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Modeling of Traffic Flow Schemes at Road Intersections in Pekanbaru City Using Compatible Graphs

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abstract

Congestion is one of the few issues that has always been the center of attention at crossroads. One of them is at the intersection of Tuanku Tambusai, Nangka and Soekarno Hatta road. This congestion can be reduced by optimizing the duration of pauses at road intersections and collecting a compatible traffic flow when a red light occurs. The two traffic flows are said to be compatible if the two flows are running together without anyone crashing. A compatible graph is a graph that has two sets in which the object to be arranged is indicated by its points, and the corresponding pair of objects is indicated by its sides. This study obtained the optimal pause duration, which assumes a left turn following a red light for 75 seconds, by applying a compatible graph. Furthermore, the optimal duration of the pause assumes that the left turn does not follow the red light for 45 seconds. The pause duration is smaller than the duration now used on Soekarno Hatta Road, which is 115 seconds, using the assumption of following the red light to turn left. So obtained, the duration of the pause is much more optimal when compared to the duration of the pause used on the current Soekarno Hatta road.

Keywords:

Compatible graph, Soekarno Hatta Road, Tuanku Tambusai Road, duration of pause



INTRODUCTION

Based on the official portal of the Pekanbaru Riau city government issued a circular saying that the decrease in PPKM levels was due to a drastic decrease in Covid-19 cases in Pekanbaru City during May 2022. The government said there was no surge in Covid-19 cases in Pekanbaru City for the past two weeks. The government hopes that people will return to their usual activities later, and the economy will be stretched again. (Nisa & Muzdalifah, 2021) With the return of people's routines in Pekanbaru city, the traffic flow in the area around shopping centers such as Transmart, Living World, and SKA located at the intersection of Soekarno Hatta Road and Tuanku Tambusai Road will increase.(Huznul Khothimah & Syafmen, 2021) With the return of community activities that switched from online routines, it has begun to return to normal. (Miftahurrahmah, 2018)

Considering the surge in the use of private vehicles and the return of work routines of the people of Pekanbaru, there is a traffic jam(Arifandy et al., 2021; Nazaruddin & Sarbaini, 2022; Sarbaini et al., 2022). Congestion is common at intersections and roads connecting main roads with city centers, shopping malls, and community enablement. High traffic jams often occur at the intersection of Soekarno Hatta Road and Tuanku Tambusai, which connects some to the mainstream. The result of congestion is the lack of optimization of the lag time at the intersection of Soekarno Hatta Road and Tuanku Tambusai Road. (Ansari, n.d.; Banerjee, 2002; Kroll et al., 2020)

To optimize the lag time at the crossroads can use compatible graphs. Using compatible graphs on traffic is an effort to reduce congestion at the Intersection of Soekarno Hatta Road and Tuanku Tambusai, as well as other efforts to build an overpass that was inaugurated by the Governor of Pekanbaru on February 14, 2019, and traffic management arrangements. (Fanani, 2016; Ramos & White, 2019; Thomas & Germina, 2010)

A Compatible Graph is a directionless graph that connects one point with another that does not intersect(Sofhya, 2022; Winarso, 2014a, 2014b). This knowledge is generally used to solve problems related to sequential data. The traffic flow in the category is optimal if it can run simultaneously without affecting others and there are no collisions or intersections(Muchyidin, 2017; Rasyidi & Winarso, 2020; Winarso & Hardyanti, 2019). The use of compatible graphs will optimize the lag time at each intersection and solve problems that occur in traffic management.(Basriati & Wahyuni, 2016; Hardianti et al., 2013)

This research was conducted to obtain a more optimal waiting time at the intersection of Soekarno Hatta Road and Tuanku Tambusai Road. This research was conducted by ignoring vehicles' intensity in Pekanbaru (Sarbaini et al., 2021). This study intends to add one of the considerations in controlling the color of traffic lights at the Soekarno Hatta Road Intersection and Tuanku Tambusai to solve congestion problems and make traffic management more effective. (Muttakin et al., n.d.)

METHODS

Population and Sample

The way to take the data used in this study is through an observation technique. The data obtained in this study is the number of lanes, traffic flow, and duration of pauses in Pekanbaru, Riau, precisely at the intersection of Tuanku Tambusai and Soekarno Hatta roads. The location of the data retrieval will be shown in Figure 1.





Figure 1.

Data collection location, Tuanku Tambusai road intersection, and Soekarno Hatta.

Data collection was carried out on Sunday, May 29, 2022, from 4 pm to 6 pm, which was taken directly in the field, assuming the crowds of road users were returning home from activities at that time.

Data Processing Procedures

The data processing procedures carried out in this study include:

- a. Made a picture of the Tuanku Tambusai Soekarno Hatta road intersection, which was then converted into a compatible graph. A compatible Graph is a directionless graph that connects one point with another that does not intersect with each other, whereas in this study, the point is the traffic flow.
- b. We created a complete subgraph of traffic flow at the intersection of Tuanku Tambusai road, Nangka Road, and Soekarno Hatta Road.
- c. The complete subgraph can be converted into a clock chart to determine the time of each traffic flow.
- d. Determine the optimal duration of the pause by calculating the amount of time from the multiplication between times obtained from the hour diagram before it.
- e. Obtain capital results from traffic flow and optimal pause duration using compatible graphs at the intersection of Tuanku Tambusai and Soekarno Hatta roads.

RESULT AND DISCUSSION

Skema Traffic Flow At Tuanku Tambusai Road Junction, and Soekarno Hatta

After making observations at the research site, data on the waiting time of traffic lights at the Tuanku Tambusai road intersection and Soekarno Hatta were obtained, which will be shown in Table 1 below.

