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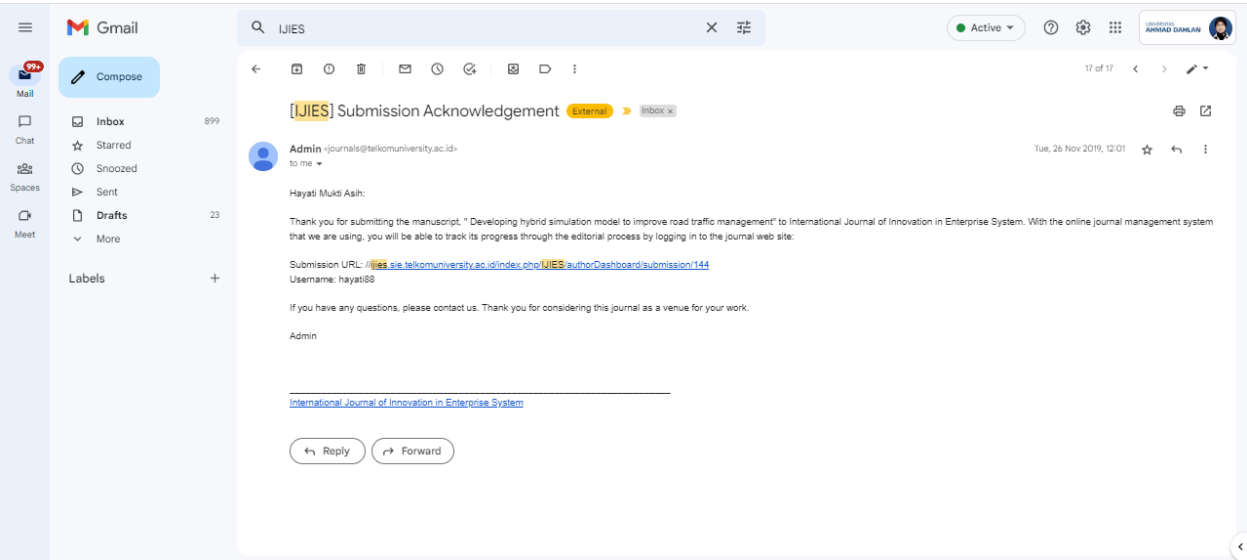

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Developing hybrid simulation model to improve road traffic management

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ABSTRACT IN ENGLISH

Yogyakarta has increasing trends in the number of vehicles and consequently intensifying the traffic volume and will effect to higher emission and air pollution. Traffic lights duration plays a vital role in congestion mitigation in the critical intersections of urban areas. This study has objective to minimize the number of vehicles waiting in line by developing the hybrid simulation method. First of all, the MKJI (Manual Kapasitas Jalan Indonesia) and Webster method were calculated to determine the green traffic light. Then, the simulation model was developed to evaluate the number of vehicles waiting in line according to different duration of green traffic lights from MKJI and Webster method. A case study will then be provided in Pelemgurih intersection located in Yogyakarta, Indonesia for demonstrating the applicability of the developed method. The result shows that the duration of green traffic lights calculated by Webster method provides lower number of vehicles waiting in line. It is due to the short duration of green traffic light resulted by Webster method so that the traffic light cycle becomes shorter and it effects the number of vehicles waiting in line which is lower than MKJI method. The results obtained can help the generating desired decision alternatives that will important for Department of Transportation, Indonesia to enhance the road traffic management with low number of vehicles waiting in line.

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1. Introduction

Yogyakarta is one of the most crowded city in Indonesia. It is known as tourist city and educational city. There are many local and foreign tourist and also student who interested come to this city in each year. It results in high congestion in some intersections around Yogyakarta. High congestion has bad impact on time, money, and air pollution as well. According to annually evaluation from Department of Transportation of Yogyakarta on 2018[1], there are average delay in some crowded intersections in Yogyakarta as presented in Fig. 1. It can be seen that Pelemgurih intersection has the highest average delay compare to others. It is caused by it connects the south ring road and the west ring road. It is also national road with environmental type is commercial which means many sales around. In addition, this intersection is one of the main ways for many workers pass this way which makes this intersection more crowded and road traffic management become challenging.

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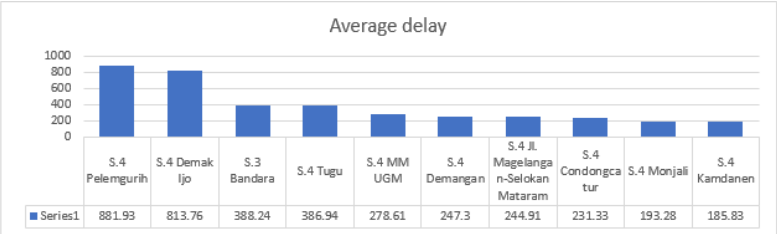

Fig. 1 – Average delay in intersection in Yogyakarta[1]

Pelemgurih intersection has four sections of road, there are Patukan road (red line) on the west, Yogyakarta-Wates road (blue line) on the east, North Siliwangi road (orange line) on the north, and South Siliwangi road (green line) on the south. It is as shown in Fig. 2. In defining the direction of each road, there are the dash line which means the vehicles must follow the traffic light, and the straight line which means the vehicle must go ahead, not follow the traffic light. For instance, it can be seen the direction from Yogyakarta-Wates road to South Siliwangi road must turn left directly, even the traffic light is red.

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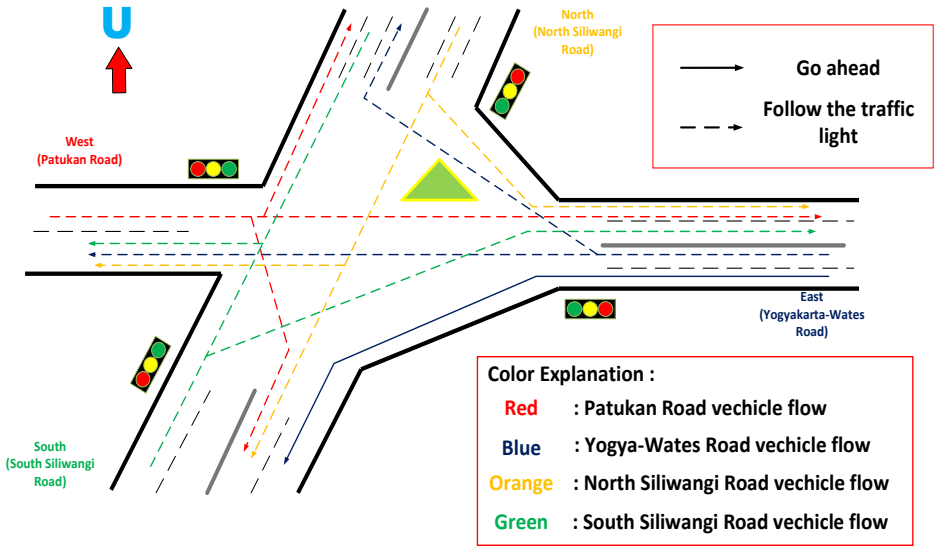

Fig. 2 – Pelemgurih intersection

The preliminary study was conducted to understand the characteristics of the system by doing initial observation. The observation is divided by three periods, i.e. morning (06.00 am – 08.00 am), noon (11.00 am – 13.00 pm), and afternoon (15.30 pm – 17.30 pm). The initial observation was conducted on weekdays (Monday to Friday) and weekend (Saturday and Sunday). In addition, this research concerns on motorcycle (MC), low vehicle (LV) which includes car, and high vehicle (HV) which includes truck and bus. The results of this initial observation was the number of vehicle on the weekdays in the morning and in the afternoon has significantly higher than on weekend (refer to Fig. 3). The main reason is many workers pass this intersection which makes the system more complicated. Hence, this research would focus on the weekdays in the morning and in the afternoon.

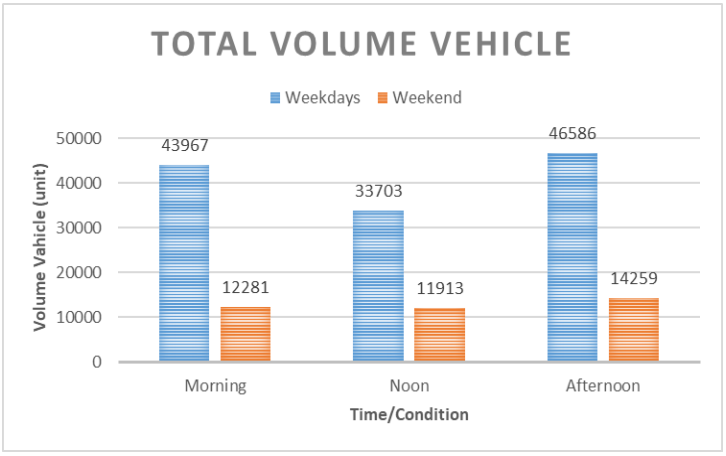

Fig. 2 – Total volume vehicle on weekdays and weekend

The higher number of vehicles waiting in line in a traffic light will effect to higher emission and air pollution. In addition, a bad road traffic management will effect to higher number of accidents. Therefore, road traffic management must be planned efficiently and effectively in order to minimize the risk of accidents and environmental impacts [2].

