The Influence of Jogjakarta Outer Ring Road Development Plan on the National Roads in DIY

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ABSTRACT The development of Jogja Outer Ring Road (JORR) has been issued by the government as one of possible alternatives to deal with traffic jams. The ring road has occupied the existing road (2018) with an extension of 7 meters to seize 14 meters. In the future, ring road will pass through 22 districts in 3 regencies. In this study, there were 4 main streets, i.e. Solo-Jogja street, Kaliurang St, Magelang St, and Palagan Tentara Pelajar St, set as the objects of comparison to the existence of JORR, using VISSUM software, which was analyzed three probabilities, namely 1) without JORR (2018), 2) JORR of government route (2026), and 3) actualized JORR with alternative route (2026). As a result, based on the standard from MoT of Indonesia, V/C ratio of four surround roads with JORR were better. Additionally, with alternate JORR, the result was much better until 5 more times. In the opposite, there were 3 roads surrounds that had more performance than the existence of JORR. Based on this study, the V/C ratio of Solo-Jogja St in front of the eastern part of Kalasan district as the north part, it decreased for about 8.79% if JORR was actualized and 60.78% if JORR was actualized with alternate road. At the western part, there was increased performance of 6.55% if JORR was actualized and 49.42% if JORR was actualized with alternate road. At southern part, there was raised performance around 16.25% if JORR was actualized and 5.27% if JORR was actualized with alternate road. As a conclusion, since the JORR with government and alternative routes have strength and weakness in some roads, additional suggestions are proposed such as traffic management and actualization of public transport.

KEYWORDS Jogjakarta Outer Ring Road; The Number of V/C; Gravity Method; PTV Visum.

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1 INTRODUCTION

Yogyakarta has been one of famous tourist destinations in Indonesia that many tourists have a visit in order to enjoy the culture and or the scenic panorama. Besides, there are so many schools and higher education institutions by which many students from out of the town are attracted to study. Therefore, this occurrence causes population explosion which brings about consequence of high number of private vehicle ownership each year. In advance, Jogja Outer Ring Road (JORR) was supposed to function to divert the traffic flow in order to eliminate the number of traffic jams in the downtown. Even though, the traffic jam is predicted to be increased since the population is raising (Stopher, 2004). But then, its main function is converted to be arterial road due to rapid regional development around Yogyakarta ring road which is considered as one of the traffic knots in Yogyakarta. Therefore, the simulation of congestion at the city authority can present the scenarios solution to solve the problems (Sánchez-Medina, Galán-Moreno and Rubio-Royo, 2010).

For that reason, the government has offered a solution for the traffic jams by building an outer ring road of Yogyakarta, or named as Jogia Outer Ring Road (JORR). The construction of JORR occupies the existing roads with an extra extension of 7 meters to seize 14 meters. Furthermore, it is estimated that the total length of road used constitutes 72.2 kilometers. This project will foresee to pass through 10 districts in Sleman Region, i.e. Prambanan, Berbah, Kalasan, Cangkringan, Pakem, Ngemplak, Turi, Tempel, Seyegan, and Minggir; 3 districts in Kulonprogo Region, i.e. Kalibawang, Nanggulan and Sentolo; and 9
districts in Bantul region, i.e. Sedayu, Pandak, Pajangan, Bantul, Jetis, Imogiri, Pleret, Piyungan and Dlingo. Therefore, the alteration of the network of the road has some reason such as specify the location of the traffic congestion that usually occurs in traffic lights, roundabout, or parking lots (Fontes et al., 2015). But, on the other hand, there were estimated that traffic congestion and traffic accidents have an inverse relationship, and as a result, this poses dilemma for transport policymakers (Wang, Quddus and Ison, 2009). However, the project of JORR construction is estimated to finish within 5-6 years and is supposed to decrease the traffic density in the main road at Jogjakarta. Since the bad road networks could be the effect of traffic congestion. (Jain, Sharma and Subramanian, 2012).

