6. Management and Engineering Optimization of Car Free Day Activities in the Simpang Lima Gumul Monument Area in Kediri Regency_compressed

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Management and Engineering Optimization of Car Free Day Activities in the Simpang Lima Gumul Monument Area in Kediri Regency

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Abstract. The car-free day area is very influential on vehicle-free day activities, and there is a difference in the level of pollution issued by motorized vehicles. In the car-free day area, there is illegal parking that eats up the shoulder of the road so that there is a decrease in the road's performance, so many traffic disturbances appear on the road, such as the emergence of on-road vehicle parking. So that it does traffic management and engineering. Several stages of activities are planning, organizing, engineering, empowering, and monitoring activities. The analysis used this research is a comparative hypothesis, which is comparative research, quantitative data analysis with problem identification, problem formulation, secondary data collection, and primary data, data processing and analysis, traffic modeling with VISSIM software) From the results of the research that has been in scenario 3, the best products and the chosen one is by moving the road body parking outside the road body and the one-way system so that there is an increase in road performance as indicated by the rise in the level of service to the sections.

Keywords: Traffic Management and Engineering, Service Level, Pollution.

A. Introduction

One of the problems of the population in big cities in the world is having the largest population. Large population and low quality of people affect the carrying capacity and carrying capacity of the environment (Daily & Ehrlich, 1994; Cohen, 1997; Wang et al., 2018). Population growth can cause the flow of mobility to increase, so that the need for transportation equipment increases and the demand for energy such as oil also increases, which can cause air pollution and depleted petroleum supplies (Colvile et al., 2001; Cramer, 2002; Shabbir & Ahmad, 2010).

Air pollution has become one of the global environmental problems of concern to the world (Mage et al., 1996; Akimoto, 2003; Zhang & Smith, 2003). A survey conducted by the World Health Organization - WHO (2004) in 1,600 cities spread across 91 countries globally shows that nearly 90% of people in urban centers breathe unhealthy air. WHO also states that about half of the world's population is exposed to pollution at least two and a half times higher than the set air quality standards. This phenomenon is mainly felt in countries as a negative impact of development-oriented economic growth (Krzyzanowsk & Schwela, 1999; Mannucci & Franchini, 2017)

After all, it is complicated to ignore the stench emanating from our open waterways or shed tears when we breathe in the air mixed with poisonous gases and solid particles scattered in the air in most areas of our big cities. Although air pollution from the motor vehicle industry is severe, this pollution is the easiest to solve many pollution problems (Wardana, 2004; Ismiyati et al., 2014).

The solution in solving this problem is that the government holds a program to reduce congestion and air pollution known as Car Free Day or days without motorized vehicles (Farda & Balijepalli, 2018; Rachman & Barus, 2019). The Car Free Day

program was first carried out in the Netherlands and Belgium to reduce the energy crisis from November 25, 1956, to January 20, 1957 (Arindra, 2019). The car-free day is a campaign activity to reduce air pollution levels in big cities worldwide caused by motorized vehicles (Kanaf, 2014). Starting on November 25, 1956, the Netherlands held Car Free Day every Sunday. Then in 1995, France had a party to commemorate Green Transport Week in Bath, all people took to the streets to celebrate the event. This is a long journey in the history of Car Free Day activities, which in the end, this activity is commemorated every September 22 throughout the world. On April 19, 2001, the Earth Car Free Day (ECFD) program was held for the first time and simultaneously worldwide. More than 300,000 organizations and cities worldwide participate in activities organized by The Commons WC / FD program and Earth Day Network (Ristanto, 2013).

In Indonesia, car-free day activities are generally used as a space for sports for urban communities. Sports activities in the field include gymnastics, cycling, running, walking, and culinary activities (Alamanda et al., 2019). Road closures resulting from car-free days' implementation provide opportunities for people to exercise on roads that can be passed by private vehicles (Wiyanto, 2012).

Public open spaces in various regions and cities in Indonesia are what society needs today. However, both central and local government's role in developing public open spaces is still lacking (Imansari & Khadiyanta, 2015). A shared open space can function as a center for community activities, both formal and informal activities; in the use of public free space, it can also serve as a center for social interaction, economic activities, and cultural arts activities (Mulato, 2008). The Car Free Day program in several cities in Indonesia is an alternative to meeting the need for public open space. Car Free Day has developed into a vehicle and place for sports, recreation, a medium for channeling various cultural arts and creating multiple economic activities for the community. Different roads function as traffic lanes and have the essence of being open public spaces (Shofia, 2019).