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This research developed hybrid simulation method with the objective is to minimize the number of vehicles waiting in lines. First of all, MKJI ("Manual Kapasitas Jalan Indonesia") and Webster method were developed to determine the duration of green light accordance with the geometric, the condition of the intersection, capacity of the road, etc. Then, the simulation model was developed to evaluate the number of vehicles waiting in lines. Finally, the least amount of vehicles waiting in line was chosen. A case study will then be provided in Pelemgurih intersection located in Yogyakarta, Indonesia for demonstrating the applicability of the developed method. The results obtained can help the generating desired decision alternatives that will important for Department of Transportation, Indonesia to enhance the road traffic management with low number of vehicles waiting in line.

The remainder of the present paper is organized as follows. Section 2 reviews the theoretical framework. Section 3 described the proposed methodology. Section 4 presents the results and discussion. Finally, section 5 concludes with a discussion of further research direction.

2. Theoretical Framework

There are previous papers that were discussed about road traffic management. Kamran et al. [3] developed simulation modeling using Arena Simulation Software to determine the traffic light timing. There were several scenarios were proposed and the minimum average time spent in the system was chosen. Then, Tama et al. [2] also developed several scenarios based on various traffic light duration by using simulation model. The objective was to find the scenario that has shorter vehicle queue on the junction. In addition, Rahman [4] developed simulation model by using Vissim 8 program and MKJI method by changing the duration of traffic light, road widening, and improvement on the road geometric. The result showed the decreases on queue length, queue length maximum, and the number of vehicles stop. Next, Prihati [5] developed simulation model by using Arena simulation software to minimize the waiting time in account payment counter. Next, Yunata [6] also proposed Arena to simulate Simpang Empat Pontianak in order to number of vehicles waiting and waiting time could be reduced. In a comprehensive study of road traffic management, Harahap et al. [7] proposed a traffic simulation system, called by LINTAS using the SimEvents toolbox and runs on MATLAB-Simulink software to minimize the average queue length.

Compare to another researches that develop simulation model for road traffic management, Fauzi et al. [8] developed Webster and Greenshield method to determine the green and red traffic light in Bandar Kidul intersection, Kediri, Indonesia. In a study conducted by Pornamasari et al. [9], it was shown that Webster method was proposed to calculate optimum cycle time in Babe Palar street intersection.

This study set out to critically examine the ways in managing road traffic. The significant findings from previous researches is to calculate the green traffic light mostly using simulation model, MKJI and Webster method separately. Therefore, this research develops the hybrid simulation model by integrating simulation model, MKJI and Webster method to calculate the green traffic light more accurate. This study has objective to minimize the number of vehicles waiting in line.

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3. Methodology

This research was conducted based on Pelemgurih intersection in Yogyakarta. It focuses on the weekdays in the morning and afternoon as this intersection as one of the main ways for people leave and go to work so that it has higher congestion. To minimize the congestion, the hybrid simulation was developed. First of all, the problem was identified and then the objective was proposed. Next, the data was collected such as inter arrival time, the velocity of vehicles, current traffic light duration, intersection geometry data, set up vehicles data, etc. Then, the experimental design 1 was calculated using MKJI and Webster method to provide the duration of green traffic lights. After that, the simulation model was developed to evaluate the number of vehicles waiting in line according to different duration of green lights from MKJI and Webster method as the experimental design 2. Finally, the duration of green traffic light with minimum number of vehicles waiting in line was chosen. It can be shown in Fig. 3.

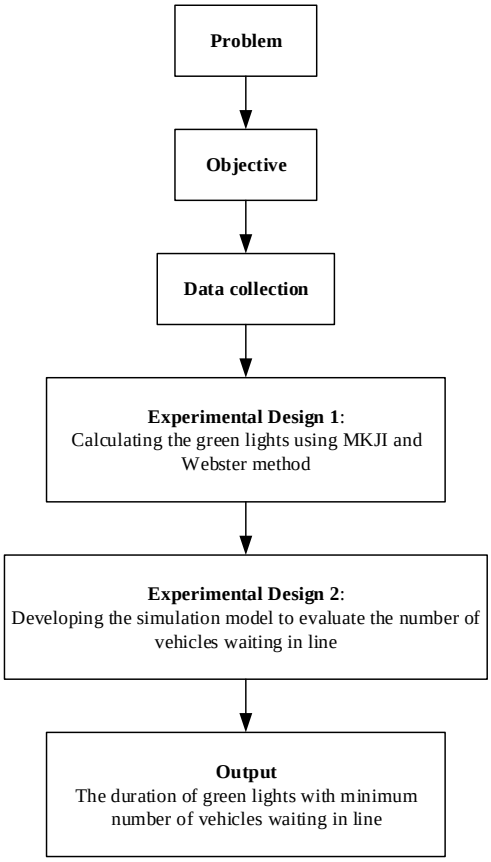

Fig. 3 – Research design

3.1 MKJI and Webster method

MKJI (Manual Kapasitas Jalan Indonesia) method was developed on 1997 to determine the duration of green traffic light [10]. On the other hand, Webster was developed on 1960s by F.V. Webster [9]. F. V. Webster developed an equation to calculate the average delay in driving when approaching an intersection and also derived an equation to obtain the optimum cycle time that results in minimum vehicle delays. Vehicle delays occur because the number of vehicles entering a junction is greater than the number of vehicles leaving the intersection. In calculating the duration of green traffic light, MKJI method considers intersection environmental conditions, but Webster method does not.

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Webster

a. Arus Jenuh

$$s = 525 \times w \text{ smp/jam} \qquad (2.1)$$

dimana:

s = Arus jenuh

w = Lebar lajur dalam meter

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b. tingkat arus lalu lintas jalan

$$y = \frac{q}{s} \quad (2.2)$$

Dimana:

q = Arus kendaraan

s = Arus jenuh

c. Waktu Hilang (L)

$$L = \sum (I - a) + \sum l \quad (2.3)$$

Dimana:

l = Rata-rata waktu hilang per fase yang diakibatkan sifat inersia antrean dan besarnya ditetapkan 2 detik per fase

I = Periode antar hijau

a = Periode kuning, ditetapkan nilainya 3 detik per fase

d. waktu siklus optimum

$$C_0 = \frac{1{,}5\,L+5}{1-Y} \quad (2.4)$$

dimana:

L = Waktu hilang total per siklus

Y = Jumlah y maksimum untuk semua fase

e. waktu hijau efektif

$$g = \frac{y(C0-L)}{Y} \quad (2.5)$$

dimana:

g = Waktu hijau efektif

y = Tingkat arus lalu lintas pada tiap persimpangan

C_0 = Waktu siklus

L = Waktu hilang total per siklus

\Y = Jumlah y maksimum untuk semua fase

MJKI

a. raiso kendaraan belok

1. kiri

$$P_{LT} = \frac{LT\ (smp/jam)}{Total\ (smp/jam)}$$

Dimana :

P_{Lt} = Rasio kendaraan belok kiri

LT = arus kendraan belok kiri

Total = total arus kendaraan

2. kanan

$$P_{RT} = \frac{RT\ (smp/jam)}{Total\ (smp/jam)}$$

Dimana :

P_{Rt} = Rasio kendaraan belok kanan

RT = arus kendraan belok kanan

Total = total arus kendaraan

b. Penentuan Merah Semua

$$\text{MERAH SEMUA}_i = [\frac{(LEV+lEV)}{VEV} - \frac{LAV}{VAV}]$$

Dimana :

L_{EV}, L_{AV} = jarak dari garis henti ke titik konflik masiing-masing untuk kendaraan yang berangkat dan yang datang

l_{EV} = panjang kendaraan yang berangkat

V_{EV}, V_{AV} = kecepatan masing-masing untuk kendaraan yang berangkatdan yang datang.

c. Waktu hilang

$$LTI = \sum (\text{MERAH SEMUA} + \text{KUNING})_i = \sum IG_i$$

d. arus jenuh dasar

1. tipe P

$S_0 = 600 \times W_e$

Dimana :

S_0 = arus jenuh dasar

W_e = lebar pendekatan efektif

2. tipe O

$S = S_{prov} - [(Q_{RTO} - 250) \times 8\ ]$

e. faktor penyesuaian parkir

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$F_P = [L_P/3 – (W_A – 2) \times (L_P/3 – g) / W_A]/g$

Dimana :