After stipulating the target road for outer ring road construction, transportation modeling is necessary to investigate the transformation in travel movements utilizing PTV VISUM software. As simulation of traffic, there were some parameters to adjust, in order to make the simulation result represents the existing condition (Fontes et al., 2015, Hollander and Liu, 2008). Specifically, PTV VISUM is a software designed by PTV Group based in German and is used to model a transportation system in urban, metropolitan, and regional areas in addition to evaluating the transportation policy. The result of modeling yielded by PTV VISUM is used to analyze the road contribution or performance based on level of service. Further, the level of service is a sort of analysis on-road performance to compare the traffic volume to the road capacity within particular period of time. There were some research using PTV VISUM as the traffic modeling in some areas such as at Banda Aceh (Hendra, 2017), at Samarinda City (Pradiya, 2016), at Bangka island (Yunus, 2018), at Palembang city (Fuady, 2015 and Arliansyah, 2017) and at Yogyakarta to predict the effect of airport relocation to the surrounds road network at Yogyakarta (Fitra, Munawar, and Dewanti 2019). Also, modelling the flows of the traffic with some scenarios, especially the changes of road network or pattern, also held in order to reach better performance (Grigonis, 2014, Taplin, 1999, and Yatski, 2007).

Therefore, in order to identify the transformation pattern that occurs along with the construction of JORR, a study on the performance of existing roads is an urgency, which is referred to V/C ratio of national roads as by modeled PTV VISUM. Moreover, this research was intended to see the V/C ratio of national roads around the city center, consisting of: Solo-Jogja St especially in front of Kalasan district; Kaliurang St especially in front of State Electricity Company; Palagan Tentara St concerned in front of Hyatt Hotel, and Magelang St in front of Wahidin Court. All of the targets are assumed under the condition of existing and post-construction of JORR in 2026. Moreover, an alternate road for JORR was put into design as comparison.

Since the location of this research was in the urban, there was also some research to analyze the transportation in the city center with some solution such as the rearrangement of public transport (Gulhan, 2014) and many ways in order to reduce the demand of traffic (Lindsney* and Verhoef*, 2001).

2 ROAD PERFORMANCE

According to the Directorate General of Bina Marga, Ministry of Transportation of Indonesia, (1997), road performance refers to a quantitative measure to define the operational condition of road which covers density or percent time delay. One of the indicators to find the congestion level could be developed from number of vehicle and road capacity. Even though the modification of demand and capacity could reduce the congestion, the research about it have not systematically exist (Çolak, Lima and González, 2016).

2.1. Volume Capacity Ratio

Volume capacity ratio as mentioned in Equation (1), means a comparison between the vehicle volume through the road within a period, with remaining space for other vehicles within range of time or capacity of the road (Transportation Research Board, 2000). When the comparison is greater, means the traffic
service is poorer. According to O’Flaherty (1997), capacity of city roads refers to a maximum number of vehicles that are allowed to pass through a road section within an hour and under particular traffic conditions. The term ‘capacity’ is defined as a maximum flow to reach a specific road point that can last for an hour under specific conditions. However, there were many types of research about the road capacity in some urban area that affected the number of traffic volumes in the related area (Gajjar and Mohadash, 2016, Tennøy, A, et al, 2019, Rao, M.A, et al, 2017).

\[ V/C \text{ ratio} = \frac{V}{C} \]  

(1)

Where \( V/C \) ratio is volume capacity ratio; \( V \) is traffic volume (PCE/h); and \( C \) is road capacity (PCE/h).

2.2. Flow Speed (Fv)

According to Hobbs (1974), the definition of speed is a rate of movement shown by the vehicles that are calculated by the distance reached per unit of time (km/h). Therefore, free-flow speed (FV) refers to the speed reached when the flow level is zero. In other words, it is related to the preferred speed that the drivers intend to reach when driving without any interference from other drivers in roads as refer in equation (2).

\[ FV = (FV_0 + FV_w) \times FFV_{SF} \times FFV_{CS} \]  

(2)

Where \( FV \) is free-flow speed of light vehicle under the field conditions (km/h); \( FV_0 \) is basic free-flow speed (km/h); \( FV_w \) is factor of speed adjustment for traffic road width (km/h); \( FFV_{SF} \) is factor of speed adjustment for side barriers; and \( FFV_{CS} \) is factor of speed adjustment for city size.

