Analysis of Traffic Performance and Handling Scenarios in The Malang Station Area, Kota Baru

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Abstract.

The Malang Kota Baru Station area is currently experiencing traffic performance problems characterized by high delays and low speeds, especially on the Trunojoyo 1 Road and Trunojoyo 2 Road sections. This condition is influenced by high side obstacles in the form of on-street parking and loading and unloading activities. This study aims to analyze the performance of the existing road network and formulate effective traffic management and engineering scenarios in improving regional traffic performance. The analysis was carried out by modeling using PTV Vissim software through the calibration and validation stages using the Geoffrey E. Havers (GEH) statistical test. The results of the analysis of existing conditions showed an average delay of 168 seconds, network speed of 13.6 km/h, total mileage of 24,120 kend-km, and total travel time of 1,774 vehicles/hour, which indicates that the performance of the road network is in the poor category. Improvement efforts are carried out through several traffic management and engineering scenarios, including moving on-street parking to off-street, repairing pedestrian facilities, adding signs and repairing road markings, as well as regulating the separation of access in and out of goods and passengers. The results of the proposed scenario simulation showed an improvement in road network performance, namely an increase in network speed to 22.04 km/h, a decrease in average delay to 90.91 seconds, a decrease in total travel time to 1,160.59 vehicles/hour, and an increase in total mileage to 25,574 kend-km. Thus, the proposed traffic management and engineering scenario has proven to be effective in improving traffic performance in the Malang Kota Baru Station Area.

Keywords: *Traffic management and engineering; PTV Vissim; traffic performance and Malang Kota Baru Station.*

I. INTRODUCTION

Malang City is one of the largest cities in Timus Java Province which has a strategic role as the center of educational, tourism and economic activities in the southern region of East Java. Based on the statistics center of Malang City, the administrative area of Malang City reaches 111.07 km² with a population density of 11,419 people/km². The high population density and growth of economic activities have an impact on the increasing volume of movement of people and vehicles in the city. One of the points with the highest movement intensity in Malang City is the Malang Station Area of Kota Baru which functions as the main transportation node and mode integration point between trains, city transportation and private vehicles. The location of the area in the Central Business District (CBD) of Klojen District causes a high flow of vehicles entering and exiting the station area. Based on the results of observations in the field, the number of movements in this group reached 457,450 people per day with 5,565 passengers boarding and 5,769 passengers getting off at Malang Kota Baru Station every day.However, the high movement activity is not balanced by adequate transportation infrastructure capacity. The main problems found include congestion during rush hour, high side obstacles due to illegal parking, loading and unloading activities, street vendors on sidewalks and intersections without traffic control (APPIL) [1]. High side barriers with an fhs value of 0.81 lead to a significant decrease in road capacity [2]. The results of the analysis show that the volume to capacity ratio (V/C) on the trunojoyo road is 0.90 with an average vehicle speed of 20.84 km/h which is included in the service level (Level Of Service / LOS) based on the Highway Capacity Manual [3].

Meanwhile, the Degree of Saturation (DS) of junction three in front of Malan Kota Baru station reached 0.88 with an average delay of 12.67 seconds which is classified as LOS B according to the Regulation of the Minister of Forestry No.96 of 2015.This condition shows that the Malang City station area of Kota Baru has been at a high level of traffic saturation. Efforts to improve traffic performance are needed without expanding the physical capacity of the road, but through the application of Traffic Management and Engineering. In his research [4] MRLL is a series of activities that aim to improve traffic efficiency and safety through planning, regulating, controlling and supervising the flow of vehicles and pedestrians. Various previous studies have shown the effectiveness of the application of MRLL based on microscopic simulations in improving the performance of road networks in urban areas [5] who conducted a performance analysis of the signaled intersection on Jalan Ahmad Yani, Semarang using PTV VISSIM and the results showed an average decrease in delays of 27%. After the implementation of the signal phase reset, it was also found that traffic engineering in Makassar City through right-turn arrangement and signal timing was able to increase the average speed of vehicles by 22% [6].

Similar research by [7] on urban roads in Indonesia assessed the impact of the U-turn facility on traffic performance using Vissim and the results showed that the elimination of U-turn can reduce the saturation rate (DS) by 0.15%. [8] researched the tourist area of Semarang Old City and concluded that the implementation of parking management and private vehicle restrictions can increase the Level Of Service (LOS) from D to C. [9] using PTV VISSIM simulation to evaluate U-turn facilities in Banda Aceh which showed an average delay reduction of 14.8%. The results of the study show that the MRLL approach based on microscopic simulations has proven to be effective in improving urban traffic efficiency [10]. However, most of the previous research has focused on signaled intersections or public roads, rather than strategic transportation node areas such as stations that have mixed flow characteristics (vehicles, passengers and pedestrians) with high intensity [11]. Thus, further research is needed that comprehensively examines the implementation of MRLL in urban station areas, especially Malang Kota Baru Station which is the main hub of transportation and economic activities in Malang City.In addition, advances in technological advances allow traffic evaluations to be carried out simulatively through software such as PTV VISSIM which is able to represent real conditions and test various improvement scenarios [12].According to [13] The use of VISSIM in transportation research allows for more accurate and efficient analysis of traffic policy impacts compared to conventional approaches.

Based on this background, this research was conducted with the title Traffic Management and Engineering in the Malang Station Area, Kota Baru. This study aims to analyze the existing conditions of traffic, parking and pedestrian movement performance in the Malang Kota Baru Station area comprehensively and conduct traffic modeling and simulation using PTV VISSIM 9.0 software. Through this approach, it is hoped that this study will formulate an optimal Traffic Management and Engineering (MRLL) scenario to improve the performance of the road network in the area and then evaluate the impact of its implementation on the level of traffic service in the area around the station. This research is expected to be a scientific reference in the development of urban transportation policy systems, especially in areas with high multimodal activities. In addition, the results of this study are expected to provide strategic recommendations for local governments in creating a more efficient, safe and sustainable traffic system in Malang City. It is also the basis for planning policy for the arrangement of urban transportation node areas that are integrated with other modes of transportation.

II. METHODS

This study uses a descriptive qualitative approach that aims to analyze and evaluate traffic conditions in the Malang Kota Baru Station area empirically based on primary field data and simulation results. This approach was chosen because it is able to describe traffic phenomena objectively and measure the influence of the implementation of Traffic Management and Engineering (MRLL) on changes in road network performance (Jaksch et al., 2021). The analysis was carried out by referring to the guidelines of the Indonesian Road Capacity to assess the performance of road sections and intersections and utilizing PTV VISSIM 9.0 software as a microscopic simulation tool to test various MRLL scenarios.

