The Influence of Yogyakarta 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 jam. The ring road has occupied the existing road with the 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 roads, i.e. Solo-Jogja road, Kaliurang road, Magelang road, and Palagan Tentara Pelajar road, set as the objects of comparison to JORR, which was analyzed three probabilities, namely 1) not actualized, 2) actualized, and 3) actualized with alternate road. Alluding to this study, the V/C ratio of Solo-Jogja road in front of the eastern part of Kalasan district 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 decrease of 6.55% if JORR was actualized and 49.42% if JORR was actualized with alternate road. In Kaliurang road in front of the State Electricity Company (PLN), there increased 13.64% if JORR was actualized and 81.13% was actualized with alternate road. In Palagan Tentara Pelajar road, in front of Hyatt Hotel, there was increase of 48.74% if JORR was actualized and 41.88% if JORR was actualized with alternate road. In Magelang, in front of Wahidin Court to the north, there happened decrease of 6.31% if JORR was actualized and increase of 8.70% if JORR was actualized with alternate road. At southern part, there was decrease of 16.25% if JORR was actualized and 5.27% if JORR was actualized with alternate road.

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

INTRODUCTION

Yogyakarta has been one of so famed tourism destinations in Indonesia that many tourists have a visit in order to enjoy the culture and or the scenic panorama. In addition, there are so many schools and higher education institutions by which many students from out of the town are attracted to study. This occurrence causes population explosion which brings about consequence of increase in number of private vehicle ownership in 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. 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.

For that reason, the government has offered a solution for the traffic jams by building an outer ring road of Yogyakarta, or named as Jogja Outer Ring Road (JORR). The construction of JORR occupies the existing roads with an extra extension of 7 meters to seize 14 meters. Further, it is estimated that the total length of road used constitutes 72.2 kilometers. This project is foreseen 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. Prior to its construction, there had been conducted an analysis on the environmental damage in 2018, followed by Detail Engineering Design (DED) in 2019. In 2020, land acquisition is prearranged to be executed in order to actualize the construction in 2021 in spite of the incomplete arrangement of Detail Engineering Design (DED). It is due to the fact that the government and related institutions are still being concerned on finishing Keuntungan and Yogyakarta International Airport underpasses. The project of JORR construction is estimated to finish within 5-6 years and is supposed to decrease the traffic density in Yogyakarta main road.

After stipulating the target road for outer ring road construction, a transportation modelling is necessary to investigate the transformation in travel movements by means of PTV VISUM software. 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 modelling 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.

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

Referring to a study carried out by Hendra (2017) about the evaluation on ring road construction in Banda Aceh, the study was based on the regional development and the level of population mobility in Banda Aceh which were assumed as the main causes of traffic jam. The study, moreover, was modelled using PTV VISUM 15 and yielded two scenarios: 1) suppose the outer ring road of Banda Aceh be constructed, V/C ratio of existing roads decreases up to 9% in 2031 and 9.6% in 2026. In addition, Praditya (2016) made a similar study in the form of transportation modelling for motorcycle in Samarinda City by means of PTV VISUM 15 software. With reference to the study, it was shown that the number of trip generation ranged between 4,720 – 89,492 motorcycles/hour. Meanwhile, the number of traffic flows occurring in Samarinda city ranged between 1,463 – 6,875 motorcycles/hour. Masarrang (2015) carried out a study about traffic performance on the rush hour in Wolter Mongindisi road, Manado under the existing and 10 years later conditions. The study indicated the V/C ratio of Malalayang signifying 0.6825 in existing condition and 0.9401 in 10 years later. Furthermore, around Pasar 45, the ratio signified 0.7325 in existing condition and 1.009 in 10 years later.