3 RESEARCH METHOD

3.1. Location

Alluding to the design of JORR, this research took place at the main streets of Yogyakarta, as follows:

1. Solo-Yogyakarta St, in front of Kalasan district;
2. Kaliurang St, in front of the State Electricity Company;
3. Palagan Tentara St, in front of Hyatt Hotel; and
4. Magelang St, in front of Wahidin Court.

3.2. Data

The research analyzed based on the secondary data from the Department of Transportation (DoT) of The Special Region of Yogyakarta in 2015-2018, such as traffic volumes, road capacities, speed, origin-destination matrix (OD matrix) that were shown on Yogyakarta main road collected. In addition, there were data of population, vehicles ownership, Gross Regional Domestic Product of Sleman Regency, number of companies in Sleman Regency, and number of schools in Sleman Regency that were collected from Central Bureau of Statistics. These data can usually be obtained from construction drawings, field surveys, geographical information system (GIS) files, or aerial photographs (Dowling, Skabardonis and Alexiadis, 2004). Based on vehicle ownership growth at Sleman Regency, the calibration of traffic at 2026 were calculated.

3.3. Trip Production and Trip Attraction

This model can be used to interrelate the number of movements heading to or leaving the destination based on population, area, the value of Gross Regional Domestic Product, and so forth. This sort of model is necessary to foresee the prospective number of movements in each of zones. Moreover, a multiple linear regression analysis is a statistical method used to study the relationship on the characteristics of the
issues under investigation. In its implementation, this analysis will have two variables or more, consisting of independent (x) and dependent (y) that will be modeled, as stated by Ortuzar (2011).

3.4. Unconstrained Gravity Method

In the origin-destination matrix, the number of prospective trips can be conjectured based on the current data and the factor of traffic flow growth. Gravity method was applied in this research, assuming that the characteristics of trip production and attraction could be linked to some parameters of origin point, such as population and the core value of origin-destination matrix which were also related to an aspect of accessibility as a function of distance, time, and cost (Tamin 1997).

Determination of trip pattern interchanges between land-use parcels or traffic zones using an appropriate analytical technique is involved in trip distribution analysis (Thamizh Arasan, Wermuth and Srinivas, 1996). This model is unlimited, which means that it does not require the movement value in each zone to be in level of predicted production phase.

3.. PTV VISUM Software

PTV VISUM is software in civil engineering for transportation subject developed by PTV Group based in Germany (PTV, AG, 2011). The main utility of PTV VISUM lies on its basic capability of designing a model for transportation issues in macro. Additionally, PTV VISUM offers the planners with a variance of direct comparison between the existing and foreseen conditions indicated by the traffic transformation that occurs within the road and transit networks. This research proposed an experiment design model to select the parameters. To search the optimal values for the parameters, two genetic algorithms are commonly used (Jiménez et al., 2016)

4 ANALYSIS AND DISCUSSION

Currently, based on DoT (2015-2018), there were some bad conditions of traffic performance in some locations in Yogyakarta as follows. Figure 1 gives information about fluctuated comparison of volume and capacity in some streets. In the beginning, Solo St had the lowest comparison than others, which means it had the best performance. Unfortunately, a year later, the west side was the most congested street during the years. On the other hand, the other street had stable condition since the V/C ratio were less than 0.8 from time to time. Nevertheless, the critical condition will make them worst if there were no actions related the management of traffic.