A. Research Location and Time

This research was carried out in the Malang Station Area, Kota Baru, which is located in Klojen district, Malang City, East Java. This area includes several main roads, namely Jalan Trunojoyo, Jalan Karta Negara, Jalan Patimura, Jalan Panglima Sudirman and Simpang Tiga Station Malang Kota Baru. The selection of location is based on the function of the area as a multi-modal transportation node, where there is an instant interaction between private vehicles, public transportation, pedestrians and commercial activities. This research was carried out during the period from July to August with the main activities of field surveys, traffic data collection and simulative modeling using PTV VISSIM.

B. Data Types and Sources

The data used in this study consisted of primary data and secondary data used to support traffic performance analysis and simulation modeling in the Malang Kota Baru Station area. Primary data was obtained through field survey activities carried out directly at the research location. This survey includes several types of data collection including:

- Traffic volume data (vehicles/hours) based on the classification of vehicle types during morning, afternoon and evening peak hours.
- The vehicle speed data measured using the floating car method to obtain the average speed of traffic flow on the main road.
- Parking data that includes parking duration, occupancy rate and frequency of vehicle changes.
- Pedestrian data was obtained through direct observation to determine the intensity of crossings and the level of utilization of sidewalk facilities.
- Side friction data which includes pedestrian activities, parking on the road, vehicles in and out of the building area and the presence of street vendors.

Secondary data is obtained from government agencies and related institutions that are used to complement field data and support quantitative analysis. Secondary data includes:

- Land use map of the area around Malang Kota Baru Station obtained from the Malang City Transportation Office.
- Malang City population and transportation data based on the publication of the Malang City Central Statistics Agency (BPS).
- Technical guidelines related to road capacity, traffic services and transportation management policies sourced from the Indonesian Ministry of Transportation.

The collection of primary and secondary data aims to ensure the compatibility between the factual conditions of the field and the results of simulation modeling conducted using PTV VISSIM 9.0 software. The data is then used to analyze road capacity, service level (LOS), degree of saturation (DS) and validation of simulation results of existing conditions.

C. Research Stages

The research stages are carried out through several systematic processes as follows:

1. Problem Identification
   Identify comrade traffic problems through field observation and study of city planning documents.
2. Data Collection
   Conduct a survey of traffic volume, speed, parking, parking, pedestrian and side obstacles.
3. Analysis of Existing Traffic Performance
   Calculating V/C Ratio, Degree of Saturation (DS)
4. Network Modeling on PTV Vissim 9.0
   Building network models according to real geometry, entering vehicle volume and parameters and calibrating to match the model to conditions in the field.
5. Simulation of Various MRLL Scenarios
   Testing several scenarios to increase traffic such as parking arrangements, *one-way flow* arrangements, intersection rearrangement and apical installation.
6. Scenario Evaluation & Comparison
   Assess traffic performance changes before and after the MRLL scenario using speed, delay, queue, DS and LOS indicators.

D. Data Analysis Techniques

This quantitative analysis and research includes several techniques as follows:

1. The analysis of the capacity of the intersection uses the formula of capacity, side obstacles, traffic flow and saturation degree (DS) based on PKJI 2023.
2. Level Of Service (LOS) analysis is determined based on indicators of speed, delay and road user comfort according to HCM 2016.

3. Microscopic simulation using PTV Vissim.
4. Model validation by using the goodness of fit approach to compare the simulation results with survey data in the field so that the model can be representative.

E. Research Flow

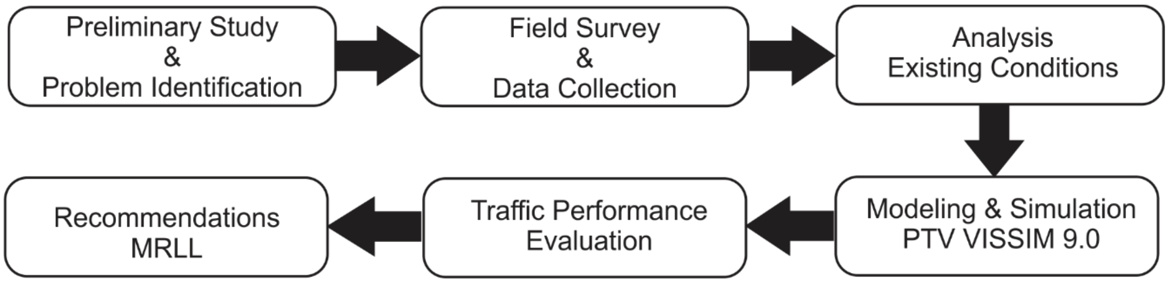

Fig 1. Research Flow Diagram

III. RESULT AND DISCUSSION

The results of the analysis show that the Malang Kota Baru Station area is an area with very high traffic activity due to the area's function as a transportation node, trade center, and its proximity to education and office areas. This condition has an impact on the increase in vehicle movement, pedestrians, and parking activities, causing congestion, especially during the morning and evening peak hours. Analysis was carried out on traffic volume, vehicle speed, side obstacles, road performance, intersection performance, and traffic simulation results using PTV VISSIM software.

Identification of Traffic Performance in the Malang Station Area of Kota Baru

This research was carried out in the Malang Station Area, Kota Baru with a focus on traffic management analysis and engineering. The scope of the study includes the analysis of roads, intersections, parking facilities, and pedestrian facilities around the station area as the main transportation node. The road sections studied are divided into several segments to obtain a more detailed picture of traffic performance in each direction of movement. The analysis of road performance is carried out by considering traffic characteristics, road geometric conditions, side obstacles, and intermodal interactions. To support this analysis, several field surveys were conducted, including:

1. Geometric inventory survey of intersections and intersections;
2. Traffic counting surveys;
3. Survey of turning movements at intersections;
4. Vehicle speed survey;
5. Parking survey.

The survey data was used to evaluate the existing traffic conditions and formulate alternatives to handling transportation problems in the research area.

Road Condition and Capacity

The road sections analyzed in the Malang Station Area of Kota Baru consist of 9 road sections which are divided into 15 segments. The inventory is carried out to identify the road function, road status, road type, segment length, and effective lane width.