Moreover, Ambroziak (2014) analyzed the traffic flow distribution in terms through identification on the areas with the highest level of pollution in Wroclaw, Poland using PTV VISUM. The research aim was to show how traffic volume decreased due to possibility of functioning train as alternative transportation mode. In the first variance, a group of passengers who entered and left Wroclaw were distributed on the road network. Whilst, the second variance gave an access to another group of passengers to road and rail transportation. An analysis on those two variances had shown that the transfer of the traffic flow to the rail network resulted in decrease in the share of road transportation for the actualization of total transportation demands. Golda (2017) dealt with selected aspects of developing a sustainable transportation system and of assessing them based on their negative impacts on society (regarding pollution and noise emissions). This analysis was subjected to assess the impacts of changes in the state of infrastructure and traffic volumes upon the harmful level of emissions. These research results indicated that the infrastructure development had contributed to reducing pollution in the 2020 scenario compared to that of in 2015. Kontelj (2014) had analyzed how investments in the railway infrastructure influenced the whole railway system in Slovenia. This paper advocated three alternatives. The first alternative was modernization on the existing railway in Divača – Koper with the cost of EUR 541 million. The second alternative was the first alternative with an extra construction of the new railway line in Divača – Koper in need of completion by the year of 2020 with the cost of EUR 5,948 million. The last alternative was the second alternative with a new double-track line in Ljubljana – Divača in need of completion by the year of 2030 with the cost of EUR 10,704 million. The results had indicated that implementing the second alternative was of greater profit with the benefit-cost ratio of 0.41 in comparison to that of in the third alternative that indicated 0.29.

Grigonis (2014) tried to model the traffic in Vilnius City during the morning peak in the hypothetical year of 2025 with various scenarios. The first scenario was executed when there was no tram and BRT development that made an average flow speed of 35.24 km/h in 2025. The second scenario was run with a new tram corridor of the Santariskės–Stoties Square and BRT development without any road reconstruction that made an average flow speed of 37.82 km/h in 2025. The third scenario was the re-execution of the second scenario with a road reconstruction that made an average flow speed of 38.16 km/h in 2025. And, the last scenario was re-implementation of the third scenario with one-way traffic that made an average flow speed of 38.03 km/h in 2025. Furthermore, Yatskiv (2010) analyzed the Riga-Mink transportation corridor, an important arterial road to link between Latvia and the Republic of Byelorussia, using PTV VISUM simulation software. The first scenario showed the capacity of some parts of a transportation corridor making an average speed of 11 km/h and the second scenario was a re-modification of the first scenario with the only track to Byelorussia control checkpoint that made an average speed of 6 km/h. Savrasov (2007) analyzed the effectiveness of reconstruction of Karosta Bridge over Karosta channel, alternate street construction for Brivibas Street from Riga, new bridge construction and using Ganibu and Zirmu Streets as one-way movement street in Liepaja.
City, Latvia. According to research, all scenarios would be effective with the volume of traffic on the new bridge over the railroad signifying 1400 cars on one side and 850 cars on the other side. In fact, one-way roads were acceptable with V/C ratio decrease from 110% to 90%. Arliansyah (2017) a traffic modelling in Palembang executed in 2022 used to have 4 connecting bridges before Ampera Bridge was constructed in 2017. Based on the analysis made in 2016, the existing Ampera Bridge could no longer able to serve the traffic movement with the percentage of 2.23% and the traffic volume of 11,237 PCE/h.

2 ROAD PERFORMANCE

According to the Directorate General of Bina Marga (1997), road performance refers to a quantitative measure to define the operational condition of road which covers density or percent time delay.

