Implementation of Graph Theory on the Setting of the Traffic Light Intersection

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Abstract - On the crossroads of course required setting traffic lights for vehicles that can be flashed with a sense of security and comfort. The duration of the traffic lights can be set to the maximum extent possible so that the vehicle could pass the road regularly. There are many solutions to manage traffic at a crossroads. One of them is a solution which will be given through this observation. This paper aims to describe the related optimization settings traffic by using the algorithm staining which aims to get the chromatic number of graphs. The optimization needs to be done due to the settings of the traffic at the Intersection of Palimanan often seen traffic jams and crowded at rush hour as a result of policies that allow the current to be incompatible. The application of the algorithm staining Welch – Powel to determine the chromatic number of graphs can be another option to resolve the problem. After the current – the current at the traffic being transformed into a graph model that will be coloring a graph and calculating the number lens. Chromatic number of the graph model is 4 so there is a change in the duration of the red and green lights on the traffic. Although there is a reduction in the duration of the red light and the addition of the duration of the green light, the removal of the current incompatibility can minimize the possibility of congestion.

Keywords : Graph Theory, Traffic Light, Intersection

1. INTRODUCTION

Congestion is one of the principal challenges in advanced cities in Indonesia. Even the traffic jam has become one of the icons to urban areas. Many factors can cause the occurrence of congestion. One of them is a factor of the density estimation of vehicles and traffic regulation that is not appropriate, causing a buildup of vehicles and traffic flow density. In addition, the development of technology has also become one of the triggers for the problem of congestion, because with the growing technology, the production of the

vehicle will also automatically increase, so that the user of the vehicle is increasing. The point of congestion, which is often found to occur at some crossroads.

At the intersection often the case of an accident is a result of vehicles that do not obey the traffic rules. Primarily occur during busy hours, such as working hours and the weekend. Many of the vehicles that want to please until the destination so drive with inconsiderate. Therefore, there is a regulation of the flow of the movement of vehicles on the traffic. The concept of setting the movement in traffic at an intersection is about setting the movement of the vehicle alternately so as not to impede travel. Setting the flow of traffic is usually using a traffic light relating to setting the period of time the lights are green and red. In a few branching paths, many encountered a traffic light that has a duration of red light and green light is quite short. For example, in the intersection of Palimanan, Cirebon Regency. The intersection of Palimanan this is an example of the intersection of quite a lot of vehicles. Because of the intersection of Palimanan this includes the path of national route 1. This road is the main road on the island of java, which is famous with the name of the north Coast road (Pantura). This route became the main line of land transport. At the intersection of Palimanan is also a terminal that hasn't officially become a stop the bus, truck, and vehicle traffic of the city, the province even up to the cross island. With it, the need for regulation of the traffic lights right, in order to avoid long traffic jams that caused the accident and the inhibition of the activity of the community.

With so many problems, traffic flow, this can be optimized by setting the Algorithm Welch Powel and Chromatic Number in the system settings of traffic lights to determine the duration of time the traffic lights are in accordance with the situation in any way. To use this algorithm, first perform a modeling of traffic flow to form the image graph, then set the algorithm Welch-powell is to carry out the staining at the point-point graph, the next is to determine the chromatic number and calculate the duration of green light and also the light red. Therefore, we plan to create a paper on "apply graph theory in the Settings of Traffic Lights At the Intersection of Paliman, the District of Cirebon".

2. LITERATURE REVIEW

Based on the by Law Number 22 Year 2009 chapter II of the Principles and Objectives, which in Article 3, that mention about the purpose of the implementation of the traffic is for the realization of traffic services which survived, orderly, safe, integrated, and smoothly. In

addition, for the realization of attitude traffic and improve the culture of the nation as well as the realization of enforcement and legal certainty for the community. With the traffic rules, there are also necessary signs or cues of a traffic light that aims to give a sign or warn, and regulate the traffic of people or vehicles on the crossing. Traffic lights are a sign for the vehicle about the time when to run and stop back by turns from a variety of directions. In addition, the existing traffic lights at the junction of this road can help to avoid obstacles because of the difference in the flow path for the movement of vehicles as well as provide facilities for pedestrians can cross the street with a sense of security and reduce the risk of accidents due to collision of vehicles from a variety of flow path. With so many important uses of traffic lights it is necessary arrangements and proper control in order to provide smooth traffic at an intersection.