Table 1. Inventory of Section and Capacity of Regional Roads

Street Name	Road Function	Road Status	Length of the Road (Km)	Tipe	Effective Bandwidth	Capacity (C)
Jl. Trunojoyo Segmen 1	Arteri Sekunder	City	0.44	4/2 TT	9.1	2505.01
Jl. Trunojoyo Segmen 2	Arteri Sekunder	City	0.46	4/2 TT	9.2	2664.9
Jl. Kertanegara A (Timur-Barat)	Arteri Sekunder	City	0.24	4/2 T	7.9	3141.03
Jl. Kertanegara B (Barat-Timur)	Arteri Sekunder	City	0.24	4/2 T	8.1	3141.03
Jl. Pattimura Segmen 1	Arteri Sekunder	City	0.21	2/2 TT	10.7	2898.21
Jl. Pattimura Segmen 2	Arteri Sekunder	City	0.24	2/2 TT	8.2	2760.44
Jl. HOS Cokroaminoto	Kolektor Sekunder	City	0.46	2/2 TT	6.6	1648.68
Jl. Panglima Sudirman Segmen 1	Arteri Primer	National	0.64	4/2 TT	12	3103.65
Jl. Panglima Sudirman Segmen 2	Arteri Primer	National	0.45	4/2 TT	8.9	2928.1

Street Name	Road Function	Road Status	Length of the Road (Km)	Tipe	Effective Bandwidth	Capacity (C)
Jl. Panglima Sudirman Segmen 3	Arteri Primer	National	0.25	4/2 TT	8.9	2928.1
Jl. Panglima Sudirman Segmen 4	Arteri Primer	National	0.09	4/2 TT	8.9	2928.1
Jl. Urip Sumoharjo	Arteri Sekunder	City	0.69	2/2 TT	10.3	3055.75
Jl. Untung Suropati Utara	Arteri Sekunder	City	0.33	2/2 TT	7.5	2760.44
Jl. Untung Suropati Selatan	Lokal Sekunder	City	0.28	2/2 TT	5	1356.01
Jl. Gatot Subroto Segmen 1	Arteri Primer	National	0.23	2/2 TT	8.4	2700.43

The calculation of road capacity is carried out based on the 2023 Indonesian Road Capacity Guidelines (PKJI), taking into account the type of road, lane width, side obstacles, directional separators, and city size. Based on Malang City population data in 2025, the population is recorded at 889,359 people. The highest capacity is found on Jl. Kertanegara 1 and 2 2505.01 and 2664.9, while the lowest capacity is found on Jl. Untung Suropati Selatan, which is influenced by the effective lane width and the characteristics of the road environment.

Capacity, Speed and Density of Road Sections

Vehicle speed on the road sections studied in the Malang Station Area, Kota Baru was obtained through the Moving Car Observer (MCO) survey on roads without a median and the Floating Car Observer (FCO) survey on median roads and one-way roads. The method was used to describe the actual operational speed conditions of vehicles in each segment of the road in the research area.

Table 2. Kapacity, Speed and Density Malang Station Area Road Sections Kota Baru

Street Name	Directions	Speed (km/jam)	Average Speed (km/jam)	Average density (smp/km)
Jl. Trunojoyo Segmen 1	Masuk	21.03	21.10	110
	Keluar	22.17		
Jl. Trunojoyo Segmen 2	Masuk	20.58	20.58	114
	Keluar	20.58		
Jl. Kertanegara A (Timur-Barat)		29.01	29.01	38
Jl. Kertanegara B (Barat-Timur)		30.15	30.15	32
Jl. Pattimura Segmen 1	Masuk	22.77	22.73	89
	Keluar	22.69		
Jl. Pattimura Segmen 2	Masuk	26.72	26.28	71
	Keluar	25.84		
Jl. HOS Cokroaminoto	Masuk	22.10	22.14	64
	Keluar	22.19		
Jl. Panglima Sudirman Segmen 1	Masuk	18.45	18.46	144
	Keluar	18.47		
Jl. Panglima Sudirman Segmen 2	Masuk	22.02	22.32	109
	Keluar	22.63		
Jl. Panglima Sudirman Segmen 3	Masuk	20.73	20.85	120
	Keluar	20.85		
Jl. Panglima Sudirman Segmen 4	Masuk	18.69	18.63	139
	Keluar	18.58		
Jl. Urip Sumoharjo	Masuk	29.24	29.32	64
	Keluar	29.41		
Jl. Untung Suropati Utara	Masuk	30.88	31.08	51
	Keluar	31.28		
Jl. Untung Suropati Selatan	Masuk	33.68	33.67	8
	Keluar	33.61		
Jl. Gatot Subroto Segmen 1	Masuk	22.54	22.73	108
	Keluar	22.92		

Based on the table above, the road segment with the highest density level is located on Jalan Panglima Sudirman Segment 1, with a density of 144 smp/km. This condition is influenced by the high volume of traffic and the existence of side obstacles around the road. On the other hand, the lowest density in the Malang Kota Baru Station Area occurred on Jalan Untung Suropati Selatan, with a density value of 8 smp/km, which shows relatively smooth traffic conditions. Vehicle speed on the road sections analyzed in the Malang Kota Baru Station Area was obtained through a survey of the Moving Car Observer (MCO) on roads without a median and the Floating Car Observer (FCO) on median roads and one-way roads. The application of these two methods aims to represent the actual operational speed conditions of vehicles in each segment of the road in the research area. The speed of vehicles on each segment of the road in the Malang Station Area, Kota Baru shows quite significant variations.

The segment with the lowest average speed is on Jalan Panglima Sudirman Segment 1, which is 18.46 km/h, which indicates heavy traffic conditions. On the other hand, the highest average speed was recorded on Jalan Untung Suropati Selatan, with a value of 33.67 km/h, which reflects relatively smooth traffic conditions. Furthermore, an analysis of the free flow speed on each road section was carried out to evaluate the level of decrease in traffic performance compared to ideal conditions. The Malang Kota Baru Station area shows variations in traffic density levels in each road segment. The road density data was used to describe the distribution of traffic load and identify segments that experienced dense to saturated conditions in the study area. Based on density data, the road segment with the highest density level is located on Jalan Panglima Sudirman Segment 1, with a density value of 144 smp/km. This condition is influenced by the high volume of traffic and the existence of side obstacles around the road. On the other hand, the segment with the lowest density level in the Malang Kota Baru Station Area is located on Jalan Untung Suropati Selatan, with a density of 8 smp/km, which shows relatively smooth traffic conditions.

Traffic Volume and Degree of Saturation

The volume of traffic is obtained from the results of a classified traffic enumeration survey or Traffic Counting (TC). This survey was conducted to determine the number and composition of vehicles that cross each segment of the road in the Malang Station Area, Kota Baru, so that it can represent the actual traffic flow conditions in the research area.