L_P = jarak antara garis henti dan kendaraan yang dipakir pertama

W_A = lebar pendekatan

g = waktu hijau pada pendekatan (nilai normal)

f. faktor penyesuai belok

1. kanan

$F_{RT} = 1,0 + p_{RT} \times 0,26$

Dimana :

F_{RT} = faktor penyesuai belok kanan

p_{RT} = rasio kendaraan belok kanan

2. kiri

$F_{LT} = 1,0 + p_{LT} \times 0,16$

Dimana :

F_{LT} = faktor penyesuai belok kiri

p_{LT} = rasio kendaraan belok kiri

g. nilai arus jenuh yang disesuaikan

$S = S_0 \times F_{CS} \times F_{SF} \times F_G \times F_P \times F_{RT} \times F_{LT}$

Dimana :

S = nilai arus jenuh yang disesuaikan

S_0 = arus jenuh dasar

F_{CS} = faktor penyesuaian ukuran kota

F_{SF} = faktor penyeuaian hambatan samping

F_G = faktor penyesuaian kelandaian

F_P = faktor penyesuaian parkir

F_{RT} = faktor penyesuaian belok kanan

F_{LT} = faktor penyesuaian belok kiri

h. rasio arus

$$FR = Q/S$$

Dimana :

Q = Arus kendaraan

S = nilai arus jenuh yang disesuaikan

i. rasio arus samping

$$IFR = \sum (FR_{crit})$$

Dimana :

FR_{crit} = rasio arus kritis

j. rasio fase

$$PR = FR_{crit}/IFR$$

k. waktu siklus sebelum penyesuaian

$$c_{ua} = (1{,}5 \times LTI + 5)/(1\text{-}IFR)$$

c_{ua} = waktu siklus sebelum penyesuaian sinyal

LTI = waltu hilang total persiklus

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IFR = rasio arus simpang $\sum (FR_{crit})$

l. waktu hijau

$$g_i = (c_{ua} – LTI) \times PR_i$$

dimana :

g_i = tampilan waktu hijau pad fase i

c_{ua} = waktu siklus sebelum penyesuaian

LTI = waktu siklus total persiklus

PR_i = rasio fase FR_{crit}/IFR

3.2 Simulation model

The simulation models are developed to evaluate the number of vehicles waiting in line with different the green light durations which are resulted from MKJI and Webster method. This research employs Arena simulation software to develop these simulation models. In developing the simulation model, some probabilistic data were considered. There are inter arrival vehicles (MC, LV, and HV), setup each vehicles before leave the line, the speed of each vehicles, etc. Fig. 4 presents the current simulation model. The verification and validation were firstly conducted before the scenarios were developed.

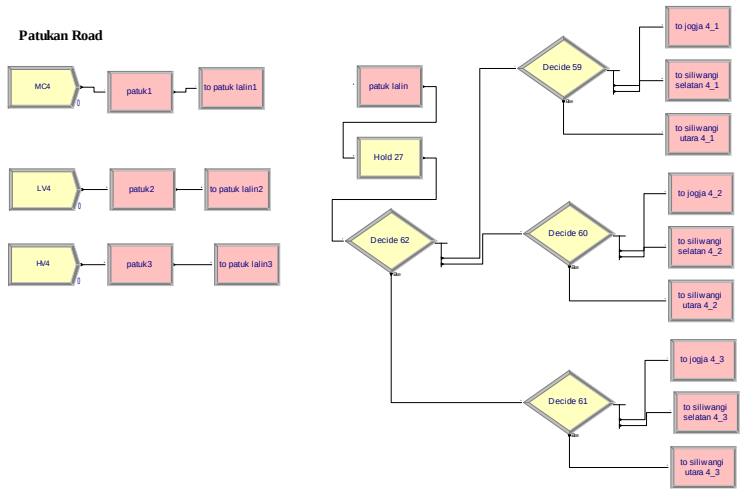

Fig. 4 – The current simulation model (Patukan Road)

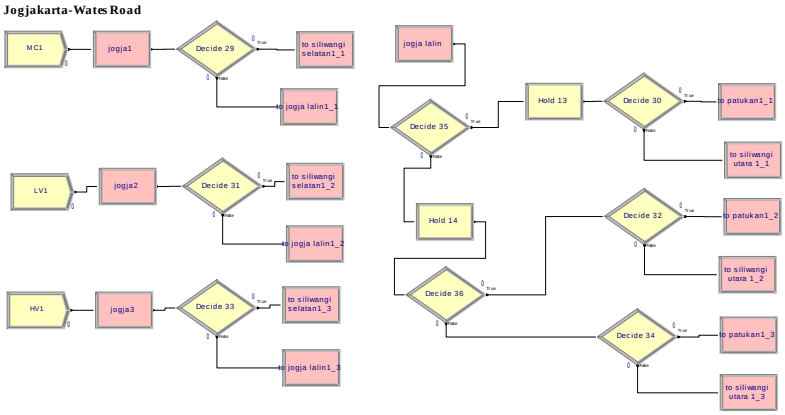

Fig. 5 – The current simulation model (Yogyakarta-Wates Road)

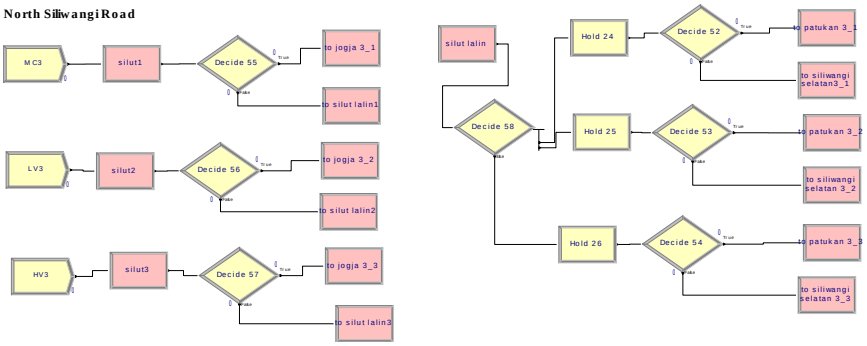

Fig. 6 – The current simulation model (North Siliwangi Road)

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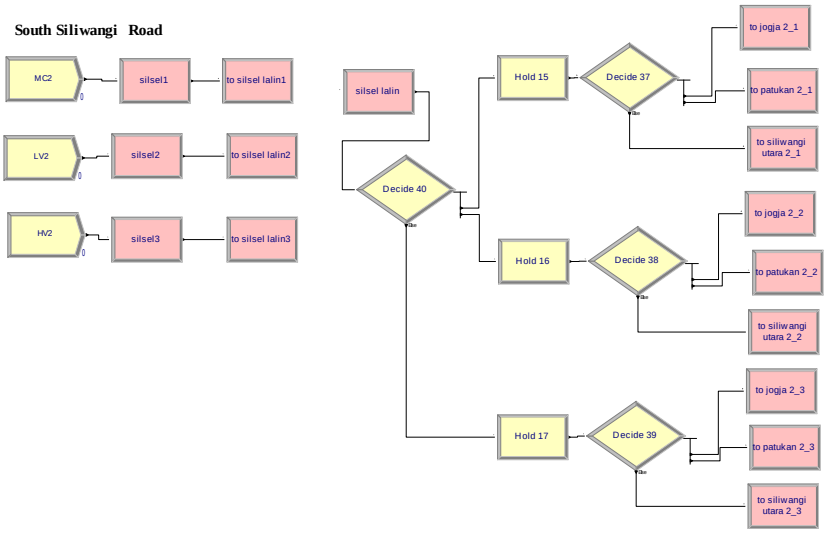

Fig. 7 – The current simulation model (South Siliwangi Road)

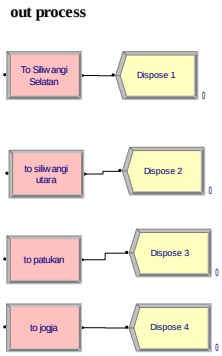

Fig. 8 – The current simulation model (Out vechicle Process)

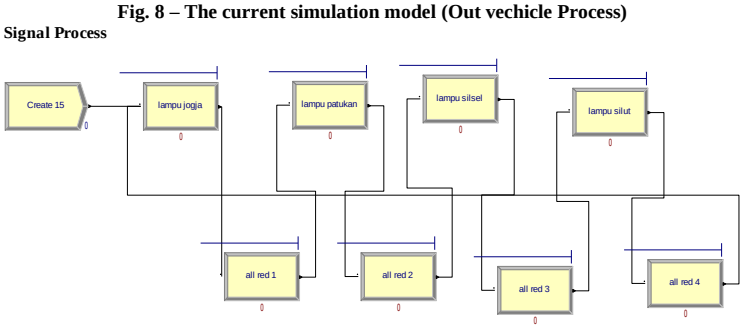

Fig. 9 – The current simulation model (Traffic Signal Process)

4. Results and Discussion

The results of experimental design 1 was the different duration of green traffic lights according to MKJI and Webster method on the weekdays in the morning and in the afternoon as presented in Table 1 and Table 2, respectively. For instance, in Table 1, North Siliwangi roadway has the current duration of green light on the weekdays in the morning is 25 seconds. After calculated with MKJI method and Webster method, the durations of green light are 25 seconds and 10 seconds, respectively. Generally, this result shows the duration of green lights from Webster method provides lower than MKJI method.