Based on the observations in general [1], today there are settings of the traffic that are not optimal. For example, we often see a traffic light with time colored lights of red and green that are not harmonious, causing long queues of vehicles or the occurrence of a traffic jam. Some of the things that can cause traffic congestion is the presence of a current to be incompatible, the buildup of volume of vehicles, the lack of road capacity, the type of the vehicle, as well as human behavior or road users. Based on [2], there are other causes that may affect the congestion that is parking on the road. These circumstances made the sections of the road able to load the number of vehicles passing, finally it came to pass congestion and peaked at the time of rush hour.

With some of these observations then we can calculate the associated capacity is the right way to load a volume of vehicle without consuming the bodies of the way so that we get the difference that can be used to determine the magnitude of the values that affect the intensity of the service road. The last goal, namely to deal with the level of congestion in the region observations made several steps based on the previous analysis is to determine the level of service of magnitude more than the ideal figure. With the reduction of those numbers to the ideal $(0,8 \pm 0,9)$ obtained figures should be lowered. That must be the control activity to lose its influence over the level of service. If the result is not sufficient, then it should be done to control the use of the road as optimal as possible, namely by the control of parking on the street. With the banning of the activities of parking on the street, as a result there should be implementation of the parking space in accordance with the volume of the vehicle. If not allow the presence of a parking space, it must be done to control the number of vehicles

passing through the road. Where some type of vehicle which has a body width large like a truck, pick up, bus given a separate time to interact on the road.

Settings like this should also be applied in the Street Dr. Setiabudi, because in the vicinity of the intersection palimanan, precisely at Jalan Dr. Setiabudi still there is a parking area using the road, one of which has been submitted previously that the presence of the terminal is not officially on the road so a lot of bus - bus parking take the road and it is not uncommon to reap the congestion. Setting the traffic at the Intersection of Palimanan is still not optimal, for example the duration of green light is shorter and there is a flow of incompatibility that leads to long queues and traffic jams. Here is a floor plan which is presented in figure 1.
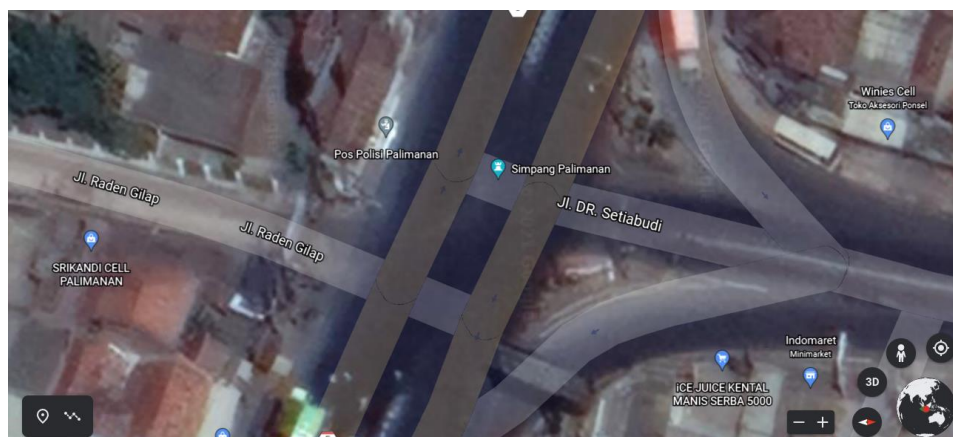

Figure 1 the Flow of Traffic at the Intersection of Palimanan

Specifications Intersection Palimanan listed in table 1.