The car-free day was held in Kediri Regency in the area of Simpang Lima Gumul Monument. The car-free day area has various zones, namely sports zones, culinary zones, children's playground zones. The Simpang Lima Gumul Monument is one of the buildings that has become an icon of Kediri Regency, built-in 2003 and inaugurated in 2008 by the Regent of Kediri. The Simpang Lima Gumul Monument is located in a strategic area. It is equipped with public facilities, such as a temporary market that is open at certain times and recreational facilities. This car-free day area has been visited by many people from Kediri to outside Kediri so that it has the potential to contribute to pollution levels in the form of carbon monoxide (CO) from motor vehicle fumes.

At present the car-free day activity has added functions. From what was originally only for sports activities, now it has become an event with new trend activism which tends to be an entertainment arena for people to enjoy entertainment and shopping, several activities such as art performances, children's games, and product promotion socialization. In the car-free day area in the Simpang Lima Gumul Monument Area in Kediri district, two roads are passed, namely Mesjid Lama street and Totok Kerot street, where the two routes are in a sports room, parking space, and culinary space, which causes it not to match the demand. There is no effective arrangement in the car-free day area.

B. Literature Review

Traffic Management and Engineering

According to Law Number 22 of 2009 concerning Traffic and Transportation. Roads that traffic management and engineering are a series of businesses and activities that include planning, procurement, installation, regulation, and maintenance of road equipment facilities in the context of realizing, supporting, and maintaining security, safety, order, and smoothness of traffic.

According to Government Regulation number 32 of 2011, traffic management is a series of businesses and activities that include planning, installing, regulating, and maintaining road equipment facilities to realize, support, and maintain traffic security, safety, order, and smoothness (Limantara et al., 2017).

Traffic engineering is the study of traffic and travel measurement, necessary legal tasks related to traffic flow and generation, and practical professional knowledge of planning, designing, and operating traffic systems to achieve people's safe and efficient movement and goods (Saputra, 2014).

Road Section Performance Indicators

Knowing the extent to which the availability of infrastructure is adequate or not for demand is needed to measure roads and intersections' performance, a standard is required, which results from a study and a reference in assessing traffic performance (Tamin, 2008). The general criterion used in measuring traffic performance is the Indonesian Highway Capacity Manual (IHCM) or the Indonesian Road Capacity Manual (MKJI), published by the Directorate General of Highways in 1996. As well as being used to analyze the operation of traffic facilities, it can also be used for design and planning (Pribadi et al., 2014).

Road performance indicators consist of road section capacity, volume, v / c ratio (traffic volume/capacity), speed, and service level.

Road Section Capacity (c)

Capacity is the maximum amount of (stable) traffic flow that can be maintained under certain conditions, including geometry, distribution of traffic directions and composition, and environmental factors, in units of pcu / hour. The calculation of the capacity of a road section uses the manual calculation of the capacity of Indonesian roads (MKJI, 1997) with the following equation:

$$C = Co \times FCw \times FCsp \times FCsf \times FCcs \quad (1)$$

Information:

C = Road capacity (pcu / hour)
Co = Basic capacity (pcu / hour)
FCw = Traffic lane width adjustment factor
FCsp = Direction divider adjustment factor for undivided roads
FCsf = Side drag adjustment factor
FCcs = City size adjustment factor

Volume

Volume is the number of vehicles passing a certain cross-section on a particular road in a specific time unit in passenger car units.

V / C Ratio

V / C Ratio is obtained from comparing road traffic volume at one peak hour with the road segment capacity.

Level of Service

The level of service or road level of service (LOS) is one of the methods used to assess road performance based on the V / C ratio and speed indicators.

Air pollution

The unbalanced increase in the number of vehicles with the available road facilities has resulted in congestion on several roads, the main routes for public transportation in big cities, especially during rush hour. This motor vehicle congestion hurts air pollution (Hobbs, 1995). The use of fuel oil, which is used as a driving force for vehicles, engine ventilation systems, and especially the exhaust from fuel combustion, a mixture of hundreds of gases and aerosols, is the leading cause of the release of various pollutants.