Table 1 – The duration of green lights on the weekdays in the morning (in seconds)

Roadway name	Current duration of green lights (sec)	The proposed solution (sec)	
		MKJI method	Webster method
North Siliwangi	25	25	10
South Siliwangi	50	45	15
Yogyakarta-wates	18	33	12
Patukan	33	59	15

Table 2 – The duration of green lights on the weekdays in the afternoon (in seconds)

Roadway name	Current duration of green lights (sec)	The proposed solution (sec)	
		MKJI method	Webster method
North Siliwangi	30	68	12
South Siliwangi	45	141	14
Yogyakarta-wates	30	124	20
Patukan	20	89	9

Then, the experimental design 2 was conducted to evaluate the number of vehicles waiting in line for different duration green traffic lights that are outputs from MKJI and Webster method. As seen in Fig. 4, Webster method has lower number of vehicles waiting line in the morning and afternoon rather than MKJI method. This is due to the long duration of the green traffic light resulted by MKJI method so that the traffic light cycle becomes longer and it effects the number of vehicles waiting in line which is higher than Webster method.

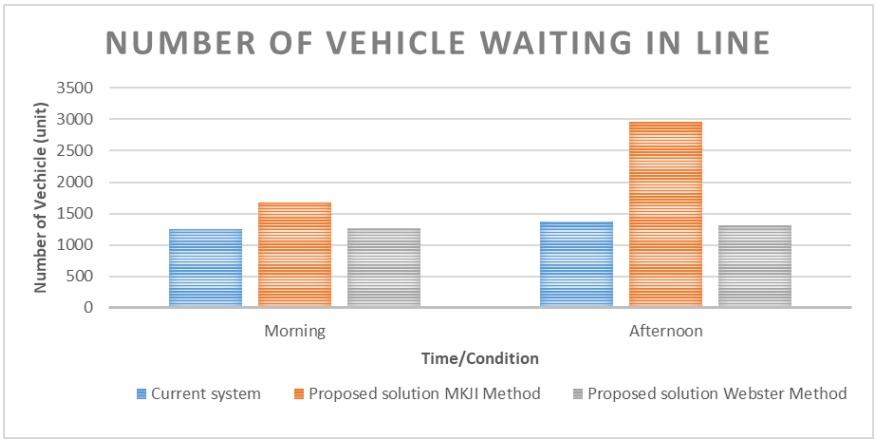

Fig. 10 – Number of vehicles: Current system and proposed solutions

5. Conclusion

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This study developed hybrid simulation method to manage road traffic, especially in determining the green traffic light. The objective is to minimize the number of vehicles waiting in line. This method incorporates MKJI, Webster method, and simulation method. First of all, the MKJI and Webster method were calculated to determine the green traffic light. Then, the simulation model was developed to evaluate the number of vehicles waiting in line according to different duration of green traffic lights from MKJI and Webster method.

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The result shows that the duration of green traffic lights calculated by Webster method provides lower number of vehicles waiting in line. It is due to the short duration of green traffic light resulted by Webster method so that the traffic light cycle becomes shorter and it effects the number of vehicles waiting in line which is lower than MKJI method.

In general, the proposed method has advantages for Department of Transportation, Indonesia in improving the road traffic management in order to low number of vehicles waiting in line. This research has opportunity to be developed by considering distance among vehicles and proposing another methods.

Acknowledgement

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LETTER OF ACCEPTANCE

Dear authors,

As a result of evaluation from the editorial board, we are pleased to inform that your following manuscript,

Developing Hybrid Simulation Model to Improve Road Traffic Management

Oddie Rafif Al Aziz[1], Hayati Mukti Asih[2]

Paper ID : 144

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Editor in Chief of IJIES

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Developing Hybrid Simulation Model to Improve Road Traffic Management

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Webster; Simulation

ABSTRACT

Yogyakarta has increasing trends in the number of vehicles and consequently intensifying the traffic volume and will effect to higher emission and air pollution. Traffic lights duration plays a vital role in congestion mitigation in the critical intersections of urban areas. This study has objective to minimize the number of vehicles waiting in line by developing the hybrid simulation method. First of all, the MKJI (Manual Kapasitas Jalan Indonesia) and Webster method were calculated to determine the green traffic light. Then, the simulation model was developed to evaluate the number of vehicles waiting in line according to different duration of green traffic lights from MKJI and Webster method. A case study will then be provided in Pelemgurih intersection located in Yogyakarta, Indonesia for demonstrating the applicability of the developed method. The result shows that the duration of green traffic lights calculated by Webster method provides lower number of vehicles waiting in line. It is due to the short duration of green traffic light resulted by Webster method so that the traffic light cycle becomes shorter and it effects the number of vehicles waiting in line which is lower than MKJI method. The results obtained can help the generating desired decision alternatives that will important for Department of Transportation, Indonesia to enhance the road traffic management with low number of vehicles waiting in line.

1. Introduction

Yogyakarta is known as tourist city and educational city in Indonesia. There are many local and foreign tourist and also student who interested come to this city in each year. It results in high congestion in some intersections around Yogyakarta. High congestion has bad impact on time, money, and air pollution as well. According to annually evaluation from Department of Transportation of Yogyakarta on 2018[1], there are average delay in some crowded intersections in Yogyakarta as presented in Fig. 1. It can be seen that Pelemgurih intersection has the highest average delay compare to others. It is caused by it connects the south ring road and the west ring road. It is also national road with environmental type is commercial which means many sales around. In addition, this intersection is one of the main ways for many workers pass this way which makes this intersection more crowded and road traffic management become challenging.

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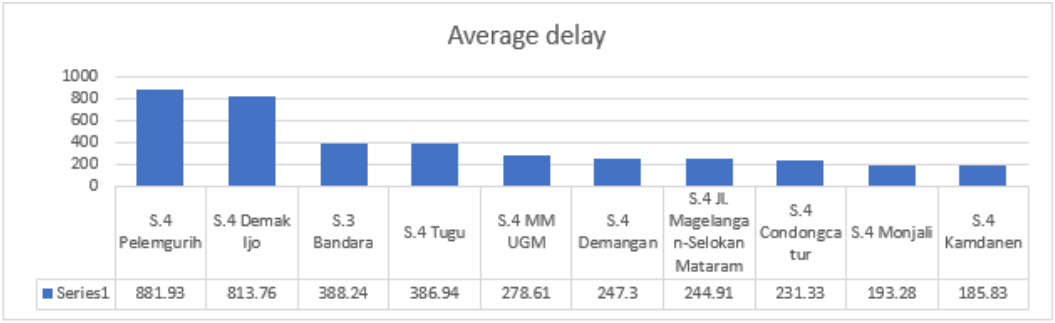

Fig. 1 – Average delay in intersection in Yogyakarta[1]

Pelemgurih intersection has four sections of road, there are Patukan road (red line) on the west, Yogyakarta-Wates road (blue line) on the east, North Siliwangi road (orange line) on the north, and South Siliwangi road (green line) on the south. It is as shown in Fig. 2. In defining the direction of each road, there are the dash line which means the vehicles must follow the traffic light, and the straight line which means the vehicle must go ahead, not follow the traffic light. For instance, it can be seen the direction from Yogyakarta-Wates road to South Siliwangi road must turn left directly, even the traffic light is red.