Table 1 Specifications Of The Intersection Of Palimanan

Descriptions	Specifications
Type	4/2D
Status Of Development	National
The function of the road	Primary Arterial
The Width of the road	$\pm 20m$

To facilitate the observation, floor plans above are converted into a series of traffic flow in figure 2.
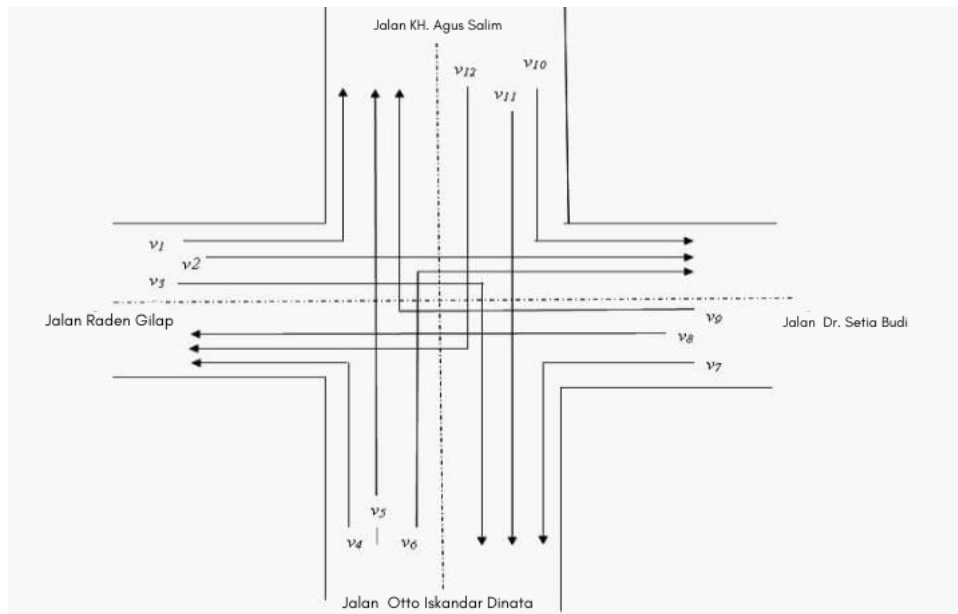
Figure 2 the Transformation of the Flow of Vehicles at the Intersection of Palimanan

Currently Incompatible are the two traffic flows or is that left to go hand in hand although can increase the buildup of the vehicle and cause the vehicle to scramble the way [2]. As an example of the flow of incompatible events that are in the picture above is the flow that occurs in v_2 and v_8. Both the current running simultaneously, causing a buildup of vehicles and traffic congestion. Based on the research conducted it turns out that the flow v_2 bypassed by approximately 35 vehicles and current v_8 traversed by the 50 vehicles, which means there are a total of 85 vehicles passing through the road simultaneously so that each vehicle scrambling looking for an empty street. This resulted in the duration of colored lights green the sign of the vehicle that has been set by the Department of Transportation could not be applied optimally done by the user of the vehicle [2]. With it, the problems related to the current in such traffic can be optimized by using the Algorithm Welch-Powell as well as the chromatic Number. Things to do in using this algorithm is to perform the modeling of traffic into a picture graph, set the algorithm welch-powell, then run the staining at the point of the graph, determine the chromatic number , and calculate the time duration of the lights from green to red light. For the application of the algorithm welch – powell had already been investigated by some researchers that Purnamasari, et al. [3] that maximizes route traffic at the intersection of Empat Kalimas Bekasi Timur. In addition it is also applied by Susiloputro [4] to perform the scheduling of the exam as well as Meyliana and Maryono that optimize coordinating the traffic in the City of Depok but they apply algorithms that are not the same as before, i.e. they use greedy algorithms. Graph theory is used to perform the optimization of a coloring of a graph and the chromatic number. According To Budayasa [5] there are two kinds of graph coloring (graph colouring), i.e., staining the point (vertex) as well as staining the side (edge). For example G is a graph. A coloring of k of G that is staining all the parts at the point G, which of course relates directly (neighbors) will get different colors. The number