Table 3. Traffic Volume and Degree of Saturation of Road Sections in Current Conditions In the Malang Station Area, Kota Baru

Street Name	Directions	Volume (smp/jam)	Bidirectional Volume (smp/jam)	Volume Upe (vehicle /jam)	Bidirectional vehicle volume	Degree of Saturation
Jl. Trunojoyo Segmen 1	S - U	1341.05	2312.55	3434	6234	0.92
	U - S	1051.75		2800		
Jl. Trunojoyo Segmen 2	S – U	1235.05	2336.70	3486	6447	0.88
	U – S	1122.60		2961		
Jl. Kertanegara A (Timur-Barat)		1091.85		3136		0.35
Jl. Kertanegara B (Barat-Timur)		959.30		2736		0.31
Jl. Pattimura Segmen 1	B – T	1182.95	2027.80	3449	5800	0.70
	T – B	1037.40		2351		
Jl. Pattimura Segmen 2	T -B	933.30	1854.50	1990	5421	0.67
	B – T	1175.80		3431		
Jl. HOS Cokroaminoto	S – U	636.30	1414.95	2011	4377	0.86
	U – S	778.65		2366		
Jl. Panglima Sudirman Segmen 1	S – U	1346.90	2651.35	2364	6355	0.85
	U – S	1641.45		3991		
Jl. Panglima Sudirman Segmen 2	U – S	1168.45	2423.40	2935	5341	0.83
	S – U	1254.95		2406		
Jl. Panglima Sudirman Segmen 3	S - U	1225.50	2498.55	3090	6266	0.85
	U – S	1273.05		3176		
Jl. Panglima Sudirman Segmen 4	U – S	1443.55	2590.75	3774	6752	0.88
	S - U	1147.20		2978		
Jl. Urip Sumoharjo	B – T	1037.95	1976.45	3030	5680	0.65
	T – B	954.75		2650		
Jl. Untung Suropati Utara	B – T	796.60	1579.70	1825	4276	0.57
	T – B	890.90		2451		
Jl. Untung Suropati Selatan	B – T	83.75	269.25	118	684	0.20
	T – B	234.50		566		
Jl. Gatot Subroto Segmen 1	U – S	1258.30	2458.95	3602	7207	0.91
	S – U	1268.55		3605		

Based on table 3 of traffic volume, the road with the highest average traffic volume is on Jalan Panglima Sudirman Segment 1, with a volume of 2,651.35 smp/hour and the number of vehicles recorded as many as 6,487 vehicles. On the other hand, the road with the lowest average traffic volume is on Jalan Untung Suropati Selatan, with a volume of 270 smp/hour, which shows a relatively low intensity of vehicle movement. The degree of saturation is obtained from the comparison between the volume of traffic and the capacity of the road. This parameter is used to assess the level of road service in serving traffic flow. Based on Table 3, it can be determined the value of the degree of saturation on each road in the Malang Station Area, Kota Baru.

Performance Conditions of Existing Intersections

Analysis of the performance of intersections in the Malang Station Area of Kota Baru shows that traffic problems on road sections have a direct impact on intersection performance, especially due to high traffic volume and side obstacle activities. Intersection performance evaluation is carried out through geometric inventory, intersection capacity calculation, traffic flow, degree of saturation, queue length, delay, and service level (Level of Service / LOS) in accordance with PKJI 2023 and PM 96 of 2015.

Table 4. Kinerja Persimpangan Kawasan Stasiun Malang Kota Baru

Nama Simpang	Tipe Pengendali	Kapasitas (smp/jam)	Arus Lalu Lintas (smp/jam)	Derajat Kejenuhan (DJ)	Rata-rata Antrian (m)	Rata-rata Tundaan (detik/kend)	LOS
Simpang 4 Rampal	APILL	3.734,37	3.530	0,94	183,14	141,00	F
Simpang 4 Embong Brantas	Non-APILL	3.115,40	2.733	0,88	9,32	26,87	D
Simpang 4 Pasar Klojen	Non-APILL	2.878,99	2.586	0,90	10,89	21,89	C
Simpang 3 Stasiun Malang	Non-APILL	2.610,81	2.289	0,88	9,42	12,67	B
Simpang 3 Yonbekang	Non-APILL	3.456,21	2.699	0,78	11,04	10,26	B

The results of the analysis showed that Simpang 4 Rampal was the intersection with the worst performance, characterized by the highest degree of saturation, the longest queue length, the largest delay, and the level of LOS F service. These findings indicate the need for traffic management and engineering handling that focuses on intersections with high levels of saturation and delays.

Parking Performance

Parking conditions in the Malang Kota Baru Station Area are dominated by on-street parking due to the limited off-street parking facilities, both from PT KAI and the local government. The existence of on-street parking on Trunojoyo Street 1, Trunojoyo Street 2, and Cokroaminoto Street causes a decrease in the effective width of the road, the loss of the road shoulder, and a decrease in the capacity of the road section which has a direct impact on traffic performance.

Table 5. Parking Performance of Malang Station Area Kota Baru

Road Sections	Parking Type	Static Capacity (MC/LV)	Max Accumulation (MC/LV)	Parking Volume (MC/LV)	Average Duration (hours) (MC/LV)	Dynamic Capacity (MC/LV)	Turn Over (MC/LV)	Parking Index (MC/LV)	Conditions
Jl. Trunojoyo 1	On-Street	88 / 29	103 / 28	410 / 201	2,69 / 1,46	457,88 / 274,97	5 / 5	1,17 / 0,98	Problematic (MC)
Jl. Trunojoyo 2	On-Street	40 / 59	62 / 40	361 / 222	1,39 / 1,14	403,92 / 718,62	9 / 4	1,55 / 0,68	Problematic (MC)
Jl. Cokroaminoto	On-Street	80 / 35	69 / 12	362 / 105	1,37 / 1,27	819,29 / 252,00	5 / 5	0,86 / 0,35	Relatively Controlled

Description: MC = Motorcycle, LV = Car

Indeks Parkir (IP):

- IP < 1 → No problem
- IP = 1 → Balanced
- IP > 1 → Problematic

The results of the analysis showed that Jalan Trunojoyo 1 had the most significant level of parking problems, as shown by the highest accumulation of motorcycle parking, the longest parking duration, and the parking index that exceeded normal capacity (IP > 1). Meanwhile, Jalan Trunojoyo 2 shows the highest rate of motorcycle turnover, which indicates a high intensity of parking activities. Overall, most of the study roads experience problematic parking conditions, especially for two-wheeled vehicles, so it is necessary to handle parking that is integrated with traffic management in the station area.

Road Network Modeling in Malang Station Area, Kota Baru

This study was modeled using PTV VISSIM 9.0 software to simulate traffic performance under existing conditions. The simulation is carried out by seeking a representation of field conditions that are close to the actual situation, so that the modeling results can be used for further analysis of the performance of road sections and intersections by considering influencing factors, such as side obstacles and road geometric characteristics.

A. Determination of Traffic Zones

The initial stage in road network modeling is the determination of traffic zones. This stage aims to identify the patterns of awakening and travel attractions originating from and to the Malang Station Area, Kota Baru. The division of zones is carried out to facilitate the analysis of traffic movements and to find out the amount of potential travel that occurs in the research area.