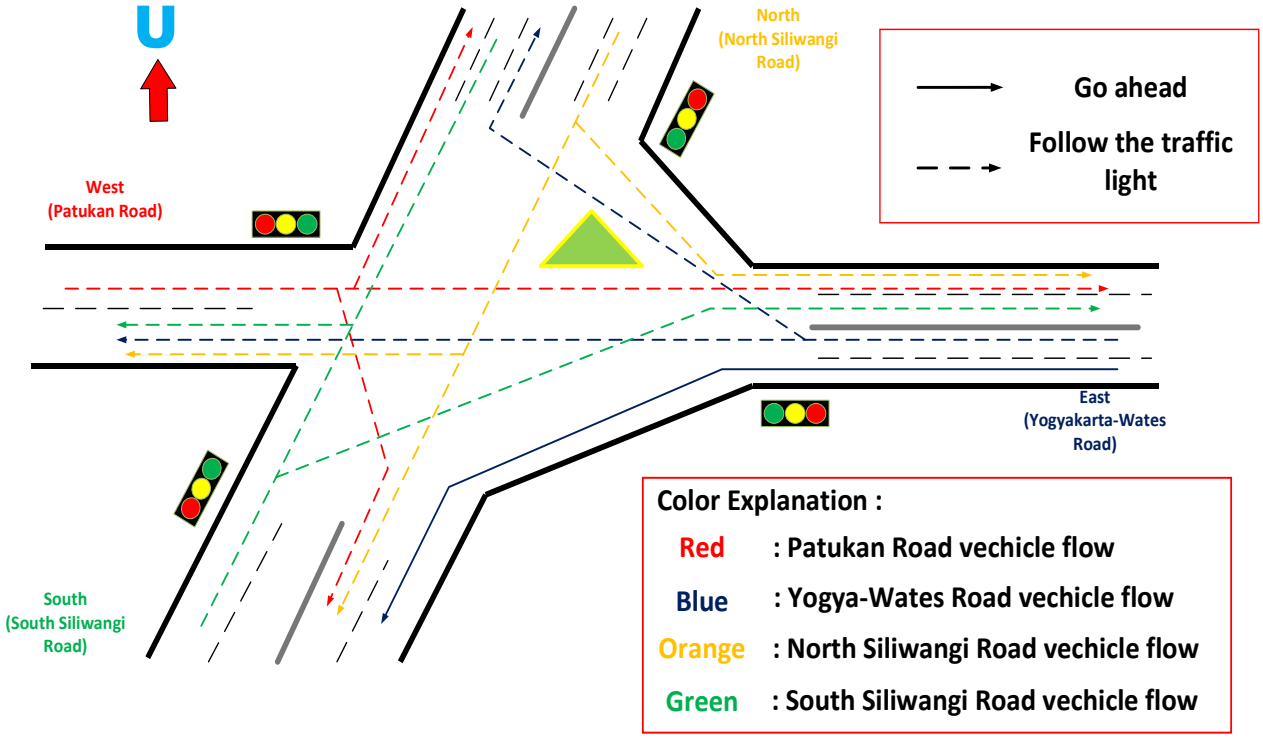

Fig. 2 – Pelemgurih intersection

The preliminary study was conducted to understand the characteristics of the system by doing initial observation. The observation is divided by three periods, i.e. morning (06.00 am – 08.00 am), noon (11.00 am – 13.00 pm), and afternoon (15.30 pm – 17.30 pm). The initial observation was conducted on weekdays (Monday to Friday) and weekend (Saturday and Sunday). In addition, this research concerns on motorcycle (MC), low vehicle (LV) which includes car, and high vehicle (HV) which includes truck and bus. The results of this initial observation was the number of vehicle on the weekdays in the morning and in the afternoon has significantly higher than on weekend (refer to Fig. 3). The main reason is many workers pass this intersection which makes the system more complicated. Hence, this research would focus on the weekdays in the morning and in the afternoon.

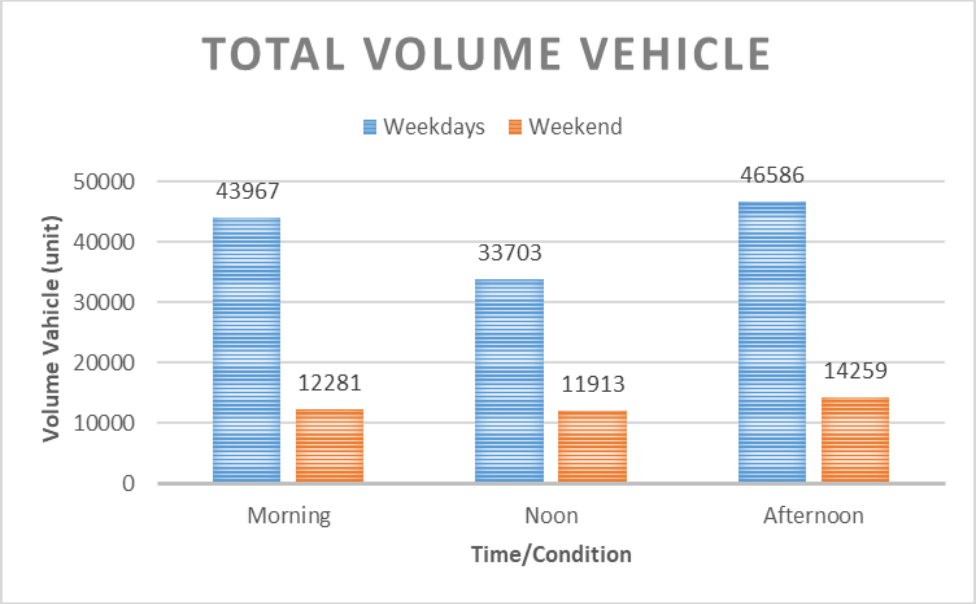

Fig. 2 – Total volume vehicle on weekdays and weekend

The higher number of vehicles waiting in line in a traffic light will effect to higher emission and air pollution. In addition, a bad road traffic management will effect to higher number of accidents. Therefore, road traffic management must be planned efficiently and effectively in order to minimize the risk of accidents and environmental impacts [2].

This research developed hybrid simulation method with the objective is to minimize the number of vehicles waiting in lines. First of all, MKJI ("Manual Kapasitas Jalan Indonesia") and Webster method were developed to determine the duration of green light accordance with the geometric, the condition of the intersection, capacity of the road, etc. Then, the simulation model was developed to evaluate the number of vehicles waiting in lines. Finally, the least amount of vehicles waiting in line was chosen. A case study will then be provided in Pelemgurih intersection located in Yogyakarta, Indonesia for demonstrating the applicability of the developed method. The results obtained can help the generating desired decision alternatives that will important for Department of Transportation, Indonesia to enhance the road traffic management with low number of vehicles waiting in line.

The remainder of the present paper is organized as follows. Section 2 reviews the theoretical framework. Section 3 described the proposed methodology. Section 4 presents the results and discussion. Finally, section 5 concludes with a discussion of further research direction.

2. Theoretical Framework

There are previous papers that were discussed about road traffic management. Kamran et al. [3] developed simulation modeling using Arena Simulation Software to determine the traffic light timing. There were several scenarios were proposed and the minimum average time spent in the system was chosen. Then, Tama et al. [2] also developed several scenarios based on various traffic light duration by using simulation model. The objective was to find the scenario that has shorter vehicle queue on the junction. In addition, Rahman [4] developed simulation model by using Vissim 8 program and MKJI method by changing the duration of traffic light, road widening, and improvement on the road geometric. The result showed the decreases on queue length, queue length maximum, and the number of vehicles stop. Next, Prihati [5] developed simulation model by using Arena simulation software to minimize the waiting time in account payment counter. Next, Yunata [6] also proposed Arena to simulate Simpang Empat Pontianak in order to number of vehicles waiting and waiting time could be reduced. In a comprehensive study of road traffic management, Harahap et al. [7] proposed a traffic simulation system, called by LINTAS using the SimEvents toolbox and runs on MATLAB-Simulink software to minimize the average queue length.

Compare to another researches that develop simulation model for road traffic management, Fauzi et al. [8] developed Webster and Greenshield method to determine the green and red traffic light in Bandar Kidul intersection, Kediri, Indonesia. In a study conducted by Pornamasari et al. [9], it was shown that Webster method was proposed to calculate optimum cycle time in Babe Palar street intersection.

This study set out to critically examine the ways in managing road traffic. The significant finding from previous researches is to calculate the green traffic light mostly using simulation model, MKJI and Webster method separately. Therefore, this research develops the hybrid simulation model by integrating simulation model, MKJI and Webster method to calculate the green traffic light more accurate. This study has objective to minimize the number of vehicles waiting in line.

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3. Methodology

This research was conducted based on Pelemgurih intersection in Yogyakarta. It focuses on the weekdays in the morning and afternoon as this intersection as one of the main ways for people leave and go to work so that it has higher congestion. To minimize the congestion, the hybrid simulation was developed. First of all, the problem was identified and then the objective was proposed. Next, the data was collected such as inter arrival time, the velocity of vehicles, current traffic light duration, intersection geometry data, set up vehicles data, etc. Then, the experimental design 1 was calculated using MKJI and Webster method to provide the duration of green traffic lights. After that, the simulation model was developed to evaluate the number of vehicles waiting in line according to different duration of green lights from MKJI and Webster method as the experimental design 2. Finally, the duration of green traffic light with minimum number of vehicles waiting in line was chosen. It can be shown in Fig. 3.

