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Implementation Coloring Graph and Determination Waiting Time Using Welch-Powell Algorithm in Traffic Light Matraman

Mathematics

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***Abstract*—**Traffic jam often occurs while going to somewhere and interfere daily activities. Traffic jam happens because of the movement conflict at the intersection. Traffic is an important thing in controlling the intersection. The use of Welch -Powell algorithm to optimize the traffic light. The purpose of this research is to find out: (1) application of graph coloring on the intersection using the Welch -Powell algorithm to optimize the traffic light settings and, (2) finding out the calculation of waiting time results accord to coloring graph with the arrangements that have been adopted. The research method is including some steps that is data collection, data analysis and processing, manufacturing simulation, and conclusion. The data that used in this paper is primary data. Retrieval of data held in Matraman intersection, East Jakarta. The data is taken by the duration of the red light, yellow, and green when its turn on each the intersection .The obtained data then analyzed by several steps, that is (1) transforming the intersection into the form of graphs; (2) Coloring graph using Welch -Powell algorithm; and (3) calculating the duration of the settlement alternative traffic light and then calculate the level of effectiveness, subsequent manufacture of simulation. From this analyze we know that the results of the calculation is for the intersection. By this application, hope that can handle of the problem at the intersections traffic light and reduce traffic jam.

Keywords: *coloring graph, traffic light, welch-powell algorithm..*

I. INTRODUCTION

The operation of standard traffic lights which are currently deployed in many junctions, are based on predetermined timing schemes, which are fixed during the installation, and remain until further resetting. The timing is no more than a default setup to control what may be considered as normal traffic. Although every road junction by necessity requires different traffic light timing setup, many existing systems operate with an over simplified sequence. This has instigated various ideas and scenarios to solve the traffic problem.

Problem solving traffic light can be reviewed in the perspective of the graph, namely by representing the junction in the form of a graph. Vertex graph shows the direction of travel is allowed on the road X towards the Y, meanwhile the edge graph indicates the direction of travel that should not be done simultaneously. Subsequently finish with vertex coloring method using Welch - Powell algorithm.

This settlement will generate currents that can run simultaneously, but it also gained new alternative cycle duration. This new cycle duration will be compared with the cycle time of secondary data from the traffic light Matraman and is expected to be a solution for road users in order to speed up the waiting period when the red light is on.

II. BASED THEORY

A. Graph

An undirected graph G is given by an ordered pair G= (V, E), where V is a set of vertices, |V|= n, and $E \subset V\ x\ V$- a set of edges, |E|= m. Two Vertices u, v ∈ V are called adjacent if they are connected by an edge: {u, v} ∈ E. An edge and a vertex on this edges incident. The degree deg (v) of a vertex v is measured as the number of edge incident to the vertex v: deg (v) = | {e∈: v ∈e}|.

B. Vertex Coloring

Let G be a graph without loops. A k-coloring of G is an assignment of k colors to the vertices of G in such a way that adjacent vertices are assigned different colors. If G has a k-coloring, then G is said to be k-colorable. The chromatic number of G, denoted by$\chi(G)$, is the smallest k for which G is k-colorable.

The color on a vertices can be represented by numbers or can also be represented directly using the color for example red, green, blue, yellow and others. The main problem in the coloring of the vertices is the search for solutions which use a minimum number of colors. The minimum number of colors used to color the graph is called the chromatic number

One algorithm that gives a good solution to a vertex-coloring problem is the *Welch•-Powell algorithm*. It may not always give the best solution, but it will usually perform better than just coloring the vertices without a plan will.

The Welch-Powell algorithm consists of the following steps:

1. Find the valence for each vertex.
2. List the vertices in order of descending valence (you can break ties any way you wish).
3. Color the first vertex in the list (the vertex with the highest valence) with color 1.
4. Go down the list and color every vertex not connected to the colored vertices above the same color. Then cross out all colored vertices in the list.
5. Repeat the process on the uncolored vertices with a new color - always working in descending order of valence until all the vertices have been colored.

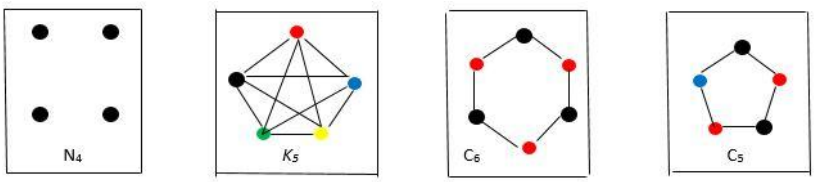

Figure 1. Example Chromatic Number

III. METHOD RESEARCH

To conduct the study must consider the procedures and steps that will be taken to initiate research that can be focused and performing well in terms of research reporting.