of minimal colors used for coloring the points on a graph is the next one referred to as the chromatic number [5]. Setiawan [4] applying the Algorithm Welch-Powell to be able to maximize the settings of the Traffic Light. He often encountered the buildup of vehicles that often occur along the way and always inhibits the activity of everyday life. The results of the calculations for the intersection of Jerakah no more effective than primary data because at that intersection has been the calculation of the most effective established by the Department of Transportation of the City of Semarang and the calculation of the intersection of college of Health Sciences Tlogorejo has produced a level of effectiveness that is more effective than from the primary data.

In addition to this, Hutabarat carried out the implementation of coloring a graph on the mapping area in Kabupaten Serdang Bedagai. Not only that, Hutabarat also performs the application of coloring a graph on solving the problems of the preparation of the schedule. Next there is Faisal [6] that has applied a staining technique to choose the route traffic that is applied using Greedy algorithms. Then Nugroho carried out an analysis of the policy to turn left directly on to the traffic at the intersection. While the research is intended in the application of the algorithm Welch-Powell as well as the chromatic number for an arrangement of traffic at the Intersection of Palimanan Cirebon Regency.

3. Methods

In this research approach will be used, namely the fusion of the approach of qualitative as well as quantitative. For the quantitative approach alone, discuss the number of vehicles that pass through the currents at certain times. The qualitative approach is discussed not only in numbers but also about the level of density of vehicles, fluency of traffic flow as well as the behavior of the riders. This research can be referred to using a qualitative method because based on what has been described by Moleong, this research will study the behavior of motorists who became one of the main aspects in the life of society and the conditions in the field. Next, can represent the community's views and convey the wishes of the citizens (particularly the driver), then include the state of the contextual citizens, namely road users, donate knowledge related to optimization of the settings of the flow of traffic that will be useful to describe the behavior of social communities, particularly road users, as well as be able to wear more than one source of actual data is written, data is the results of observation and documentation.

Stages observations to be carried out is:

a. Collecting data and documentation of Direct Observation,

b. Carry out observations/observation of traffic flow during peak hours i.e. 06.30 - 07.30 am and 16.30 - 17.30 performed at the location of the observation that the Intersection of Palimanan.

c. Collects data of the traffic flow.

d. Modeling traffic flow at the Intersection of Palimanan.

e. Applying the algorithm Welch-Powel to study the data model .

f. Carry out the coloring a graph and calculate the chromatic number .

g. Linking the results of the algorithm as well as the chromatic number of graphs .

h. Summarize the results of the analysis or study

4. Results and Discussion

4.1 Presentation of Data

Data the duration of the lamp based on the observations on the intersection of palimanan presented in table 2

Table 2 Data the Duration of the Time of the exchange of the color of traffic lights at the intersection of palimanan

No	traffic flow	Eksisting (Dua Fase)					
		Red	Green	IG	All Red	Delay Traffic	Queue Length
1	North (Raden Gilap)	102	20	5	1	1050.5	249.8
2	South (Setia Budi)	102	20	5	1	975.6	267.5
3	East (Otto Iskandardinata)	45	102	5	1	578.4	135
4	West (Agus Salim)	122	25	5	1	315`78	105.4

Source: Observation

From the results in figure 2, presented the following data on the volume of vehicles that cross the flow of traffic observed at the peak hour.