2.1 Traffic Volume

According to Sukirman (1994) traffic volume is defined as the number of vehicles passing through a point or spot the cross section of road. The data of traffic volume enumeration refer to any information needed to define plan, design, management and operation of daily traffic road in average. In other words, it can be referred to an average traffic volume in a day.

$$\text{AADT} = \frac{\text{Average Annual Daily Traffic}}{365}$$

AADT (Annual Average Daily Traffic) is the quotient of the perceived number of vehicles during observation and the length of observation.

$$\text{ADT} = \frac{\text{The number of vehicles during observation}}{\text{The length of observation}}$$

2.2 City Road Capacity

According to Sukirman (1994), 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. For two-way roads, the capacity depends on the two-way flows. Meanwhile, for multi-lane roads, the flows should be separated into specific direction, and the capacity will be defined based on each of the lanes. The capacity value is made based on the data collected from the field. In respect of unit, capacity is stated into ‘passenger car equivalent’ (PCE) or ‘passenger car unit’ (PCU).

$$C = C_0 \times FC_w \times FC_{SP} \times FC_{SF} \times FC_{CS}$$

Descriptions:

- $C$ = Capacity
- $C_0$ = Basic capacity (PCE/h)
- $FC_w$ = Factor of width adjustment of traffic road
- $FC_{SP}$ = Factor of separation adjustment of direction
- $FC_{SF}$ = Factor of side barrier adjustment
- $FC_{CS}$ = Factor of city size adjustment

2.3 Free-Flow Speed (Fv)

According to Hobbs (1995), speed is defined as a rate of movement shown by the vehicles which is calculated from the distance reached per unit of time (km/h). Meanwhile, 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 the drivers intend to reach when driving their vehicles without any interference from other drivers in roads.

$$FV = (FV_0 + FV_w) \times FFV_{SF} \times FFV_{CS}$$
Description:
\(FV\) = Free-flow speed of light vehicle under the field conditions (km/h)
\(FV_0\) = Basic free-flow speed (km/h)
\(FV_w\) = Factor of speed adjustment for traffic road width (km/h)
\(FFV_{SF}\) = Factor of speed adjustment for side barriers
\(FFV_{CS}\) = Factor of speed adjustment for city size

2.4 Volume Capacity Ratio
Volume capacity ratio constitutes a comparison between the vehicle volume to pass through the road within a period of time, with remaining space for other vehicles within particular range of time. The greater the comparison is, the poorer the traffic service will be.

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

Description:
\(V/C\) ratio = Volume capacity ratio
\(V\) = Traffic volume (PCE/h)
\(C\) = Road capacity (PCE/h)

3 Origin-Destination Matrix
According to Miro (2005), it is explained that origin-destination matrix refers to a moving pattern in the transportation system (of vehicles, passengers, and goods) that shows a movement from the origin point to the specific destination within particular areas and for a period of time. The origin-destination matrix can illustrate the moving pattern of an observed system with diverse sizes, such as the moving pattern of vehicles that occurs in intersections and the one in urban areas within a particular country.

Table 1. Origin-Destination Matrix

<table>
<thead>
<tr>
<th>Zona</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>.....</th>
<th>N</th>
<th>( O_i )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>( T_{11} )</td>
<td>( T_{12} )</td>
<td>( T_{13} )</td>
<td>.....</td>
<td>( T_{1N} )</td>
<td>( O_1 )</td>
</tr>
<tr>
<td>2</td>
<td>( T_{21} )</td>
<td>( T_{22} )</td>
<td>( T_{23} )</td>
<td>.....</td>
<td>( T_{2N} )</td>
<td>( O_2 )</td>
</tr>
<tr>
<td>3</td>
<td>( T_{31} )</td>
<td>( T_{32} )</td>
<td>( T_{33} )</td>
<td>.....</td>
<td>( T_{3N} )</td>
<td>( O_3 )</td>
</tr>
<tr>
<td>.....</td>
<td>.....</td>
<td>.....</td>
<td>.....</td>
<td>.....</td>
<td>.....</td>
<td>.....</td>
</tr>
<tr>
<td>N</td>
<td>( T_{N1} )</td>
<td>( T_{N2} )</td>
<td>( T_{N3} )</td>
<td>.....</td>
<td>( T_{NN} )</td>
<td>( O_N )</td>
</tr>
<tr>
<td>Dd</td>
<td>( D_1 )</td>
<td>( D_2 )</td>
<td>( D_3 )</td>
<td>.....</td>
<td>( D_N )</td>
<td>( T )</td>
</tr>
</tbody>
</table>

