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Application of Graph Hamilton on Determining the Shortest Route of *Trans Metro Bandung*

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Abstract

Graph applications develop quite rapidly in the transportation system. One of the applications is used to search for travel routes. The route from a terminal to an intersection that must be passed exactly once and must return to the original terminal is a very important issue. Determination of the TMB travel route (Trans Metro Bandung) using the Nearest Neighbor method. The results show that the TMB bus journey on corridor 2 (Cibeureum - Cicaheum) can be formulated into graph form. The bus transportation system is modeled in graph using the point symbol (Vertex) as a shelter and edge symbol as a path that connects between shelters. The TMB bus route in the graph is a closed track and is called the Hamilton Cycle. The results of route calculation and search from TMB corridor 2 produce different routes and distances from the initial, including: St. Ah. Nasution - St. Ahmad Yani - St. Ibrahim Adjie - St. Jakarta - St. Ahmad Yani - St. Asia Afrika - St. Sudirman - St. Rajawali Barat - St. Elang - St. Rajawali Timur - St. Kebon Jati - St. Perintis Kemerdekaan - St. Lembong - St. Ahmad Yani - St. Ah. Nasution. From a distance of 28.4 km to 27.65 km.

Keywords:
Graph Hamilton, Cycle Hamilton, Nearest Neighbor, Trans Metro Bandung.

1. INTRODUCTION

Resolving the problem of transportation routes and accurate traffic (Jiang Zhao et al., 2018) is the key to controlling transportation and traffic routes (Lun Zhang et al. 2013). The routes is visiting each node for exactly once no through any repeated path (Tan 2015) also a Hamiltonian Path in a connected graph is a path which contains each vertex of graph exactly once (Dharwardker et al., 2007), it is to find the shortest Hamilton cycle in the graph (Fleischner et al., 1974), There are a number the algorithm used to find the optimal route (Johnson et al., 2002), but it doesn't exist worthy of a big example because everything grows exponentially (Steven Farber et al., 2009).

Graph theory is a branch of discrete mathematics (Song et al., 2013). Graph theory is the study of graphs which are mathematical structures (Dogan et al., 2013) used to model pair wise relations between objects. A graph is made up of vertices V (nodes) and edges E (lines) that connect them (Zia UI hussain et al., 2016). A Graph is an ordered pair $G = (V, E)$ consist a set of vertices V with a set of edges E (Kaundal et al., 2017).

The travel route covered in this article is the TMB (*Trans Metro Bandung*) corridor 2 transportation system in the form of the Hamilton Cycle also has two travel routes, namely the initial route and alternative routes with different distances. The aim is to formulate the TMB travel route into graphical form and find the shortest route using Nearest Neighbor method; it has characteristics determination of distribution routes in accordance with real conditions, contained in conditions in the field (Kushe et al., 2017).

2. METHODOLOGY

2. 1. Nearest Neighbor Method.

Nearest Neighbor method is chose one point that focuses on the beginning, and selects the next point that has a distance from the previous point (Xiyu Pang et al., 2016). If all points are connected, then close the trip by returning to the starting point (Madona et al., 2013).

The following in table 1 are the steps that must be taken in the construction of route formation with the Nearest Neighbor method (Rifai 2009).

Table 1. The steps in the nearest neighbor method

STEPS	INFORMATION
1	Inisialization: 1. Determine one point that will be the starting point of the trip. 2. Determine C = {1, 2, 3, 4, ... , n} as the set of points to be visited. 3. Determine the order of the route of travel (R).
2	Choose the point that will be visited next If n_1 is the next n_2 point that has a minimum distance with n_1, where n_2 is a member of C. If there are many optimal choices, it means that there is more than one point that has the same distance from the last point on route R and that distance is the minimum distance then select randomly.
3	Add the point selected in step 1 to the next route sequence, then add n_2 point at the end of the temporary route and delete the selected point from the list of points that have not been visited.
4	If all points that must be visited have been entered in the route or $C = \emptyset$, then there is no point in C. Next, close the route by adding the initialization point or the starting point of the trip at the end of the route. In other words, the route is received by returning to origin. If the reverse goes back to step 1.

2. 2. Hamilton

In the given figure, graph $G\ (V, E)$, the problem is that to find Hamiltonian circuit, in the given problem contains every vertex exactly one. And it covered each vertex only once. So, this circuit is called Hamiltonian Circuit (Sutaria et al., 2016).

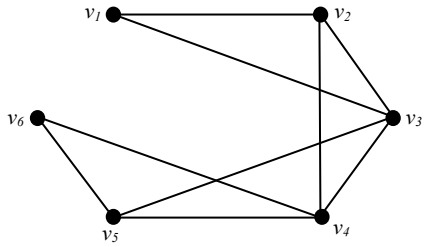


Figure 1. Hamiltonian Graph

In a figure 1 a path that cover each vertex of the given graph once and only once that is called Hamiltonian path (Kureethara et al., 2017). In graphical manner, consider that the edges between any cities, the graph shown in Figure 1 and we want to know if there is a Hamiltonian cycle in this directed graph (Grunbaum et al., 1971). This is a Hamiltonian cycle is directed cycle (Pettersson et al., 2014) because it include only once vertex exactly once (Jemal Abawajya et al., 2013).