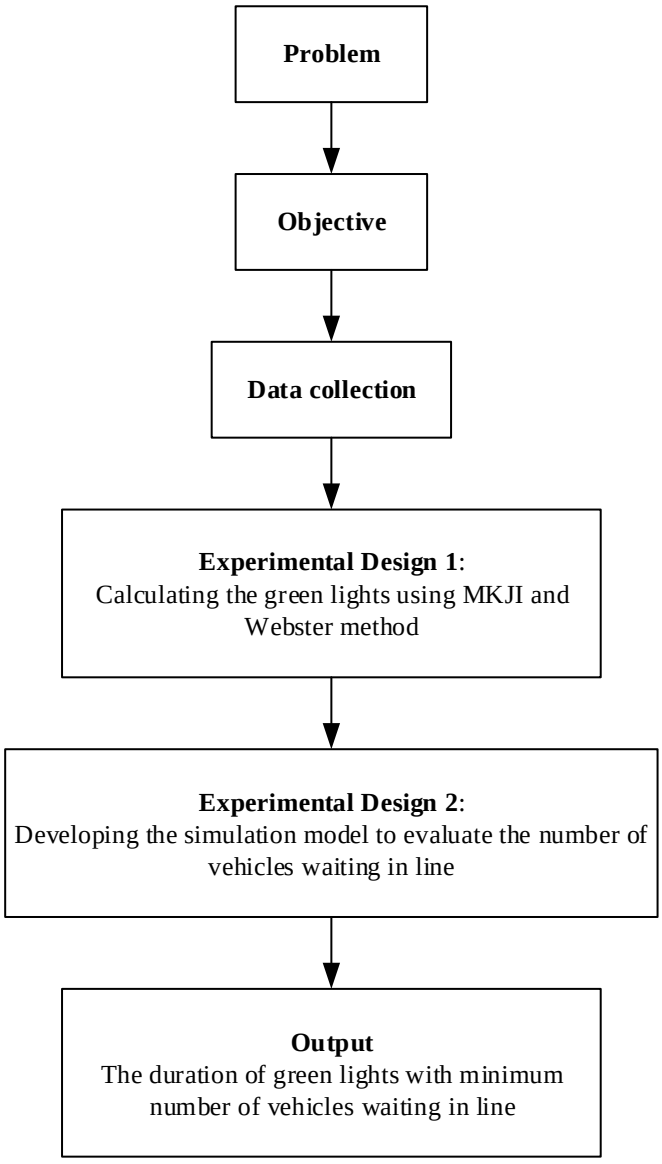

Fig. 3 – Research design

3.1 MKJI and Webster method

MKJI (Manual Kapasitas Jalan Indonesia) method was developed on 1997 to determine the duration of green traffic light [10]. Fig. 4 presents how the MKJI works in calculating the green duration for each intersection. On the other hand, Webster was developed on 1960s by F.V. Webster [9]. Fig. 5 presents step by step of Webster in calculating the the green duration for each intersection.

F. V. Webster developed an equation to calculate the average delay in driving when approaching an intersection and also derived an equation to obtain the optimum cycle time that results in minimum vehicle delays. Vehicle delays

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occur because the number of vehicles entering a junction is greater than the number of vehicles leaving the intersection. In calculating the duration of green traffic light, MKJI method considers intersection environmental conditions, but Webster method does not.

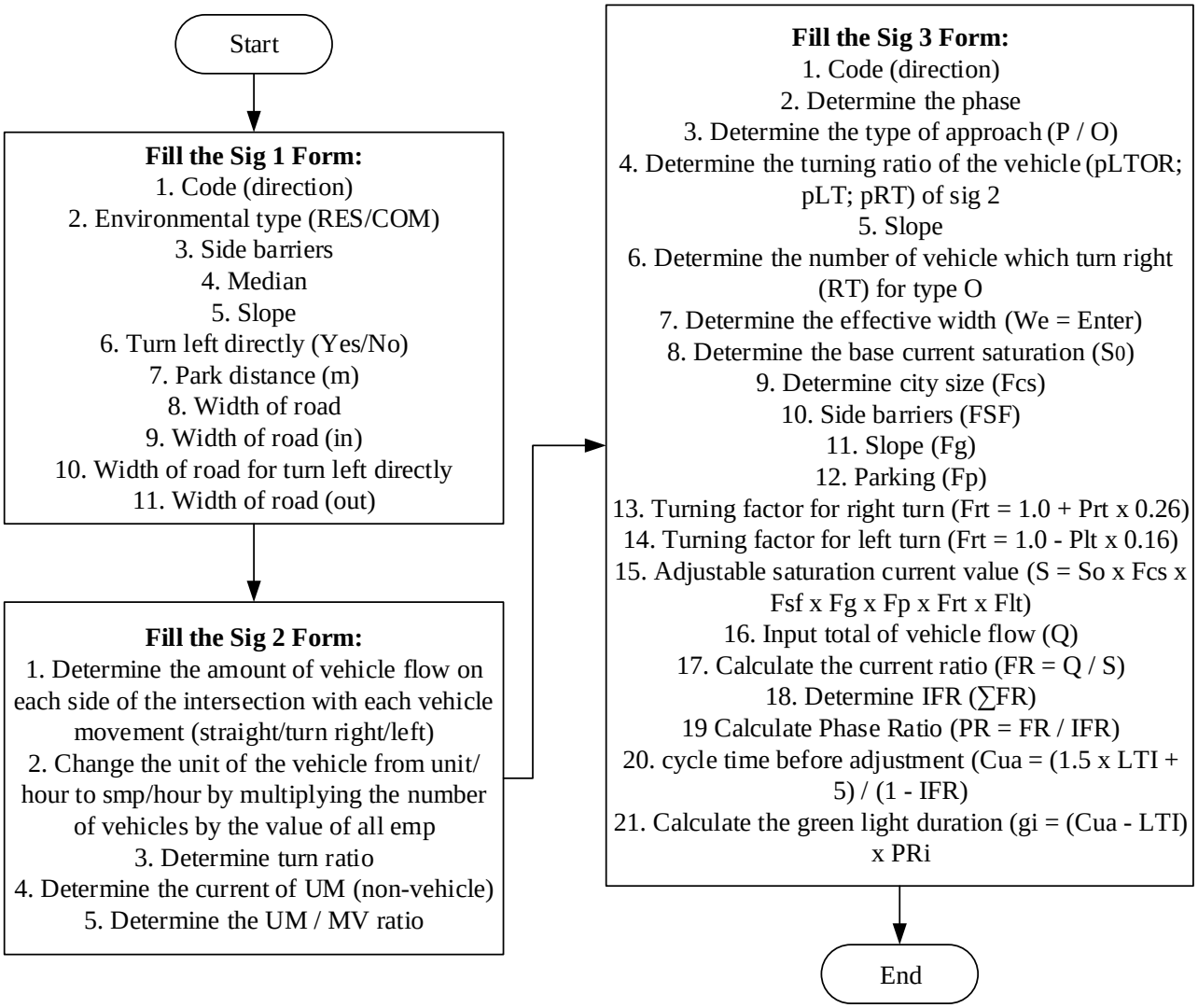

Fig. 4 – The Procedure of MKJI in Calculating The Green Duration

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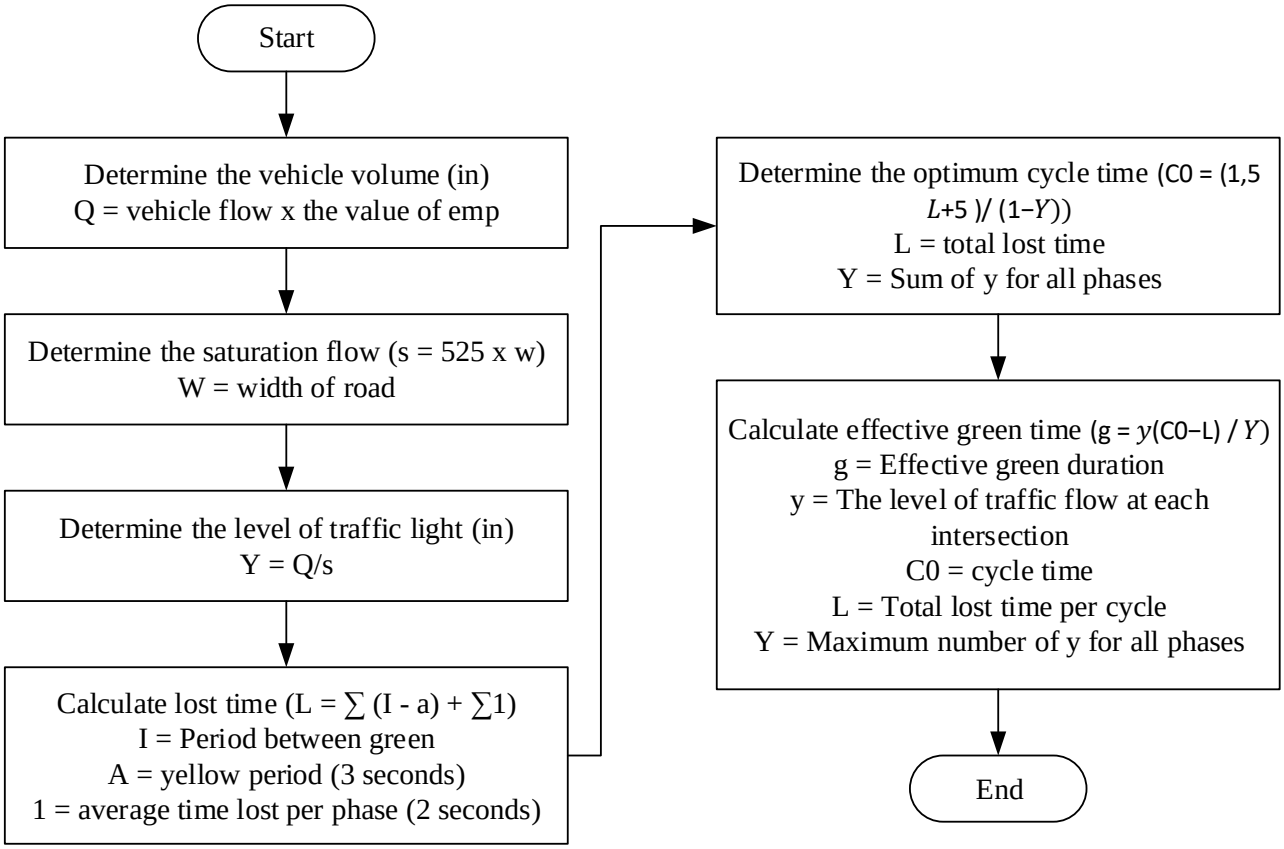