Table 6. Determination of Traffic Zones

Zone	Akses
Zone 1	Jl. Kertanegara
Zone 2	Jl. Pattimura 2
Zone 3	Jl. Cokroaminoto
Zone 4	Jl. Panglima Sudirman 1
Zone 5	Jl. Urip Sumoharjo
Zone 6	Jl. Untung Suropati Utara
Zone 7	Jl. Untung Suropati Selatan
Zone 8	Jl. Gatot Subroto 1
Zone 9	Malang Kota Baru Station

Traffic zones are determined based on land use characteristics, regional functions, and the connectivity of the road network around Malang Kota Baru Station. The results of the analysis show that the Malang Kota Baru Station Area is divided into 8 (eight) traffic zones, which are then used as a basis for calculating travel generation and pull as well as as input for movement distribution in road network modeling. The division of traffic zones is the main basis in the preparation of traffic models, because it affects the formation of vehicle movement patterns and the distribution of traffic flows on each road and intersection in the study area.

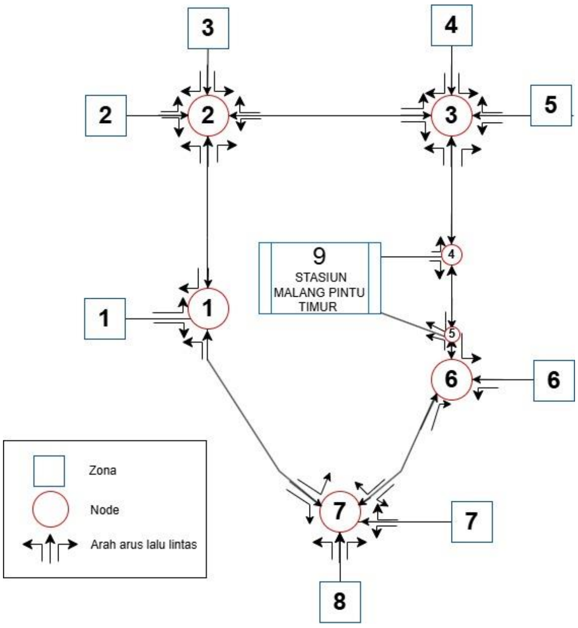

Fig 2. Zone Division of Malang Station Area Kota Baru

B. Creation of Road Network at PTV VISSIM

The creation of the road network in the PTV VISSIM software is carried out based on the results of the inventory survey of road sections and intersections, so that the geometric configuration is modeled in accordance with the existing conditions in the field. The network modeling process is carried out using link and connector features to represent road sections, traffic lanes, and relationships between sections at each intersection.

C. Determination of Vehicle Type

At this stage, the types of vehicles that pass on roads and intersections in the study area are identified and determined. The type of vehicle used in the modeling was adjusted to the results of the vehicle classification survey in the field, so that the distribution of vehicle characteristics in the model was close to the actual traffic conditions.

D. Making a Travel Awakening in the Malang Station Area, Kota Baru (Trip Generation)

The preparation of the rise and pull of the trip is carried out by considering the modeling arrangements available on PTV VISSIM through the determination of the vehicle route. This stage aims to ensure that the movement of vehicles in the model can be distributed according to the actual conditions in the field, both for trips in and out of the station area.

E. Determination of Data on Number of Vehicles, Composition, and Vehicle Speed

The data entered into the VISSIM model on each road section is the result of a field survey which includes the Traffic Counting (TC) survey and the Classified Turning Movement survey. The data includes vehicle volume, composition by vehicle type, and vehicle speed. Furthermore, the data is distributed into movement zones and poured into an origin-destination matrix so that vehicle movement patterns can be thoroughly described in the model.

F. Trip Distribution in the Malang Kota Baru Station Area

The distribution of trips in the Malang Kota Baru Station area is represented in the origin-destination matrix (OD matrix). Each movement activity has its own origin zone and destination zone, where the origin zone is the region that generates movement, while the destination zone is the region that attracts movement. This origin-purpose matrix was obtained from the results of a survey at each observation point designated as a zone in the Malang Station area of Kota Baru. The data obtained as a whole is then used as the input of the total origin–destination matrix in units of vehicles per hour in the PTV VISSIM software. The determination of the origin-destination matrix is carried out through the processing of survey data so that the amount of movement between zones divided into nine zones in the Malang Kota Baru Station area is obtained.

Table 7. Proportion of Vehicles Turning Around the Area

Simpang Name	**Directions**	**Approach**	**Proportion of Vehicles Turning**		
			Left	**straight**	**Right**
Simpang 4 Rampal	U	Jl. Panglima Sudirman I	33%	32%	35%
	S	Jl. Panglima Sudirman II	34%	31%	35%
	B	Jl. Pattimura I	33%	35%	32%
	T	Jl. Urip Sumoharjo	32%	40%	28%
Simpang 4 Embong Brantas	U	Jl. Panglima Sudirman III	2%	51%	47%
	S	Jl. Gatot Subroto	48%	51%	1%
	B	Jl. Trunojoyo I	50%	49%	1%
	T	Jl. Untung Suropati Selatan	65%	30%	5%
Simpang 4 Pasar Klojen	U	Jl. HOS Cokroaminoto	46%	37%	17%
	S	Jl. Trunojoyo II	24%	21%	55%
	B	Jl. Pattimura II	17%	50%	33%
	T	Jl. Pattimura I	36%	34%	30%
Simpang 3 Stasiun Malang	U	Jl. Trunojoyo II		48%	52%
	S	Jl. Trunojoyo I	56%	44%	
	B	Jl. Kertanegara	47%		53%
Simpang 3 Yonbekang	U	Jl. Panglima Sudirman III	55%	45%	
	S	Jl. Panglima Sudirman IV		80%	20%
	T	Jl. Untung Suropati Utara	100%		
Zona 9 Stasiun Malang Pintu Timur	U	Jl. Panglima Sudirman II		88%	12%
	S	Jl. Panglima Sudirman III	10%	90%	
	B	Malang Station	60%	40%	

The distribution of travel is represented in the form of an origin-destination matrix that describes the magnitude of movement from the origin zone to the destination zone, expressed in units of junior high school/hour. The use of junior high school units/hours is intended to standardize different types of vehicles into one equivalent size. This origin-destination matrix is based on the number of vehicles entering and exiting the area as the rise and pull of travel in each zone. The matrix is compiled using the Furness iteration method until a balance between the total awakening and the total travel pull is obtained.

Oi = the number of vehicles entering each zone.

Dd = the number of vehicles that exit in each zone.

oi = The total number of all vehicles entering the entire zone.

dd = The total number of all vehicles that came out of the entire zone.