![Figure 1. V/C Ratio in Some Arterial Roads in Yogyakarta from 2015-2018](image)
In addition, regarding to origin-destination data from DoT of Yogyakarta, PTV VISSUM presented the traffic matrix per zone surrounds the research area as Figure 2. Therefore, from Figure 2 and data proportion of OD matrix, the load of traffic network can be seen in Figure 3 below.

![Image](image1.png)

**Figure 2. Matrix Data in Each Connected Zone**

![Image](image2.png)

**Figure 3. The Load of Traffic Network Based on OD Matrix**

According to Figure 3, this research designed shorter route for JORR as figure 4 below. The proposal route of this research had less distance around 17 km since the length of JORR route based on government is 72.2 km while the other alternative approximately 55.3 km. Therefore, the comparison of V/C results in 2026 through 3 different methods that were presented in Table 2 and the comparison of speed results in 2026 through 3 different methods is presented in Table 3 as follows.

Regarding with Table 1, almost all streets in 2026, without the construction of JORR, were on congestion since the value of V/C was more than 0.85. Therefore, with the construction of the planning routes from the government, there were raising performance at Jogja-Solo St and Magelang St because of the lower
V/C (volume/capacity) ratio around 10%. On the other hand, with the alternatives plan, the road performance could increase around 50% at Jogja-Solo St even though it makes worse comparison between volume and capacity at Kaliurang St and Palagan St. As the sample of calculation, based on equation (1) at Kaliurang street at existing condition without JORR, as follows.

Volume at 2026 is 2,694 pcu/h (based on exponential growth of secondary data from DoT, 2018)  
Capacity is 3,494 pcu/hr (based on secondary data from DoT, 2018)  
\[ V/C \text{ ratio } = \frac{2,694}{3,494} = 0.7712 \]

Even though the comparison for speed as the level of traffic performance in Table 2 was not complete since some data were not available during to the figure of the speed from Directorate General Bina Marga (DGBM), MoPW of Indonesia, 1997, the construction of JORR can raise the speed in some locations, such as Magelang St and Kaliurang St. As the sample of calculation based on equation (2) at Kaliurang street, at existing condition without JORR as follows. Basic free-flow speed and adjustment factors were based on DGBM, MoPW of Indonesia, 1997, depends on the characteristics of the road.

\[ FV = (FV_0 + FV_w) \times FHV_{SF} \times FHV_{CS} \]
\[ = (44 + 0) \times 0.79 \times 1 \]
\[ = 37.76 \text{ km/h} \]

From the free flow speed and V/C ratio at previous calculation, the speed at Kaliurang St were 23 km/h, based on the figure of the correlation between V/C and FV of DGBM, 1997

![Figure 4. Planning Route from Government (red line) and Alternative Planning Route (yellow line)](image)

**Table 1. The Comparison of V/C Results in 2026**

| No | Road                  | Direction | Capacity (pcu/h) | Without JORR | With JORR of Government Route | V/C at 2026 | Difference | With JORR of Alternative Route | V/C at 2026 | Difference |
|----|-----------------------|-----------|-----------------|--------------|------------------------------|-------------|-----------|-------------------------------|-------------|-----------|
| 1  | Jogja-Solo St (in front of Kalasan District) | East      | 3,953           | 1.02         | 0.93                         | -9.00%      | 0.39      | -60.87%                       |             |           |
|    |                       | West      | 3,953           | 1.50         | 1.22                         | -6.51%      | 0.66      | -49.29%                       |             |           |
| 2  | Kaliurang St (in front of PLN)               |           | 3,494           | 0.77         | 0.87                         | 13.82%      | 1.39      | 81.42%                        |             |           |
Table 2. The Comparison of Speed Results in 2026

| No | Road                          | Direction | Without JORR | With JORR of Government Route (km/h) | With JORR of Alternative Route (km/h) |
|----|-------------------------------|-----------|--------------|--------------------------------------|--------------------------------------|
| 1  | Jogja-Solo St (in front of Kalasan District) | East      | N/A          | 3.25                                 | 4.6                                  |
|    |                               | West      | N/A          | 25                                   | 42                                   |
| 2  | Kaliurang St (in front of PLN) |           | N/A          | 23                                   | N/A                                  |
| 3  | Palagan Tentara St (in front of Hyatt Hotel) |           | N/A          | 32                                   | N/A                                  |
| 4  | Magelang St (in front of Wahidin Court) | North     | N/A          | 34                                   | 34                                   |
|    |                               | South     | N/A          | 34                                   | N/A                                  |