Pollutants released by motorized vehicles include carbon monoxide (CO), nitrogen oxides (NOx), hydrocarbons (HC), sulfur dioxide (SO2), lead (Pb), and carbon dioxide (CO2). Of these several types of pollutants, carbon monoxide (CO) is one of the most pollutants produced by motorized vehicles (Sengkey et al., 2011). CO pollutants released by motor vehicles hurt human health. Carbon monoxide is a highly toxic gaseous pollutant. This compound binds to hemoglobin (Hb) which functions to deliver fresh oxygen throughout the body, causing Hb's function to carry oxygen throughout the body to be disturbed. The reduced supply of oxygen throughout the body will cause shortness of breath and cause death if not immediately fresh air.

Hobbs (1979) describes the stages of pollution analysis of the northern ring road using the Air Pollution Regression modeling approach. This modeling is used to calculate the air pollution emitted by each vehicle in the study area, both in the existing and operational conditions. Modeling can also be used to calculate the value of savings due to the ring road. The Pollution Efficiency calculation formula in table 1 is as follows:

Table 1 Pollutant Regression Formulas

No	Types of Pollutants	Regression Formulas	Description
1	CO concentration (ppm)	C = 2.96+0.00032V+0.0000005V^2	V = The volume of the vehicle for 3 hours
2	NOx Concentration (μ/gm^3)	N = 46.9-0.036T+0.00004T^2	T = Vehicle Volume for 1 Hour
3	Smoke Rate (μ/gm^3)	S = 9.49 + 0.022 V	

Source: Hobbs Regression Model, 1979

C. Method

This research was carried out based on the research methodology from the initial stage of problem identification, problem formulation, secondary data collection, and primary data, data processing, and analysis, traffic modeling with VISSIM software) problem-solving alternatives and problem-solving alternatives with multi criteria analysis, to the stage Finally, there are suggestions or recommendations for optimizing traffic performance (Aryandi & Munawar, 2014).

This type of research is included in the kind of comparative hypothesis, which is comparative research, with quantitative data analysis (Rosana & Setyawarno, 2016). The stages of traffic management and engineering research consider planning, regulation, engineering, empowerment, and supervision activities.

D. Result and Discussion

Existing Road Network Model Performance

From the results of the analysis on the road load process using the Vissim software, it can be seen that the traffic performance in the car-free day area shows a problem. This affects the decline in the performance of the road network in the car-free day area. From table 2, it can be seen from a macro level that the traffic performance on the road network in the car-free day area has problems. Based on the loading results carried out with Vissim software on the road network in the car-free day area, the existing road network's performance can be seen in Table 2 below:

Table 2 Performance of the existing network of car-free day areas

Parameters	Road Network Performance
Average Delay (seconds)	26.19
Network Speed (km / h)	22.72
Total Travel Distance (Vehicle. km)	6,270.42
Total Travel Time (Vehicle. hours)	275.99

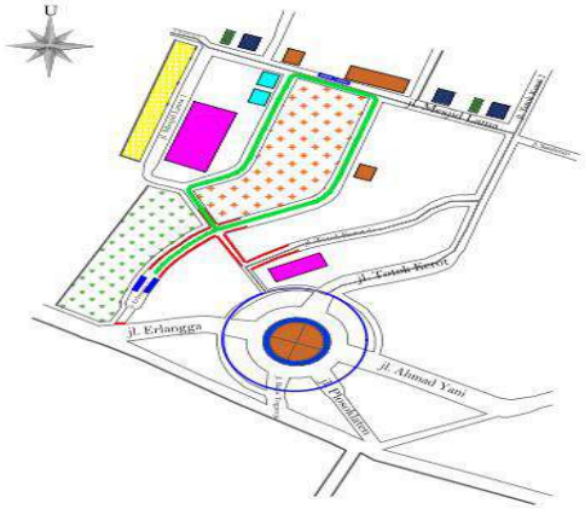

Figure 1. Car-free day activities in Kediri Regency

The model validation is based on the test/chi-square test results between the results of the traffic survey in the field and the results of the models that have been made from the results of VISSIM. Model validation is intended to test whether the results of the model traffic volume obtained significantly differ from traffic volume observations (observations).

1. Stating the null hypothesis and the alternative hypothesis (Hypothesis) H0: Model result = Observation result
   H1: Model results ≠ Observation results
2. Determination of the Value of the Trust Level (Level of Signification)
   The rejection area limit or critical limit from the dari² Table determines the significance level with the degree of confidence 95% or α = 5% (0.05).
3. Degree of freedom (degree of freedom)
   There are 40 conditions under observation, which means k = 14 so that the degrees of freedom df = V, V = k-1, V = 14-1. Then V = 13.
4. Value of Chi-Square Table (χ^2 Table)
   By looking at the ² distribution table, it can be seen that the value of χ^2 (0.05; 13) = 22.36
5. Rules of decision
   H0: accepted if χ^2 count < 22.36
   H1: accepted if χ^2 count > 22.36
6. Calculation χ^2
   Calculation χ^2 (χ^2 count) can be seen on weekdays of 21.95.
7. Decision Making:
   Based on the calculation result, χ^2 count = 21.95 χ^2 count <22.36 so that H0 is accepted. So the model results can be obtained with a level of significance (level of significance) of 95% and can present conditions in the field.