Description:
\( T_{id} \) = The movement from origin point \( i \) to destination \( d \)
\( O_i \) = The number of movements from zone \( i \)
\( D_d \) = The number of movements to zone \( d \)
\( \{ T_{id} \} \) = Matrix in total
\( N \) = The number of zones

4 TRIP PRODUCTION AND TRIP ATTRACTION
This model can be used to interrelate the number of movements heading to or leaving the destination on the basis of 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 model a relationship between two variables or more, consisting of independent (x) and dependent (y) variables.
5 UNCONstrained GRAVITY METHOD

In origin-destination matrix, the number of prospective trips can be conjectured based on the current data and the factor of traffic flow growth. In this research, gravity method was applied, 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 aspect of accessibility as function of distance, time, and cost (Tamin, 1997). In gravity method, the following formula is used.

\[ T_{id} = A_i \times O_i \times B_d \times D_d \times f(C_{id}) \]

Description:
- \( T_{id} \): The prospective movement from origin zone \( i \) to destination
- \( A_i \): Factor of production counterweight
- \( B_d \): Factor of attraction counterweight
- \( O_i \): The number of productions in zone \( i \)
- \( D_d \): The number of attractions in zone \( d \)
- \( f(C_{id}) \): Function of barrier

In unconstrained gravity model, only one limitation is found, which is that a total of movements produced should be equal to a total of movements that have been, in advance, predicted in the phase of trip production. This model is unlimited, which means that it does not require that the movement value in each zone be in level with that of predicted in production phase. Therefore, the unconstrained gravity model denotes:

- \( A_i = 1 \) for the entire production \((i)\)
- \( B_d = 1 \) for the entire attraction \((d)\)

The function of exponential-negative barrier refers to a measure of accessibility between \( i \) and \( d \) zones. The accessibility occupied within this function of barrier covers distance, time, and cost. To seek the value of exponential-negative barrier, the following equation is applied.

\[
B = \frac{N \sum_{i=1}^{N} (X_i Y_i) - \left( \sum_{i=1}^{N} X_i \right) \left( \sum_{i=1}^{N} Y_i \right)}{N \sum_{i=1}^{N} X_i^2 - \left( \sum_{i=1}^{N} X_i \right)^2}
\]

\[
A = \bar{Y} - B \bar{X}
\]

\[
\beta = -B
\]

Matrix \( \exp(-\beta C_{id}) = \exp(-\beta C_{id}) \)

Description:
- \( A \): Factor of production counterweight
- \( B \): Factor of attraction counterweight
- \( N \): The number of data
- \( C_{id} \): accessibility (distance, time, and cost)
- \( X_i \): \( \log_e(C_{id}) \)
- \( T_{id} \): The value of movement in each zone
- \( Y_i \): \( \log_e(T_{id}) \)
- \( \bar{Y} \): The mean \( Y_i \)
- \( \bar{X} \): The mean \( X_i \)

6 PTV VISUM SOFTWARE

PTV VISUM is a kind of software in civil engineering for transportation subject developed by PTV Group based in Germany. The main utility of PTV VISUM lies on its basic capability of designing a model for transportation issue
in macro. Further, 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.

**7 RESEARCH METHOD**

7.1 Location
Alluding to the design of JORR, the research took place at the main roads of Yogyakarta, to name:
1. Solo-Yogyakarta road to cover that of in front of Kalasan district;
2. Kaliurang road to cover that of in front of the State Electricity Company;
3. Palagan Tentara road to cover that of in front of Hyatt Hotel; and
4. Magelang road to cover that of in front of Wahidin Court.