Name of the current traffic	Traffic Flow	The Volume of Vehicles
The Flow Of Raden Gilap towards Agus Salim	v_1	15
The Flow Of Raden Gilap towards Setia Budi	v_2	35
The Flow Of Raden Gilap towards Otto Iskandardinata	v_3	20
The Flow Of Otto Iskandardinata towards Raden Gilap	v_4	35

The Flow Of Otto Iskandardinata towards Agus Salim	v_5	80
The Flow Of Otto Iskandardinata towards Setia Budi	v_6	60
The Flow Of Setia Budi towards Otto Iskandardinata	v_7	70
The Flow Of Setia Budi towards Raden Gilap	v_8	50
The Flow Of Setia Budi towards Agus Salim	v_9	35
The Flow Of Agus Salim towards Setia Budi	v_{10}	30
The Flow Of Agus Salim towards Otto Iskandardinata	v_{11}	70
The Flow Of Agus Salim towards Raden Gilap	v_{12}	50

Source : Observation on Sunday and Monday(6 and 7 November 2021).

4.2 Data Analysis

The currents are incompatible (should not be running simultaneously) is

a. Traffic Flow v_2 with $v_5, v_6, v_9, v_{11}, v_{12}$

b. Traffic Flow v_5 with $v_2, v_3, v_8, v_9, v_{12}$

c. Traffic Flow v_3 with $v_5, v_6, v_8, v_9, v_{11}, v_{12}$

d. Traffic Flow v_6 with $v_2, v_3, v_8, v_9, v_{11}, v_{12}$

e. Traffic Flow v_8 with $v_3, v_5, v_6, v_{11}, v_{12}$

f. Traffic Flow v_{11} with v_2, v_3, v_6, v_8, v_9

g. Traffic Flow v_9 with $v_2, v_3, v_5, v_6, v_{11}, v_{12}$

h. Traffic Flow v_{12} with $v_2, v_3, v_5, v_6, v_8, v_9$

Furthermore, the problems of traffic flow can be modeled into a graph with the terms of the current must be described as a point, then the current incompatible side graph [3]. So that the obtained graph of the current incompatible in accordance with figure 3 is as follows:
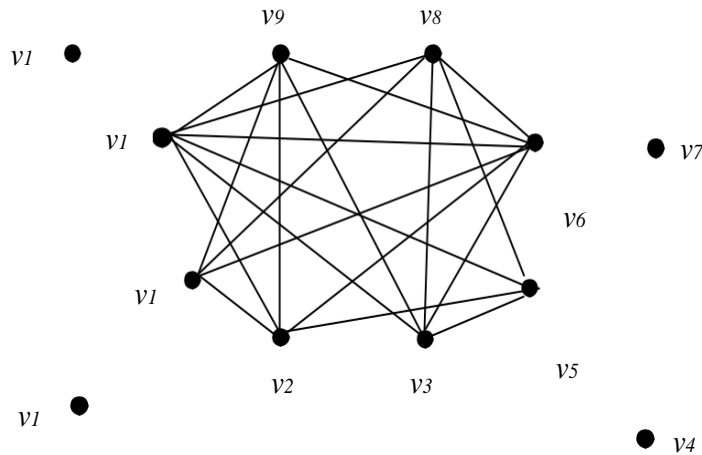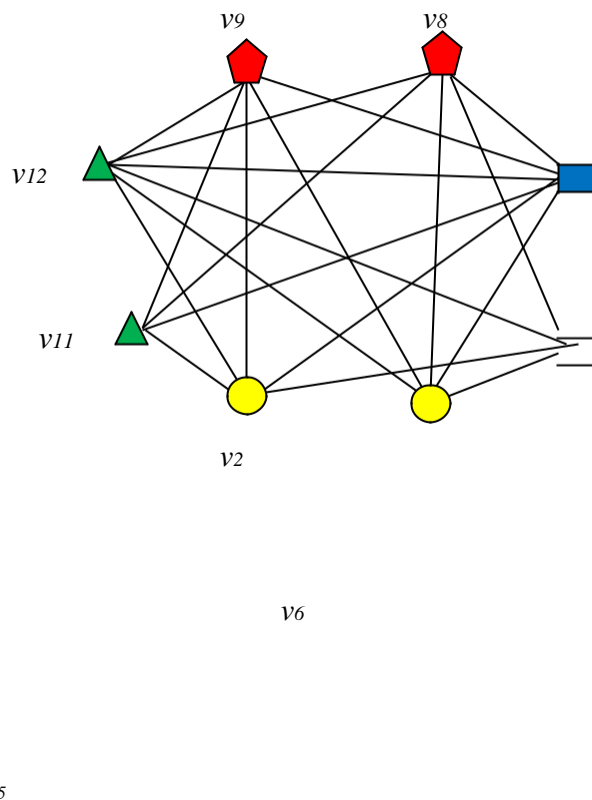
Figure 3 Graph model of the problem of the traffic flow of the intersection palimanan