Comparison of Network Performance with Application of Problem Solving Scenarios

Based on each scenario application's analysis result, it can be seen the difference in the performance of the road network in the car-free day area in Kediri Regency. Comparisons are made both in the existing conditions without treatment or in the states after treatment or scenarios. The best network performance will be obtained from this comparison, which means that it is the best recommendation in handling problems. The results of the comparison of network performance can be seen in Table 3 below:

Table 3 Comparison of Road Network Performance

Parameters	Existing	Scenario 1	Scenario 2	Scenario 3
Average delay (seconds)	26.19	25.77	13.75	13.68
Network Speed (km / h)	22.72	22.86	24.75	24.7
Total Travel Distance (vehicle. km)	6,270.42	6,143.02	6,036.37	6,032.63
Total Travel Time (vehicle. hours)	275.99	268.77	244.29	244.19

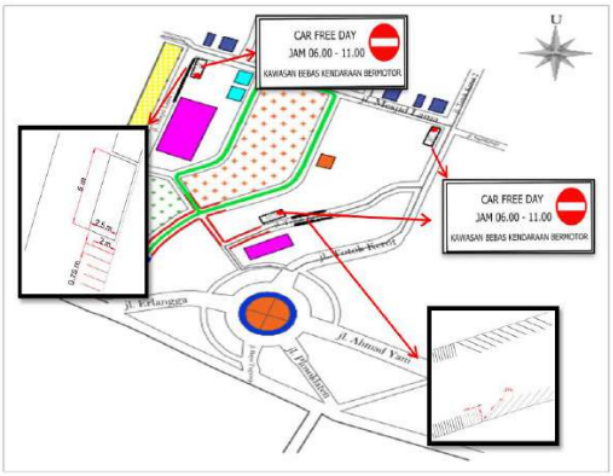

Figure 1 Engineering Car-Free Day Area in Kediri Regency

Table 4 explains that the SRP (parking space unit) for each vehicle is different, and the amount for each leg width of the parking space and maneuver space has been a provision for each car, in finding the required parking area using the calculation of the parking area for motor vehicles.

Table 4 Parking Offers in the Car Free Day Area

No	Street Name	Transport type	Road Length (m)	Angle (x°)	Parking Space Foot Width B (m)	Adequate Parking Space D (m)	Maneuver Room M (m)	Unit Parking space (m^2)
1	St Mesjid Lama 1	Car	57	0	5	2.5	3	33
		Motorcycle	55	90	0.75	2	5.8	5.9
		Bike	10	90	0.75	2	5.8	5.9
2	St Totok Kerot 1	Car	45	30	5	4.5	2.9	37
		Motorcycle	40	90	0.75	2	5.8	5.9
		Bike	15	90	0.75	2	5.8	5.9

From table 5, it is known that the required parking area for cars on Mesjid Lama 1 road is 330 m2 and can accommodate as many as 10 vehicles with an angle of 0o.

Table 5 Required Parking Area

No	Street Name	Transport type	Number of Parking Space Offers	Parking Space Unit	Parking Area (m^2)
1	St Mesjid Lama 1	Car	10	33	330
		Motorcycle	28	6	164
		Bike	5	6	29
2	St Totok Kerot 1	Car	10	37	370
		Motorcycle	20	6	117
		Bike	8	6	47

Pollution Level in Existing Conditions

The pollution level in the existing conditions in 7 sections in the car-free day area, for example, on the Erlangga road, the CO level is 4.08 ppm, the NOx level is 38.85 μgm^3, and the smoke level is 275.77 $\mu g/m^3$. Table 6 describes the level of pollution in existing conditions, as follows:

Table 6 Pollution Level in Existing Conditions

No	Street Name	Volume (pcu/hour)	CO (ppm)	Nox (μgm^3)	Smoke Level ($\mu g/m^3$)
1	St Erlangga 1	484	4.08	38.85	275.77
2	St Mesjid lama	420	3.85	38.84	240.49
3	St Mesjid lama 1	245	3.34	40.48	144.24
4	St Mesjid lama 2	357	3.64	39.15	205.84
5	St Totok Kerot	739	5.26	42.14	415.94
6	St Totok Kerot 1	390	3.75	38.94	223.99
7	St Totok Kerot 2	586	4.50	39.54	331.79
	Total		28.42	277.93	28.42

Pollution Level in Recommended Situation

The pollution level in the recommended situation, for example, on the Erlangga road section, the CO level is 4.12 ppm, the NOx level is 38.88 μgm^3, and the smoke level is 275.77 $\mu g / m^3$. The following is an example of calculating the level of pollution using an air pollution regression model calculation (Hobbs, 1979).

Table 7 describes the level of pollution in the recommended situation, as follows:

Table 7 Pollution Level in Recommended Situations

No	Street Name	Volume (pcu/hour)	CO (ppm)	NOx (μgm^3)	Smoke Level ($\mu g/m^3$)
1	Jl. Erlangga 1	38.88	4.12	38.88	281.44
2	Jl. Mesjid lama	39.34	3.57	39.34	193.03
3	Jl. Mesjid lama 1	43.54	3.08	43.54	67.71
4	Jl. Mesjid lama 2	40.19	3.39	40.19	154.63
5	Jl. Totok Kerot	42.22	5.28	42.22	417.81
6	Jl. Totok Kerot 1	38.89	3.79	38.89	230.87
7	Jl. Totok Kerot 2	39.43	4.46	39.43	326.09
Total			27.68	282.48	27.68

Comparing the level of pollution in the car-free day area in the existing conditions with the recommendation situation, while in the existing conditions, the CO level is 28.42 ppm, the NOx level is 227.93 μgm^3. The smoke level is 1838.06 μ / gm^3, while in the recommended situation, the CO level was 27.68 ppm, the NOx level was 282.48 μgm^3, and the Smoke level was 1671.59 μ / gm^3.

The difference in carbon monoxide levels (CO) in the existing conditions with the recommended situation is a difference of 74% ppm. The difference in Nitric Oxide (Nox) levels in the existing conditions with the recommended situation was obtained by a difference of 455% μgm^3. In contrast, for the difference in Smoke Levels in the existing conditions with the recommendation situation, the difference was 16647.23% μ / gm^3.

To design the arrangement of parking spaces at the car-free day location in the area of the Simpang Lima Gumul Monument, with the provision of parking space on Mesjid Lama 1 street, with a land area of 330 m2 for car parking, 164 m2 for parking motorbikes, and 29 m2 for parking for bicycles. While on Totok Kerot 1 street, with a land area of 444 m2 for car parking, 47 m2 for motorcycle parking, and 17 m2 for bicycle parking.

Optimizing traffic flow management in the Simpang Lima Gumul Monument Area during the car-free day by applying the selected scenario, there is a change in the performance of the road network in the car-free day area and compared with the existing conditions with parameters namely average delay, network speed, total distance trip, and total travel time. The average mark in the existing situation is 26.19 seconds. In contrast, in the 13.68-second scenario, the network speed in the existing condition is 22.72 km/hour. In contrast, in scenario 3, it is 24.7 km/hour, for the total travel distance in The existing conditions are 6270.42 vehicles. In contrast, in scenario 3, it is 6032.63 vehicles, and the full travel time in the existing conditions is 275.99 vehicles hours, while in scenario 3, it is 244.19 vehicles hours. So it can be seen that there is an improvement in the road network's performance after the selected scenario is applied.

E. Conclusion

Problems commonly experienced by densely populated areas in Indonesia are the level of air pollution and congestion. The solution to this problem is that the district or city government conducts a program to reduce congestion and air pollution known as Car Free Day or days without motorized vehicles. The Kediri Regency Government also held a Car Free Day by taking place in the Simpang Lima Gumul Monument area, an icon of the Kediri district.

After implementing the scenario for solving the road network performance problems around the Simpang Lima Gumul monument, the results were better than the scenario without the scenario, which means that this scenario's application is the best recommendation. From the results of the analysis that has been in scenario 3, the best products and the chosen one is by moving the road body parking outside the road body and one-way system so that there is an increase in road performance as indicated by the rise in the level of service to the section. Meanwhile, for air pollution, there is also a decrease in the level of pollution between the existing conditions and the recommended level due to the flow's service level.

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11

PAGE 12