$E_i = \frac{O_i}{o_i}$ [14]

$E_d = \frac{D_i}{d_i}$ [14]

Table 8. Origin Matrix Initial Destination Input Volume Mauk and Out (smp/hour)

	1	2	3	4	5	6	7	8	9	Oi	oi	Ei
1		1	1	1	1	1	1	1	1	959	8	120
2	1		1	1	1	1	1	1	1	1176	8	147
3	1	1		1	1	1	1	1	1	779	8	97
4	1	1	1		1	1	1	1	1	1641	8	205
5	1	1	1	1		1	1	1	1	955	8	119
6	1	1	1	1	1		1	1	1	884	8	111
7	1	1	1	1	1	1		1	1	235	8	29
8	1	1	1	1	1	1	1		1	1269	8	159
9	1	1	1	1	1	1	1	1		240	8	30
Dd	1092	933	636	1347	1038	618	84	1258	233			
dd	8	8	8	8	8	8	8	8	8			
Ed	136	117	80	168	130	77	10	157	29			

Based on the origin-destination matrix (OD Matrix), the travel pull and pull data have not reached the equilibrium value (1.00), so an iteration process is needed to obtain the similarity between the total return and the total travel pull. The preparation of the origin-destination matrix is carried out using the Furness method through the following stages. First, the origin-destination matrix is multiplied by the growth factor in the origin zone. The results of the first iteration matrix were then multiplied by the growth factor in the destination zone. This process is continued by multiplying the iteration matrix with the growth factor in the origin zone alternately. The iteration is carried out continuously until a condition is obtained where the total awakening is equal to or close to equal to the total pull in all zones. In the Furness iteration method, the initial movement was first corrected using the growth factor of the origin zone. The results of the next iteration were corrected again using the growth factor of the destination zone and the origin zone alternately. The modification remains until the total values of the rows and columns in the origin-destination matrix are close to or equal to the desired total. In Zone 1, the number of incoming vehicles was 959 smp/hour and the number of outgoing vehicles was 1,092 smp/hour. The awakening and pull values are then used to calculate the origin adjustment factor (Ei) and the objective adjustment factor (Ed).

Known:

- O_i = 959 smp/hour
- D_i = 1.092 smp/hour
- $\sum O_i$ = 959 smp/hour
- $\sum D_i$ = 897 smp/hour

So:

$$E_i = \frac{O_i}{\sum O_i} = \frac{959}{959} = 1{,}00$$

$$E_d = \frac{D_i}{\sum D_i} = \frac{1.092}{897} = 1{,}22$$

The results show that Zone 1 has an original adjustment factor of 1.00 which means that the generation value is balanced, while the objective adjustment factor of 1.22 indicates that the pull value is still greater than the total existing pull so that the next iteration in the Furness method is still needed.

Table 9. 1st Furnees Iteration Destination Origin Matrix (smp/hour)

	1	2	3	4	5	6	7	8	9	Oi	oi	Ei
1		120	120	120	120	120	120	120	120	959	959	1.0
2	147	0	147	147	147	147	147	147	147	1176	1176	1.0
3	97	97	0	97	97	97	97	97	97	779	779	1.0
4	205	205	205	0	205	205	205	205	205	1641	1641	1.0
5	119	119	119	119	0	119	119	119	119	955	955	1.0
6	111	111	111	111	111	0	111	111	111	884	884	1.0
7	29	29	29	29	29	29	0	29	29	235	235	1.0
8	159	159	159	159	159	159	159	0	159	1269	1269	1.0
9	30	30	30	30	30	30	30	30	0	240	240	1.0
Dd	1092	933	636	1347	1038	618	84	1258	233			
dd	897	870	920	812	898	907	988	859	987			
Ed	1.22	1.07	0.69	1.66	1.16	0.68	0.08	1.47	0.24			

The Furness iteration is repeated until the values of the origin adjustment factor (Ei) and the objective adjustment factor (Ed) are obtained, indicating that the ratio between the awakening and the pull of travel reaches a value of 1 or close to 1. This condition indicates that the total awakening has been balanced with the total pull in all zones. After the iteration process is completed, the origin-destination matrix (OD Matrix) is obtained as a calibration in junior high school units/hour for the Malang Kota Baru Station Area. This matrix represents the amount of movement of vehicles from each origin zone to each destination zone after the balance of awakening and pull is met.

Table 10. Furnees Iteration Destination Origin Matrix (smp/hour)

	1	2	3	4	5	6	7	8	9	Oi	oi	Ei
1		146	94	226	157	93	12	200	32	959	959	1.0
2	199	0	113	271	189	111	14	240	39	1176	1176	1.0
3	125	110	0	171	119	70	9	151	24	779	779	1.0
4	302	267	172	0	287	169	21	364	59	1641	1641	1.0
5	163	144	93	223	0	92	11	197	32	955	955	1.0
6	142	125	81	193	135	0	10	171	28	884	884	1.0
7	35	31	20	48	33	20	0	42	7	235	235	1.0
8	227	200	129	310	216	127	16	0	44	1269	1269	1.0
9	36	32	21	49	34	20	3	44	0	240	240	1.0
Dd	1092	933	636	1347	1038	618	84	1258	233			
dd	1230	1055	722	1490	1171	702	95	1408	264			
Ed	0.89	0.88	0.88	0.90	0.89	0.88	0.88	0.89	0.88			

G. Calibration

At the calibration stage, adjustments were made to the driver's behavior parameters to determine the level of compatibility between the modeling results and actual traffic conditions. This parameter adjustment aims to make the simulation model built able to represent real conditions in the field more accurately, so that the simulation results can be used as a reference in traffic performance analysis. The parameters of adjusted driving behavior in the modeling process are presented in table 11.

Table 11. Changes in Driver Behavior Parameters

No	Changed Parameters	Default (Before Calibration)	Simulation							
			1	2	3	4	5	6	7	8
1	Desired position at free low	middle of lane	any	any	any	any	any	any	any	any
2	Overtake on same line	off	on	on	on	on	on	on	on	on
3	Distance standing	1	0,5	0,5	0,5	0,1	0,5	0,3	0,5	0,1
4	Distance driving	1	0,5	0,5	0,5	0,1	0,5	0,3	0,6	0,2
5	Average standstill distance	2	1	1,5	0,5	0,5	0,4	0,4	0,3	0,3
6	Additive part of safety distance	2	1	1,5	0,5	0,5	0,4	0,4	0,3	0,3
7	Multiplicative part of safety distance	3	2	3	1	1	0,8	0,8	0,6	0,6

Under the default condition, the driving behavior characteristics in the simulation software still describe regular traffic conditions and are not fully in accordance with real conditions in the field. This is because the software's built-in parameters do not represent the behavioral characteristics of riders in Indonesia who tend to have different tolerances for distance, speed, and maneuver than international standards. Therefore, a process of parameter adjustment is required through calibration activities. The calibration process is carried out by changing several driving behavior parameters and running simulations repeatedly. Each combination of parameters results in a different volume of model traffic on each experiment. A comparison between the model volume and the volume of field survey results is then used to determine the parameters that most closely approximate the real conditions.