Fig. 5 – The Procedure of MKJI in Calculating The Green Duration

3.2 Simulation model

The simulation models are developed to evaluate the number of vehicles waiting in line with different the green light durations which are resulted from MKJI and Webster method. This research employs Arena simulation software to develop these simulation models. In developing the simulation model, some probabilistic data were considered. There are inter arrival vehicles (MC, LV, and HV), setup each vehicle before leave the line, the speed of each vehicles, etc. Fig. 6 presents the current simulation model. The verification and validation were firstly conducted before the scenarios were developed.

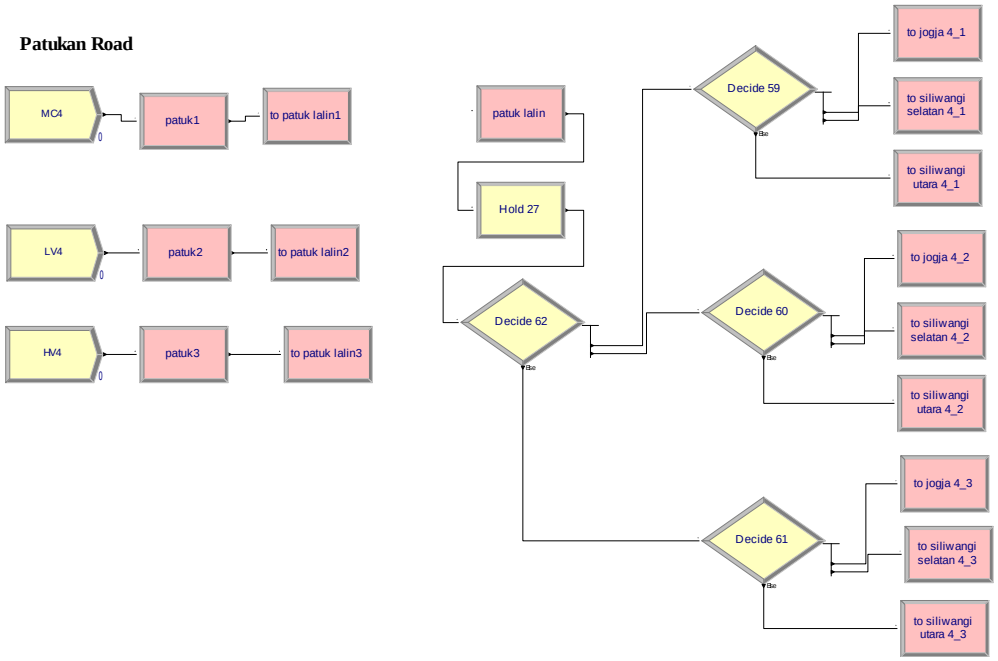

Fig. 6 – The current simulation model (Patukan Road)

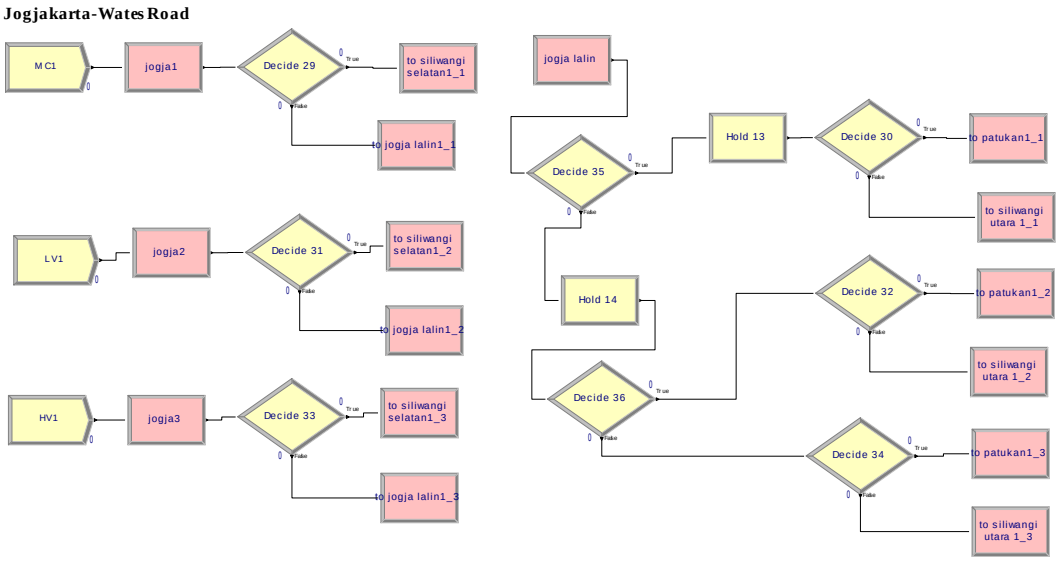

Fig. 7 – The current simulation model (Yogyakarta-Wates Road)

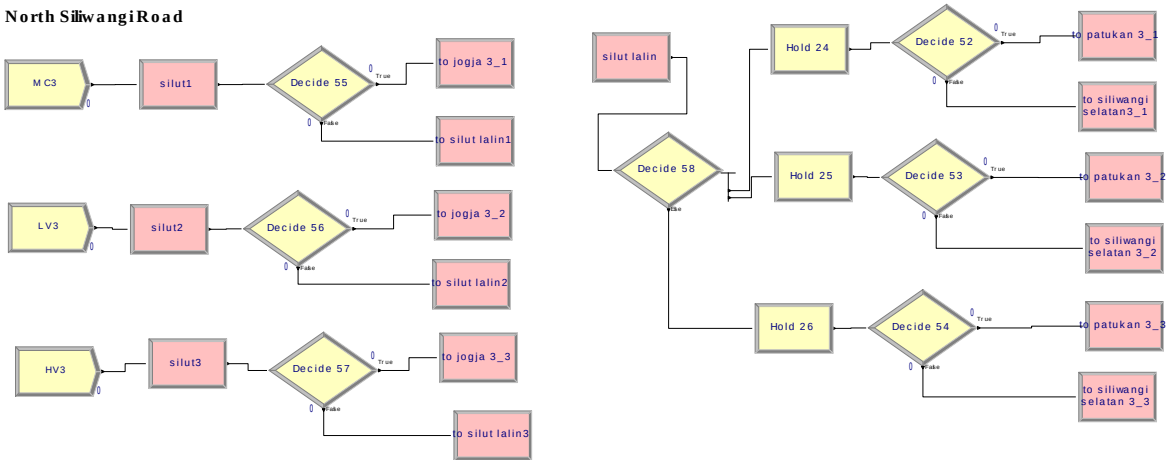

Fig. 8 – The current simulation model (North Siliwangi Road)