7.2 Data
The data used for the research constituted the secondary data collected from the institutions that involved, i.e. data of traffic volumes, data of road capacities, data of speed, data of origin-destination matrix (OD matrix) that were shown on Yogyakarta main road collected from Department of Transportation of The Special Region of Yogyakarta and data of population, data of vehicles ownership, data of Gross Regional Domestic Product of Sleman Regency, Data of the number of companies in Sleman Regency, Data of the number of schools in Sleman Regency that were collected from Central Bureau of Statistics.

**ANALYSIS AND DISCUSSION**

Figure 1. The Proposal of JORR in Yogyakarta

The government plan of JORR starts from Solo-Jogia road, turning to the north to Candi Cangkringan road, turning left to Selomartani roadway, and turning right to Tajem roadway. From Tajem roadway turning left to Umbul Pajangan road, going straightforward to Krapyak roadway, continued to Kaliurang Timur road to end at Kaliurang main road. From Kaliurang main road, the route continues to Kapten Haryadi road heading to Palagan Tentara Pelajar main road. Afterwards, the route is continued to Gito-Gati road straightforward to Magelang main road. From Magelang main road, the route continues and goes past Krt Pringgodani road, turning left to Purbaya road. From Purbaya road, the route is turned to Kebon Agung road, turning left to Gedongan-Tempel road which ends at Godean road.
Under the actualized condition with alternative JORR, it is of probability to construct the route from Solo-Jogja road, turning to the north to Candi Sambisari road, turning left to Kadisoka road, and turning right to Tajem roadway. From Tajem roadway, the route follows that of the outer ring road under planning, turning left to Umbul Pajangan road, going straightforward to Krupyak roadway, continued to Kaliurang Timur road to end at Kaliurang main road. From Kaliurang main road, the route continues to Kapten Haryadi road heading to Palagan Tentara Pelajar main road. Afterwards, the route is continued to Gito-Gati road straightforward to Magelang main road. From Magelang main road, the route continues and goes past Krt Pringgodani road, turning left to Sambisari road and continued to Kabupaten road. From Kabupaten road, the route is turned to Kebon Agung road, turning left to Sidomoyo road which ends at Godean road. The comparison of V/C results in 2026 through 3 different method is presented in Table 2 and the comparison of speed results in 2026 through 3 different method is presented in Table 3 as follows.

Table 2. The Comparison of V/C Results in 2026

<table>
<thead>
<tr>
<th>No</th>
<th>Road</th>
<th>Direction</th>
<th>The Existing V/C 2026</th>
<th>The Prospective, with JORR V/C 2026</th>
<th>Alternative Outer Ring Road Plans V/C 2026</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jl. Solo (in front of Kalasan District)</td>
<td>East</td>
<td>1,02</td>
<td>0,9282</td>
<td>0,3991</td>
</tr>
<tr>
<td></td>
<td></td>
<td>West</td>
<td>1,30</td>
<td>1,218</td>
<td>0,6592</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-9,00%</td>
<td>-60,87%</td>
</tr>
<tr>
<td>2</td>
<td>Jl. Kaliurang (in front of PLN)</td>
<td>North</td>
<td>0,77</td>
<td>0,8764</td>
<td>1,3969</td>
</tr>
<tr>
<td></td>
<td></td>
<td>South</td>
<td>1,20</td>
<td>1,784</td>
<td>1,7017</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13,82%</td>
<td>48,67%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4,86%</td>
<td>41,81%</td>
</tr>
<tr>
<td>3</td>
<td>Jl. Palagan Tentara (in front of Hyatt Hotel)</td>
<td>North</td>
<td>0,82</td>
<td>0,772</td>
<td>0,8957</td>
</tr>
<tr>
<td></td>
<td></td>
<td>South</td>
<td>1,32</td>
<td>1,1049</td>
<td>1,2497</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-16,30%</td>
<td>-5,33%</td>
</tr>
</tbody>
</table>