In 2026, the best achievement without JORR, based on V/C ratio, was at Kaliurang St with less than 0.80 since the traffic volume was lower than others even the capacity was the lowest. In comparison, Jogja-Solo St with higher capacity had lower V/C ratio than Kaliurang St due to greater number of vehicles.

Also, from the figure 5 about V/C ratio of arterial roads at Jogjakarta, the construction of JORR will decreasing the traffic congestion in some street with median/ divided such as at Jogja Solo St and Magelang St. On the other side, at undivided road, like Kaliurang ST and Palagan Tentara Pelajar St, the performance seems worse with JORR since there were higher value of V/C.

On the contrary, with better V/C ratio, the speed of LV at both streets (such as Kaliurang St and Jogja-Solo St) in the opposite conditions. Particularly, this common happen at different types of the streets with contrast adjustment factors.

Therefore, regarding the results of the study, some suggestions are proposed as the push factor to pull down private vehicle usage, such as traffic management to set up on the 4 target main roads, like...
disallowance for parking and stipulation of one-way scheme. In addition, the actualization of public transportation maintenance is very necessary as the pull factor to reduce number of private vehicles since there were 'Trans Jogja Bus' as the modern system of public transportation.

Whilst there can be little doubt that a wide range of factors influences the demand for public transport, and there was plenty of empirical evidence as to what the relevant factors are, and which of them may be more important than others, in different circumstances, it must always be recognized that the results may be subject to a considerable degree of uncertainty. One of the problems encountered during the study was in determining the context under which some of the reported experiments and studies had been conducted. This was especially marked regarding separating short and long-run effects. This whole issue would benefit from further investigation, particularly to ascertain whether attribute valuations refer to the short- or the long run (Paulley et al., 2006). Also, runs that change time and cost affect destination choice more than mode choice, and tour frequencies. The changes in the input variables performed here (of which income and car ownership are the most important) affect tour frequency and mode choice more than destination choice, and therefore lead to broadly similar effects in terms of tours and kilometers (de Jong et al., 2007).

5 CONCLUSIONS

Based on the analysis, there will be many congestions at Yogyakarta without the construction of JORR in 2026. As the shreds of evidence is the high value of V/C ratio as speed as follows: Jogja Solo St (in front of Kalasan District) with V/C ratio of 1.02 to the east and 1.30 to the west; on Kaliurang St (in front of State Electricity Company) with V/C ratio of 0.77 and low speed at 23 km/hour; on Palagan Tentara Pelajar St (in front of Hyatt Hotel) with V/C ratio of 1.20; and on Magelang St (in front of Wahidin Court) with V/C ratio of 0.82 to the north and 1.32 to the south.

The application of JORR at some locations in Yogyakarta expressed raising conditions with the decreasing of V/C ratio and higher speed in some locations. Nevertheless, the improvement of JORR route with government proposal can increase the speed but not as much as the route of alternative proposal. On the other hand, in Kaliurang St, using the alternative route of JORR makes the performance were much lower than the route of the government.

Finally, a solution could not stand alone. It needs integrated traffic management with push and pull factor of private vehicle, thus could knock down number of vehicles, such as traffic management to set up on the 4 target main roads (in this research location), like disallowance for parking and stipulation of one-way scheme and the actualization of public transportation. Further research on JORR construction in the south is necessary to be conducted for a better and deeper overview and illustration upon Yogyakarta main roads like the effect of safety. Even though new arterial roads will induce more traffic, the advantage is worthful since the rate of accidents could be decreased. (Amundsen and Elvik, 2004).

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