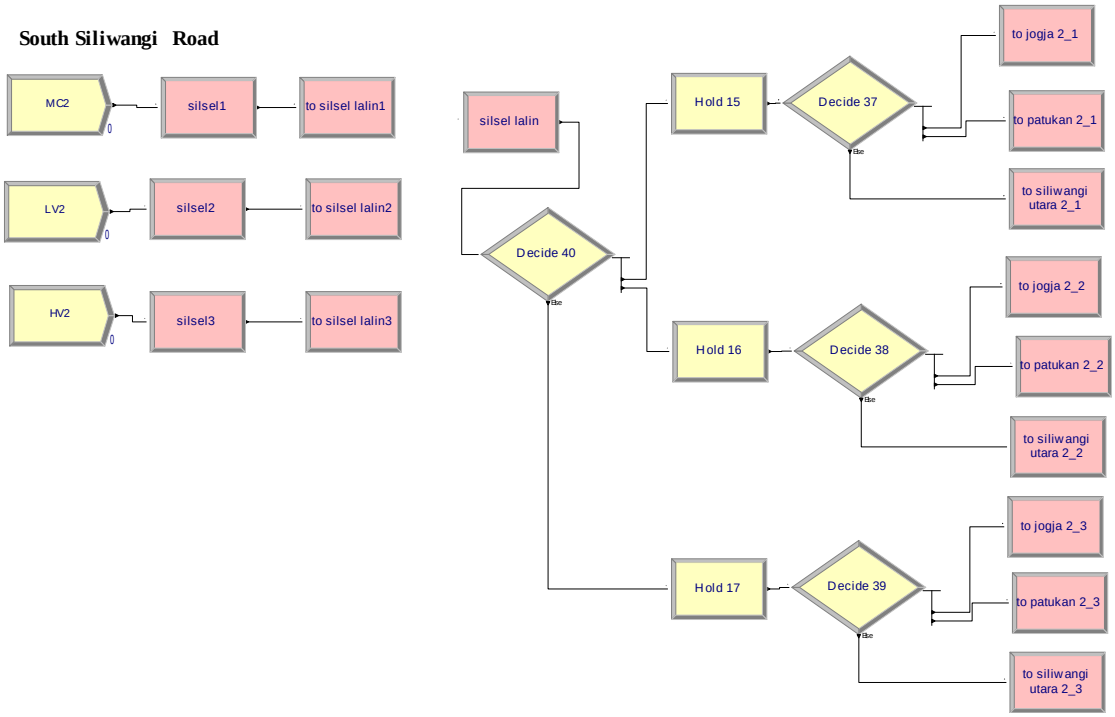

Fig. 9 – The current simulation model (South Siliwangi Road)

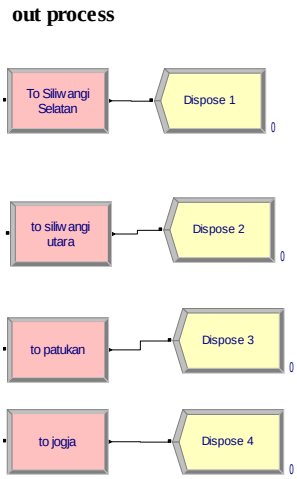

Fig. 10 – The current simulation model (Out vechicle Process)

Signal Process

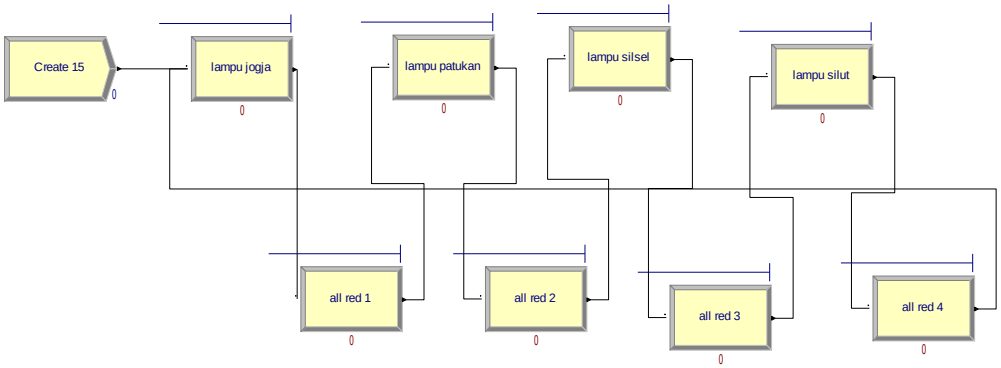

Fig. 11 – The current simulation model (Traffic Signal Process)

4. Results and Discussion

The results of experimental design 1 was the different duration of green traffic lights according to MKJI and Webster method on the weekdays in the morning and in the afternoon as presented in Table 1 and Table 2, respectively. For instance, in Table 1, North Siliwangi roadway has the current duration of green light on the weekdays in the morning is 25 seconds. After calculated with MKJI method and Webster method, the durations of green light are 25 seconds and 10 seconds, respectively. Generally, this result shows the duration of green lights from Webster method provides lower than MKJI method.

Table 1 – The duration of green lights on the weekdays in the morning (in seconds)

Roadway name	Current duration of green lights (sec)	The proposed solution (sec)	
		MKJI method	Webster method
North Siliwangi	25	25	10
South Siliwangi	50	45	15
Yogyakarta-wates	18	33	12
Patukan	33	59	15

Table 2 – The duration of green lights on the weekdays in the afternoon (in seconds)

Roadway name	Current duration of green lights (sec)	The proposed solution (sec)	
		MKJI method	Webster method
North Siliwangi	30	68	12
South Siliwangi	45	141	14
Yogyakarta-wates	30	124	20
Patukan	20	89	9

Then, the experimental design 2 was conducted to evaluate the number of vehicles waiting in line for different duration green traffic lights that are outputs from MKJI and Webster method. As seen in Fig. 12, Webster method has lower number of vehicles waiting line in the morning and afternoon rather than MKJI method. This is due to the long duration of the green traffic light resulted by MKJI method so that the traffic light cycle becomes longer and it affects the number of vehicles waiting in line which is higher than Webster method.

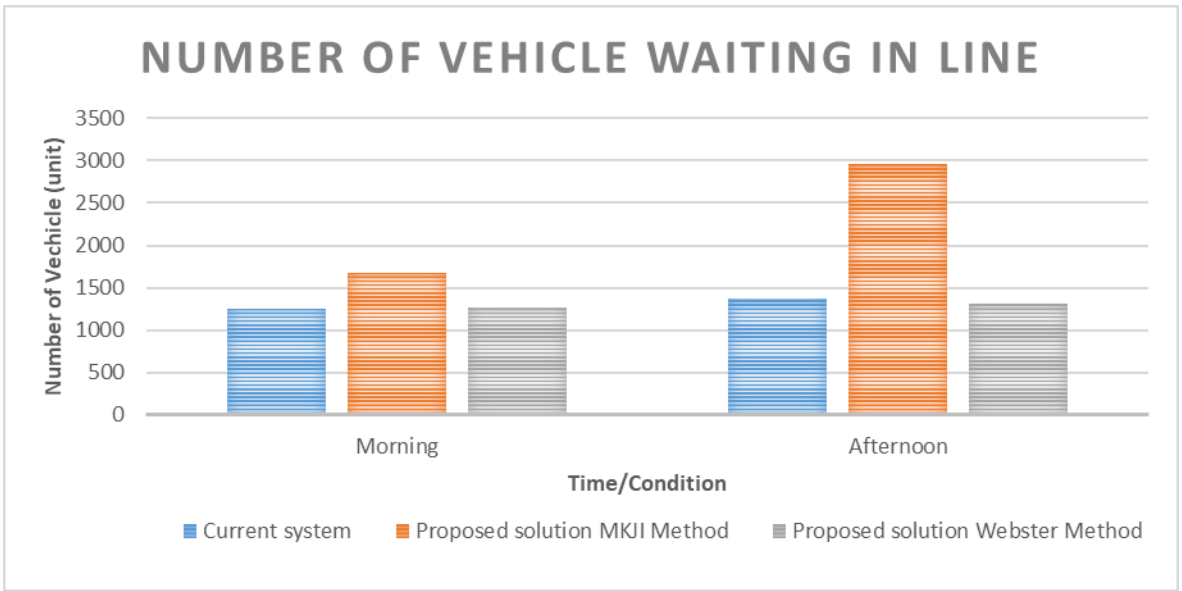

Fig. 12 – Number of vehicles: Current system and proposed solutions

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5. Conclusion

This study developed hybrid simulation method to manage road traffic, especially in determining the green traffic light. The objective is to minimize the number of vehicles waiting in line. This method incorporates MKJI, Webster method, and simulation method. First of all, the MKJI and Webster method were developed to calculate the green traffic light duration. Then, the simulation model was developed to evaluate the number of vehicles waiting in line according to different duration of green traffic lights from MKJI and Webster method.

The result shows that the duration of green traffic lights calculated by Webster method provides lower number of vehicles waiting in line. It is due to the short duration of green traffic light resulted by Webster method so that the traffic light cycle becomes shorter and it affects the number of vehicles waiting in line which is lower than MKJI method.

In general, the proposed method has advantages for Department of Transportation, Indonesia in improving the road traffic management in order to low number of vehicles waiting in line. This research has opportunity to be developed by considering distance among vehicles and proposing the other methods.

Acknowledgement

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