,}62 \sim 2.520 \text{ PCU/hour}$$

This result shows that the degree of saturation (DJ)in the Cimencrang Intersection area is (2520/3400) = 0,74.

3. Anomalous Conditions in The Traffic Survey

During peak hours on weekdays, particularly in the morning, traffic congestion (traffic bottleneck) may occur for vehicles intending to head to Soekarno-Hatta Road via North Cimencrang Road. This bottleneck can worsen when there is a railway crossing, as vehicles must stop, causing a buildup on the crosswalk. A traffic bottleneck is a localized traffic disturbance on highways or toll roads, distinct from traffic congestion caused by high vehicle volumes. Traffic bottlenecks often arise from certain physical conditions, such as uneven road capacity, improper synchronization of traffic lights, or sharp turns. Other causes can include vehicle accidents, known as "rubbernecking." This term refers to traffic disruptions caused by drivers slowing down to look at an incident on the road, which can cause traffic to slow down and potentially lead to more accidents, even in lanes not directly affected by the incident. This behavior is driven by curiosity but can be reduced by barriers that obstruct the view of the incident (Daganzo, 1997; Masinick, J., Teng, H., and Orochena, N., 2014).

During several survey sessions, traffic officers often use water road barriers at the railway crossings to manage traffic. They consider whether traffic should continue uninterrupted (from the SOR GBLA West Section to the SOR GBLA East Section and vice versa) or be diverted, causing vehicles from North Cimencrang and South Cimencrang to take a longer route to the SOR GBLA East Section and SOR GBLA West Section. Four-wheeled vehicles are usually the most affected by the installation of these water road barriers, while pedestrians, cyclists, motorcyclists, and other narrower transport modes can pass through these barriers with minimal difficulty.

Conclusion and Recommendations

The degree of saturation of 0.74, obtained from the calculation of traffic volume and side constraints using weekday recap data, meets the intersection design standards, where the degree of saturation should be ≤ 0.85. This figure of 0.74 can be seen as an early warning signal for the development and adjustment of land use policies and accessibility in the Cimencrang intersection area, located in a new commercial district near Al Jabbar Mosque. Based on the author's observations and official information released by the Bandung City Government in early February 2024, traffic in this area is expected to become more congested in the future due to several attractive locations nearby, such as the commercial and residential areas of Summarecon and the Gelora Bandung Lautan Api Stadium, which is planned to host various national, regional (Southeast Asia), and international sports competitions.

Therefore, the current access needs to be further developed as it is expected to become a key mobility route for communities and long-distance transportation. This road will play an increasingly important role in land access and public services (Kamaluddin, 1987). The collector road in the Cimencrang area is funded from various sources, such as the state budget (APBN) from domestic revenue and foreign loans, the regional government budget (APBD), and regional government spending sourced from government revenue.

Additionally, it is crucial to consider the specifications and needs of vehicles passing through the Cimencrang intersection area, as well as the importance of accelerating the provision of adequate public transportation that supports the integration of this area with the city center of Bandung and the tourist destinations for both domestic and international visitors in the Bandung Raya region. Furthermore, this area has significant potential to become an

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alternative hub for KCIC/KCJB transportation modes, given that the Gedebage toll access in this area often experiences over-capacity during holidays, both during long weekends and regular weekends. This condition highlights the urgent need to improve traffic management and infrastructure in the area. Improvements could include alternative solutions such as adding traffic signals, widening roads, recalculating flexible railway crossing closure times, or reorganizing vehicle flows to reduce congestion and enhance road user safety. With the ongoing population growth and urbanization in Indonesia, the number of motor vehicles continues to increase, especially in large cities like Bandung.

Road intersections near railway crossings, such as in Cimencrang, have a significant impact on traffic flow, particularly during peak hours. This condition is not only observed in Bandung but also in many large cities in Indonesia such as Jakarta (Kesaulya, 2019), Surabaya (Amal A.S., Pudjianto, B., and Mujihartono, E., 2002; Utami, A., and Widyastuti, H., 2019), and Medan (Asfiati and Mutiara, 2019), where railway crossings often cause significant traffic delays. The findings from this study in Bandung are expected to serve as a foundation for local government in planning more effective and efficient traffic policies in the Cimencrang area, especially around the railway crossings. This research also aims to make a significant contribution to the field of transportation and traffic management studies and serve as a reference for future research related to railway crossings and intersections in urban areas, as well as the correlation between attractions and production with nearby attractions such as GBLA Football Stadium, ITB Techno Park, and the new commercial trading center, Summarecon Mall.

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