A graph is then stained with the principle of two points that relate directly or neighborly should be given different colors. Next is to calculate the chromatic number, namely the minimum number of colors is a graph. One of the results of staining of the graph above is as figure 4. Chromatic number obtained from the results of the staining [2].

Image 4 of Coloring a graph model of the traffic Flow of Intersection Palimanan

Based on figure 4, the chromatic number of graph that there are 4, it is seen that the first color (yellow), namely v_2 and v_3, the second color (blue) is v_5 and v_6, the third color (red) is v_8

and v_9 , the fourth (green) is v_{11} and v_{12} . Therefore the flow of traffic that is allowed to be run simultaneously, is:

I. The traffic coming from the direction of jalan Raden Gilap to Setia Budi simultaneously with the flow of Raden Gilap towards Otto Iskandardinata

II. The flow of Otto Iskandardinata towards Agus Salim simultaneously with the flow of Otto Iskandardinata towards Setia Budi

III. The flow of Setia Budi towards Raden Gilap simultaneously with the flow of towards Setia Budi menuju Agus Salim

IV. The flow of Agus Salim towards Raden Gilap simultaneously with the flow of Agus Salim towards Otto Iskandardinata

Based on the data that has been obtained in the field after carrying out the observations in the peak hours, if the current incompatible is allowed to run simultaneously, then there will be krodit. For example, the current that comes from jalan Raden Gilap towards Setia Budi traversed 35 vehicles and current coming from the direction of Setia Budi towards Raden Gilap skipped as many as 50 vehicles, akibatnya akan terjadi perebutan jalan oleh 85 vehicles in a period of time simultaneously. This will result in krodit, crash, vehicle queue length. With that based on the calculation Algorithm Welch Powell obtained suggestions to the new data set lanes to 4, the duration of the red light will be reduced to 70 seconds and the duration of the green light will be increased to 50 seconds, but the current incompatible, flows that should not be running simultaneously, does not happen again, thereby reducing congestion due to crowd (crowded). The following data the duration of the new can be asked.

Table 4 Proposed duration of the new green light-red the Intersection of Palimanan

Traffic Flow	Observation Data		New Proposal	
	Red	Green	Red	Green
North	102	20	70	50
East	45	102	70	50
South	102	20	70	50
West	122	25	70	50
Total	**371**	**167**	**280**	**200**

5. Conclusion

The problems of congestion and buildup of the volume of vehicles trailing the length at the intersection of palimanan can be solved using the principle of the optimization Algorithm by applying the Welch Powel with and determining the chromatic number of graphs. After doing the analysis, it can be concluded that optimization can be obtained by eliminating incompatible currents, then changing the duration of the green light and red light. This setting will cause the reduction of the duration of the red light and increase the duration of the green light, but no current incompatibility.

Documentations

Photos	Descriptions
	The Flow of The Street Otto Iskandar Dinata
	The Flow of The Street Setia Budi

	The Flow of The Street Agus Salim
	The width of the Road Intersection Palimanan from Google Earth

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