Tuanku Tambusai Road and Soekarno Hatta Road.				
Lamp No.	Red (seconds)	Yellow (seconds)	Green (seconds)	
Lamp 1	100	5	80	
Lamp 2	95	5	32	
Lamp 3	95	5	45	
Lamp 4	115	5	30	

Table 1. The duration of the initial pause of the Traffic Light at the intersection of Tuanku Tambusai Road and Soekarno Hatta Road.

The data in the table above was taken on Sunday, May 29, 2022, from 4 pm to 6 pm. The picture of the traffic flow system at the Tuanku Tambusai-Soekarno Hatta road intersection can be seen in Figure 2.



Figure 2. Schema Traffic intersection Tuanku Tambusai-Soekarno Hatta road

For the notations, 1,2,3, and 4 is a point of the trajectory at the intersection, as for a, b, c, d, e, f,g,h, i, and j according to the traffic flow of each line.

Modeling Compatible Graphs on Traffic Flow at Tuanku Tambusai-Soekarno Hatta Road Intersection

Compatible traffic flow is a traffic flow that does not result in accidents with other traffic flows. The capitalization of compatible graphs in this study can be seen in Figure 3.



Figure 3. The compatible graph on schema traffic flow at Tuanku Tambusai- Soekarno Hatta road junction

Information:

- 1. Line a is compatible with lines b, d, e, f, g, and j
- 2. Line b is compatible with all lines
- 3. Line c is compatible with lines b, c, d, e, g, h, and j
- 4. Line d is compatible with lines a, b, c, d, e, g, i, and j
- 5. The e line is compatible with all lines
- 6. Line f is compatible with lines a, b, e, f, g, i, and j
- 7. The g line is compatible with all lines
- 8. Line h is compatible with lines b, c, e, f, g, h, i, and j
- 9. Line i is compatible with lines b, d, e, f, g, h, i, and j
- 10. The j line is compatible with all lines

Modeling Compatible Graphs on Traffic Flow at Tuanku Tambusai-Soekarno Hatta Road Intersection

The two presuppositions will be the presupposition of switching directly to the left following the red light and switching direction to the left not following the red light in applying the compatible graph in this study.

1. Assumption of switching directions based on traffic sign lights Traffic system with presuppositions based on traffic sign lights. The system can be pictured as follows:



Figure 4. The presupposition of turning left based on traffic lights



Figure 5. Complete subgraphs



Figure 6. Hour diagram Presupposing left turn based on traffic lights

If the forging of the traffic light works in 60 seconds per turn, then a solution is obtained by letting each traffic flow work in 60 seconds because it consists of 4 complete subgraphs then 60 seconds divided by 4, namely:

60 seconds divided by the number of its complete subgraphs, namely: 60 seconds : 4 subgraphs = 15 seconds/subgraph. Since a complete subgraph it consists of 3 and 2 points formed then, the path runs each current during: $3 \times 15 = 45$ seconds $2 \times 15 = 30$ seconds.

From the complete subgraph above, there are 5 points, then the maximum duration of the pause is 5×15 seconds = 75 seconds.

2. The assumption of switching directions to the point of not following the lights of traffic signs



Figure 7.

Left turn presuppositions are not based on traffic lights



Figure 8. Complete Subgraphs



Figure 9.

The clockwise rotation diagram with the presupposition of switching directly to the left does not follow the traffic light

Because in the complete subgraph, there are 2 and 1 points formed. Each turn is 60 seconds. Therefore the traffic flow runs each line during:

 $2 \times 15 = 30$ seconds

 $1 \times 15 = 15$ seconds

From the subgraph above, there are 3 points, then for the maximum duration of the pause is 3×15 seconds = 45 seconds.

Table 2. Comparison of pause durations before and after using compatible

Lamp No.	Wait time before	Waiting time
	(seconds)	after (seconds)
Lamp 1	100	45
Lamp 2	95	45
Lamp 3	95	45
Lamp 4	115	45

Table 2 above the difference between waiting before and after applying compatible graphs. The first light, namely from Tuanku Tambusai Road towards Soekarno Hatta Road, found that the waiting time was 100 seconds, and after using the Graf, it was compatible with 45 seconds. For the second lamp, namely from Soekarno-hatta 1 Road towards Soekarnohatta 2 Road, the waiting time was 95 seconds after using the compatible graph to 45 seconds. For the third lamp, namely from Nangka Road towards Tuanku Tambusai Road, the waiting time was found to be 95 seconds, and after using the Graf, it was compatible with 45 seconds. For the fourth lamp from Soekarno-hatta 2 Road towards Soekarnohatta 1 Road, the waiting time was found for 115 seconds, and after using the compatible graph to 45 seconds.

CONCLUSION

Considering the surge in the use of private vehicles and the return of work routines of the people of Pekanbaru, there is a traffic jam. The result of the congestion is the optimization of the lag time at the intersection of Tuanku Tambusai-Soekarno Hatta Road. To optimize the lag time at the crossroads can use compatible graphs. A Compatible Graph is a directionless graph that connects one point with another that does not intersect. In making the graph compatible, accurate data from the results of research carried out directly in the field is needed, or the data taken is the original/actual data from the observations that have been made. From observations in the field, it was obtained that the results of the length of the waiting time before and after the application of the compatible graph which was divided into two, namely the presupposition of the direction to the left following the traffic signs light in the waiting time is 45 seconds. So the process of maximum waiting time with a compatible graph application has an adequate time of 45 seconds.

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