A. Method of Collecting Data

Research using several types of data collection methods, among others: the study of literature by collecting journals both national and international, dealing with Welch-Powell algorithm on graph coloring and traffic light settings, as well as field observations.

B. Method of Data Analysis

Qualitative methods used to identify and formulate the design principles Welch - Powell algorithm on graph coloring and setting the current total waiting time at traffic light intersections through qualitative descriptive analysis and content analysis. Literature study method is used to analyze matters concerning the concept of Welch - Powell algorithm on graph coloring and total waiting time at traffic light.

IV. RESULTS

A. Implementation of vertex coloring on traffic light Matraman

Traffic light available at a road intersection has several purposes, such as avoid obstacles because of differences in the flow path for the movement of vehicles, in order to facilitate pedestrians can cross

safely, and reduce the rate of accidents caused by collisions due to differences in the flow path. But traffic light also has some problems that need to be resolved, one of the setting from duration of the red and green lights. This problem can be studied using the principle of vertex coloring settings.

For more details, here are the steps vertex coloring app on the traffic light at the intersection:

1. Transforming the crossroads along the current into the form of graphs. The vertex represents the current and the edge represents uncompatible currents, meaning that currents that should not be run simultaneously, which further vertices are interconnected.
2. Coloring each vertex in a graph using the Welch - Powell algorithm. In addition to knowing where the currents that could run concurrently, obtained also the amount of chromatic number that will be useful at a later stage.
3. Specifies an alternative to the settlement duration of green lights and red lights with a certain time cycle, how to divide one cycle consisting of a total duration of red and green light with chromatic number has been obtained from step 2 , the result of the division indicates the duration of the green light .

The following will describe one of case settlement arrangement that traffic light of Matraman intersection. Here is an illustration of the road at the intersection Matraman.

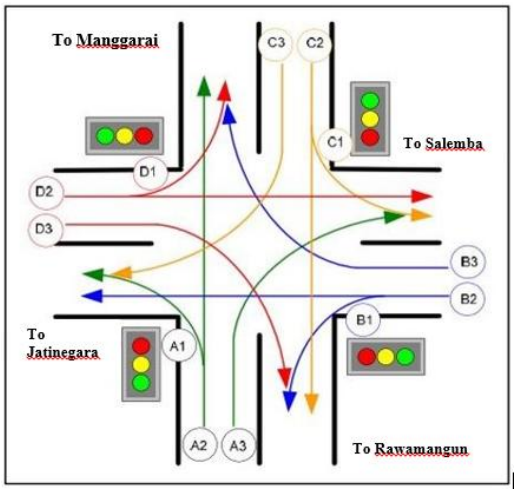

Figure 2. Illustration of Matraman traffic light

From the illustration Figure 2 by referring to the steps that have been described previously obtained results graph transformation as follows:

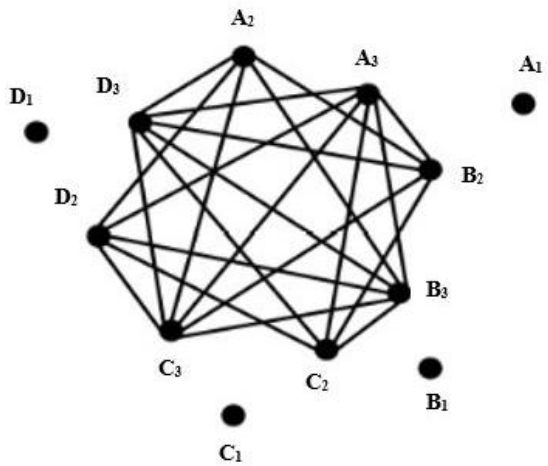

Figure 3. Graph of Matraman Traffic Light

From transformation of graph above, we know that the vertex A_1, B_1, C_1, D_1 are vertex foreign, it's mean that A_1, B_1, C_1, D_1 can simultaneously with other currents. So for the current stated by A_1, B_1, C_1, D_1

always apply the green light. Then, to the remaining vertex will be colored with Welch-Powell algorithm. Vertex coloring produced can be seen in Figure 4 below:

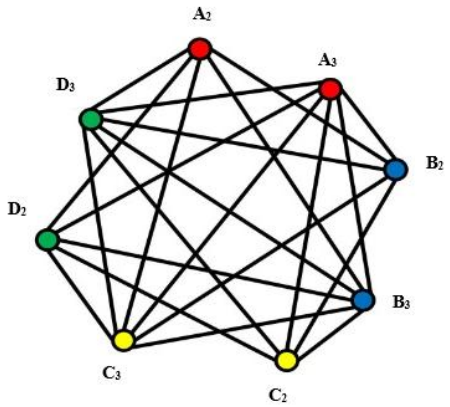

Figure 4. Result of Coloring Graph at Matraman Traffic Light

Obtained by the above coloring graph of chromatic number is 4 and the currents can be together as bellows:

Table 1. Vertex Colors Graph Matraman Traffic Light

Colors	Vertex
Red	A_2, A_3
Blue	B_2, B_3
Yellow	C_2, C_3
Green	D_2, D_3

From Table 1, can be formed partition of settings traffic light as bellows: 1) First partition, the current A_2 goes along with the current A_3, 2) Second partition, the current B_2 goes along with the current B_3, 3) Third partition, the current C_2 goes along with the current C_3, 4) Fourth partition, the current D_2 goes along with the current D_3.

Table 2. Primary Data of Matraman Traffic Light

Intersections	Red	Yellow	Green	Total
Rawamangun	420	2	15	**437**
Jatinegara	244	2	85	**331**
Manggarai	320	2	42	**364**
Salemba	162	2	195	**359**
Total	**1146**	**8**	**337**	**1491**

Based on primary data obtained has found that intersection Matraman cycle time and the amount of chromatic number is 4. For alternative settlement of traffic lights can be seen below.

Table 3. Alternative settlement duration of traffic lights

Intersections	Traffic Light	Calculation	Results (second)
Rawamangun	Green Yellow Red	437/4 437-109.25-2	109.25 2 325.75
Jatinegara	Green Yellow Red	331/4 331-82.75-2	82.75 2 246.25
Manggarai	Green Yellow Red	364/4 364-91-2	91 2 268

Salemba	Green Yellow Red	359/4 359-89.75-2	89.75 2 267.25

from the above data, found that the results of new data as follows:

Table 4. New Data of Matraman Traffic Light

Intersections	**Red**	**Yellow**	**Green**
Rawamangun	325.75	2	109.25
Jatinegara	246.25	2	82.75
Manggarai	268	2	91
Salemba	267.25	2	89.75
Total	**1107.25**	**8**	**372.75**

Based on the duration of the red light and green light on traffic light Matraman. it can be seen that the new data the result of resolving cases Matraman traffic light settings by using welch-powell algorithm more effective than primary data. The following table is presented primary data and new data Matraman traffic light.

Table 4. Primary Data and New Data of Matraman Traffic Light

	Primary Data			**New Data**		
Intersections	**Red**	**Yellow**	**Green**	**Red**	**Yellow**	**Green**
Rawamangun	420	2	15	325.75	2	109.25
Jatinegara	244	2	85	246.25	2	82.75
Manggarai	320	2	42	268	2	91
Salemba	162	2	195	267.25	2	89.75
Total	**1146**	**8**	**337**	**1107.25**	**8**	**372.75**

The total duration of the green light from the primary data is 337 seconds, while the total duration of the vertex coloring green light was 372.75 seconds. The level of effectiveness that is

$$\frac{375.75 - 337}{337} x100\% = 11.49\%$$

The total duration of the red light from the primary data is 1146 seconds, while the total duration of the vertex coloring red light was 1107.25 seconds. The level of effectiveness that is

$$\frac{1146 - 1107.25}{1107.25} x100\% = 3.49\%$$

So for the case Matraman traffic light, green light duration will increase by 11.49% while the duration of the red light can be reduced by 3.49%

CONCLUSION

Based on the analysis and discussion can be drawn the conclusion that implementation of the intersection graph Welch - Powell algorithm for optimization of traffic light settings is by means (1) Transforming intersection along the current path to the form of graphs, (2) Coloring each vertex in the graph with Welch - Powell algorithm, (3) Determine the duration of the settlement alternative green light and red light, (4) Calculating the total duration of effectiveness level traffic light.

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