The results of the calibration process for each variation of driving behaviour parameters are presented in table 12.

Table 12. Vehicle Volume Calibration

No	Street Name	Directions	Default	1	2	3	4	5	6	7	8
1	Jl. Pattimura Segmen 2	B - T	559	1873	1779	2223	3397	2368	3397	2483	3397
		T - B	355	985	1003	1291	1861	1094	1574	1192	2038
2	Jl. Cokroaminoto	S - U	385	969	1022	1253	1819	1199	1618	1261	1972
		U - S	288	1148	937	1659	2333	1122	2312	1359	2333
3	Jl. Pattimura Segmen 1	B - T	440	1440	1176	2091	2119	1651	2522	1730	3220
		T - B	799	1605	1496	1855	2071	1813	2014	1921	2538
4	Jl. Trunojoyo Segmen 2	S - U	239	1112	1464	1798	3192	1495	2395	1541	3274
		U - S	537	1534	1379	1952	2685	1763	2571	1900	2861
5	Jl. Trunojoyo Segmen 1	S - U	422	1840	1664	2577	3516	2743	3524	2600	3653
		U - S	554	1549	1501	1990	2703	2170	2650	2066	2792
6	Jl. Kertanegara	B - T	584	2637	2637	2638	2638	2637	2637	2637	2637
7	Jl. Kertanegara	T -B	431	1502	1412	2067	2850	2030	2795	2041	2997
8	Jl. Gatot Subroto	S - U	558	2753	2340	3162	3589	3589	3589	3378	3589
		U - S	754	2285	2029	3054	3462	3050	3445	2880	3665
9	Jl. Untung Suropati Selatan	T - B	299	533	425	555	555	555	555	555	555
		B - T	17	66	57	96	100	96	100	86	108
10	Jl. Panglima Sudirman Segmen 4	S - U	541	1662	1485	1954	2403	2109	2103	2054	2431
		U - S	527	1399	1230	1781	1985	1637	2011	1691	2678
11	Jl. Untung Suropati Utara	B - T	307	944	840	1312	1490	1250	1509	1271	1884
		T - B	454	2235	1849	2493	2493	2493	2494	2313	2493
12	Jl. Panglima Sudirman Segmen 2	S - U	471	1827	1655	2339	2866	2678	2849	2303	2907
		U - S	550	1678	1502	2058	2254	1920	2291	1969	2959
13	Jl. Urip Sumoharjo	T - B	494	1598	1439	1546	2614	1613	1959	1972	2614
		B - T	745	1675	1423	2099	2267	1960	2336	2066	2772
14	Jl. Panglima Sudirman Segmen 1	S - U	429	1195	1066	1520	1705	1374	1852	1496	2367
		U - S	1481	2885	2635	3470	3946	3525	3689	3476	3947
15	Stasiun Malang	Keluar	432	622	622	622	622	622	622	622	622
		Masuk	161	444	441	567	766	638	737	573	777
16	Jl. Panglima Sudirman 3	S – U	541	1994	1820	2545	3142	2901	3116	2515	3185
		U – S	573	2455	2121	3405	3488	3299	3512	3038	3806

H. Validation

In the validation stage, tests are carried out on the simulation model that has been built to ensure that the model is able to represent real traffic conditions. Validation is a process to assess whether the simulated model is conceptually appropriate and produces accurate outputs. A model is declared valid if the simulation results are close to the conditions obtained from field data. The validation process in this study was carried out using traffic volume data. The comparison between the simulation results and existing conditions was analyzed using the Geoffrey E. Havers (GEH) statistical test for the parameters of traffic volume, queue length, and speed. The GEH value is used to measure the degree of proximity between the simulated data and the observation data. The model is declared to meet the valid criteria if the GEH value is < 5. If the GEH value is in the range of 5–10, the model is still acceptable but there is an indication of the possibility of error. Meanwhile, if the GEH value is > 10, the model is declared invalid because the difference in simulation results with field data is too large.

Table 13. Vehicle Volume GEH Test Validation

No	Street Name	Directions	Volume		Differences	GEH	Remarks
			Survey	Model			
1	Jl. Trunojoyo Segmen 1	S - U	3434	3653	-219	3.67898	Accepted
		U - S	2800	2792	8	0.15129	Accepted
2	Jl. Trunojoyo Segmen 2	S - U	3486	3274	212	3.64651	Accepted
		U - S	2961	2861	100	1.85344	Accepted
3	Jl. Kertanegara A (Timur-Barat)	T - B	3136	2997	139	2.51011	Accepted
4	Jl. Kertanegara B (Barat-Timur)	B - T	2736	2637	99	1.91004	Accepted
5	Jl. Pattimura Segmen 1	B - T	3449	3220	229	3.9657	Accepted
		T - B	2351	2538	-187	3.7822	Accepted
6	Jl. Pattimura Segmen 2	T - B	1990	2038	-48	1.06958	Accepted
		B - T	3431	3397	34	0.58189	Accepted
7	Jl. HOS Cokroaminoto	S - U	2011	1972	39	0.87393	Accepted
		U - S	2366	2333	33	0.68081	Accepted
8	Jl. Panglima Sudirman Segmen 1	S - U	2364	2367	-3	0.06168	Accepted
		U - S	3991	3947	44	0.69841	Accepted
9	Jl. Panglima Sudirman Segmen 2	U - S	2935	2678	257	4.85122	Accepted
		S - U	2406	2431	-25	0.50835	Accepted
10	Jl. Panglima Sudirman Segmen 4	U - S	3774	3806	-32	0.51979	Accepted
		S - U	2978	3185	-207	3.72897	Accepted
11	Jl. Urip Sumoharjo	B - T	3030	2772	258	4.79011	Accepted
		T - B	2650	2614	36	0.70171	Accepted
12	Jl. Untung Suropati Utara	B - T	1825	1884	-59	1.37006	Accepted
		T - B	2451	2493	-42	0.84474	Accepted
13	Jl. Untung Suropati Selatan	B-T	118	108	10	0.94072	Accepted
		T-B	566	555	11	0.46463	Accepted
14	Jl. Gatot Subroto Segmen 1	U - S	3602	3665	-63	1.04515	Accepted
		S - U	3605	3589	16	0.266778	Accepted
15	Zona 9 Stasiun Malang	Masuk	634	622	12	0.47885	Accepted
		Keluar	672	777	-105	3.90095	Accepted
16	Jl. Panglima Sudirman Segmen 3	S – U	3090	2907	183	3.34194	Accepted
		U – S	3176	2959	217	3.91803	Accepted

The performance of the road section is obtained through the Result List feature in the PTV Vissim software, then the Link Segment Performance menu is selected. Through this feature, the speed and traffic density values on each road segment were obtained from the modeling. The performance output of the segment is presented per segment at intervals of 10 meters in length along the modeled path. The data from the calculation of speed and density in each road segment based on Link Segment Performance are presented in the following table.