Table 3. The Comparison of Speed Results in 2026

<table>
<thead>
<tr>
<th>No</th>
<th>Road</th>
<th>Direction</th>
<th>The Existing Speed (km/h) of 2026</th>
<th>Prospective, with JORR Speed (km/h)</th>
<th>Alternative Outer Ring Road Plans Speed (km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jl. Solo (in front of Kalasan District)</td>
<td>East</td>
<td>-</td>
<td>36,5</td>
<td>47,5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>West</td>
<td>-</td>
<td>-</td>
<td>43</td>
</tr>
<tr>
<td>2</td>
<td>Jl. Kaliurang (in front of PLN)</td>
<td>North</td>
<td>23</td>
<td>32</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>South</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Jl. Palagan Tentara (in front of Hyatt Hotel)</td>
<td>North</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>South</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Jl. Magelang (in front of Lapangan Wahidin)</td>
<td>North</td>
<td>34</td>
<td>38</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td></td>
<td>South</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

The comparison of V/C ratio in 2026 under three possibilities, i.e. not actualized, actualized, and actualized with alternative road is presented in the following graphic.
CONCLUSIONS

Referring to the purposes of this study, some points are concluded.

1. Under the existing (not actualized) condition in 2026, Yogyakarta main roads had elevated, such as: on Solo road (in front of Kalasan District) with V/C ratio of 1.02 to the east and 1.30 to the west; on Kaliurang road (in front of State Electricity Company) with V/C ratio of 0.77; on Palagan Tentara Pelajar road (in front of Hyatt Hotel) with V/C ratio of 1.20; and on Magelang road (in front of Wahidin Court) with V/C ratio of 0.82 to the north and 1.32 to the south.

2. Under the actualized condition of JORR in 2026, the main roads had increased higher than that of in 2017, but had decreased lower than that of in not-actualized condition of JORR, covering: on Solo road (in front of Kalasan District) with V/C ratio of 0.9282 to the east and 1.218 to the west; on Kaliurang road (in front of State Electricity Company) with V/C ratio of 0.8764; on Palagan Tentara Pelajar road (in front of Hyatt Hotel) with V/C ratio of 1.784; and on Magelang road (in front of Wahidin Court) with V/C ratio of 0.772 to the north and 1.1049 to the south.

3. Under the actualized condition with alternative JORR, it is of probability to construct the route from Solo-Jogja road, turning to the north to Candi Sambisari road, turning left to Kadisoka road, and turning right to Tajem roadway. From Tajem roadway, the route follows that of the outer ring road under planning, turning left to Umbul Pajangan road, going straightforward to Krupyak roadway, continued to Kaliurang Timur road to end at Kaliurang main road. From Kaliurang main road, the route continues to Kapten Haryadi road heading to Palagan Tentara Pelajar main road. Afterwards, the route is continued to Gito-Gati road straightforward to Magelang main road. From Magelang main road, the route continues and goes past Krt Pringgodani road, turning left to Sambisari road and continued to Kabupaten road. From Kabupaten road, the route is turned to Kebon Agung road, turning left to Sidomoyo road which ends at Godean road.

4. Under the actualized condition with alternative JORR in 2026, there are found some decreases, lower than that of in not-actualized condition of JORR. It is shown that on Solo road (in front of Kalasan District), the V/C ratio is 0.3991 to the east and 0.6592 to the west; on Kaliurang road (in front of State Electricity Company), the V/C ratio constitutes 1.3969; on Palagan Tentara Pelajar road (in front of Hyatt Hotel), the V/C ratio signifies 1.7017; and on Magelang road (in front of Wahidin Court), the V/C ratio indicates 0.8957 to the north and 1.2497 to the south.
CONCLUSIONS

Regarding the results of the study, some suggestions are proposed as follows.

1. Traffic management is necessary to set up on the 4 target main roads, such as disallowance to for parking and stipulation of one-way scheme.
2. Public transportation maintenance is in need of actualization in order to lessen the number of private vehicles occupied.
3. 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.

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