Table 14. Model Road Performance (Link Segment Performance)

No	Roads	Free Current Speed	Density Vehicle/km	Speed (km/h)
1	Jl. Trunojoyo Segmen 1	35.40	125,86	23,58
2	Jl. Trunojoyo Segmen 2	35.40	115,30	26,57
3	Jl. Kertanegara A (Timur-Barat)	53.89	92,15	32,50
4	Jl. Kertanegara B (Barat-Timur)	53.89	76,39	34,50
5	Jl. Pattimura Segmen 1	40.50	96,62	35,12
6	Jl. Pattimura Segmen 2	41.04	89,66	30,65
7	Jl. HOS Cokroaminoto	31.52	83,16	24,11
8	Jl. Panglima Sudirman Segmen 1	41.43	116,615	26,03
9	Jl. Panglima Sudirman Segmen 2	39.33	97,97	30,11
10	Jl. Panglima Sudirman Segmen 3	39.33	95,92	29,47
11	Jl. Panglima Sudirman Segmen 4	39.33	95,68	25,19
12	Jl. Urip Sumoharjo	42.41	59,36	27,61
13	Jl. Untung Suropati Utara	41.04	59,70	37,17
14	Jl. Untung Suropati Selatan	29.64	9,19	29,05
15	Jl. Gatot Subroto Segmen 1	39.76	89,52	29,64

On several roads, low traffic speeds were found accompanied by high levels of density. This condition is caused by high side obstacles and large traffic volumes, while the capacity of the road section is insufficient to accommodate the flow of vehicles. One of these conditions can be seen on the Trunojoyo Road 1 and Trunojoyo Road 2 sections, where there are high side obstacles due to the existence of parking on the road body.

I. Proposed Traffic Management and Engineering Scenarios

After obtaining the results of the analysis on the proposed problem handling, the last stage in traffic management and engineering in the Malang Kota Baru Station Area is to compare the performance of the road network in unhandled conditions (existing) and with the application of the best scenario. The application of the handling scenario results in different road network performance compared to existing conditions. The handling proposals proposed in this study are prepared based on a traffic management and engineering approach, so that all handling actions are considered as a mutually supportive unit. The proposed handling includes:

1. The move of on-street parking to off-street on Jalan Trunojoyo 1 and Jalan Trunojoyo 2 is to eliminate side obstacles and restore the effective width of the road. The planned off-street parking facility is capable of accommodating around 712 motorcycles and 160 cars, and is managed by PT KAI.
2. Improvement of pedestrian facilities, including improving the quality of sidewalks and crossings, to improve pedestrian safety and comfort.
3. Installation of signs and repainting of road markings on the Trunojoyo Road section to improve readability and assist drivers in maneuvering.
4. Arrange the layout of access in and out of goods and passengers so that there is no accumulation of activities at one point that has the potential to disrupt traffic flow.

Table 15. Comparison of Road Network Performance Without and Handling

No	Conditions	Average Delay (sec)	Network Speed (km/h)	Total Mileage (vehicle-km)	Total Travel Time (vehicle-hours)
1	Eksisting	168,00	13,60	24.120	1.774,47
2	Usulan	90,91	22,04	25.574	1.160,59

In the table above, a comparison of the performance of the road network for each proposed problem handling scenario is shown. The performance of the road network is compared based on four main parameters, with the following assessment criteria.

1. Average delay

The higher the average delay value, the worse the performance of the road network. Conversely, the lower the average delay value, the better the performance of the road network.

2. Network speed

The higher the network speed, the better the road network performance level. On the other hand, if the network speed is getting lower, the road network performance will decrease.

3. Total mileage (vehicle-km)

Semakin besar total jarak tempuh, menunjukkan pergerakan kendaraan pada jaringan lebih lancar sehingga kinerja jaringan membaik. Sebaliknya, semakin kecil total jarak tempuh, menunjukkan terjadinya hambatan pergerakan sehingga kinerja jaringan memburuk.

4. Total travel time (vehicle-km)

The greater the total travel time, the worse the performance of the road network because the vehicle requires a longer travel time. Conversely, the smaller the total travel time, the better the performance of the road network.

Furthermore, there is also a difference in the value of free flow speed after the implementation of traffic management and engineering scenarios. This analysis was carried out to determine the speed change in each road segment (link by link) based on the results of simulation through the Link Segment Performance feature on PTV VISSIM. Based on the results of the simulation, the speed and traffic density values in each segment were obtained after the implementation of traffic management and engineering scenarios.

IV. CONCLUSION

Based on the results of the analysis that has been carried out on the problem of the Malang Station Area, Kota Baru can be concluded that the existing condition of traffic performance shows a poor level of service, especially on the sections of Jalan Trunojoyo 1 and Jalan Trunojoyo 2 which have service level D according to the 2016 Highway Capacity Manual with an average speed of 20.84 km/h. This condition is caused by high side obstacles in the form of on-street parking and loading and unloading activities from PT KAI. The results of the parking analysis showed that the highest motorcycle on-street parking index was found on the Trunojoyo 2 road section at 155%, while the highest car on-street parking index was found on the Trunojoyo 1 road section at 98%. Overall, the road network performance in this area has an average delay of 168 seconds, network speed of 13.6 km/h, total mileage of 24,120 km, and total travel time of 1,774 km. These values show that the performance of the road network is in the poor category because of the high side barriers that affect the flow of traffic.

Traffic modeling using PTV Vissim software also shows that network performance is still not good, so the implementation of traffic management and engineering is needed in accordance with the Regulation of the Minister of Transportation Number 96 of 2015. The handling proposals provided include moving on-street parking to off-street on Jalan Trunojoyo 1 and Jalan Trunojoyo 2, improving pedestrian facilities to improve safety and user comfort, adding signs and redesigning and repainting inadequate road markings, as well as regulating and separating access in and out of goods and passengers so that there is no accumulation that interferes with traffic flow. The modeling results after applying traffic management and engineering scenarios showed an improvement in road network performance. The network speed increased to 22.04 km/h, the average delay decreased to 90.91 seconds, the total travel time decreased to 1,160.59 km, and the total mileage increased to 25.574 km. Thus, the proposed scenario is proven to be able to improve the performance of the road network in the Malang Station Area, Kota Baru.

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