3. RESULT AND DISCUSSION

3. 1. *Trans Metro Bandung Route*

Trans Metro Bandung corridor 2 bus route (*Cibeureum-Cicaheum*) with a total distance of 28.4 km is shown in table 1 as follows by Bandung Transportation Agency:

Table 1. Distance data for each *Trans Metro Bandung* bus stop in corridor 2 (*Cicaheum-Cibeureum*)

Shelter	Street	Location Point	Distance of the next bus stop
A	St. *Ah. Nasution*	Terminal *Cicaheum* area.	1.4 km
B	St. *Ahmad Yani*	In front of the BCA office on the cicadas street.	1.1 km
C	St. *Ibrahim Adjie*	Front ex. *Matahari*	0.4 km
D	St. *Jakarta*	70 m after St. *Kiaracondong* crossing	0.8 km
E	St. *Jakarta no.40*	In front of the building *Agronesia*	1.2 km
F	St. *Ahmad Yani*	In front of the *PERSIB* stadium.	2.2 km
G	St. *Ahmad Yani*	In front of the Post Office on St. *Kosambi*	0.7 km
H	St. *Asia Afrika*	In front of the Bank Panin office	0.45 km
I	St. *Asia Afrika*	Close to *Bandung* Square.	2.8 km
J	St. *Sudirman*	In front of the *SD. Raya Barat.*	0.9 km
K	St. *Sudirman*	70 m before the *Cibeureum* roundabout.	0.5 km
L	St. *Sudirman*	In front of the St. *Cijerah* (Pal 3)	1 km
M	St. *Rajawali Barat*	In front of the building *Gudang Barat*	0.35 km
N	St. *Elang*	Next to *Indomaret*	0.5 km
O	St. *Rajawali Timur*	60 m after the St. *Garuda* crossing.	2.4 km
P	St. *Rajawali Timur*	In front of the building *Rajawali Plaza.*	1.5 km
Q	St. *Kebon Jati*	In front of the *Kebon Jati* hospital.	1 km
R	St. *Perintis Kemerdekaan*	In front of the building *Indonesia Menggugat*	0.6 km
S	St. *Lembong*	In front of the building *Telkom Plaza*	1.3 km

T	St. *Ahmad Yani*	In front of the *Kosambi* market.	1 km
U	St. *Ahmad Yani*	In front of the building *Segi Tiga Emas*	0.9 km
V	St. *Ahmad Yani*	In front of the building *Dinas Pendidikan*	4.4 km

3. 2. Formulation of Graf Route Bus *Trans Metro Bandung*

The first step was given the *Trans Metro Bandung* corridor 2 bus model (*Cibeureum-Cicaheum*). In corridor 2 consists of 22 stops, where each stop is connected by road, in the Graph for the distance of each bus stop is the Edge of the transportation system.

From the description, it is assumed that each stop can be passed from each stop connected by road and vice versa (Glebov et al., 2017). Determination of the route or trajectory of the bus journey to find the closest distance by representing inward from the initial terminal to the bus stop by the *Trans Metro Bandung* bus on corridor 2 (*Cibeureum-Cicaheum*) to the original terminal.

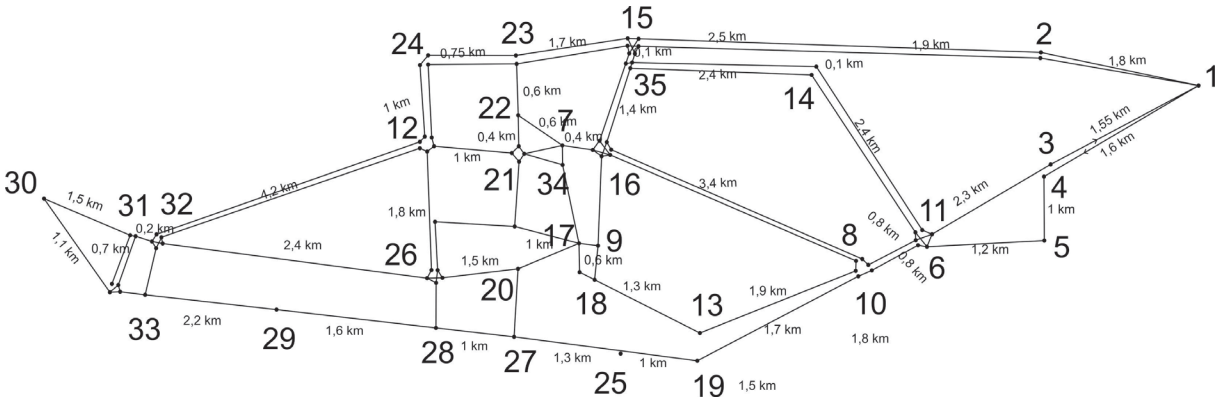
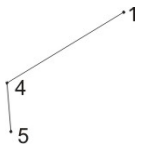


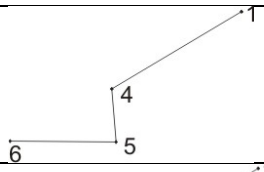
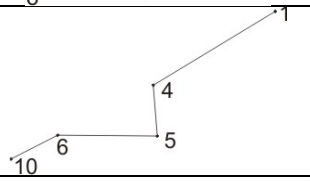
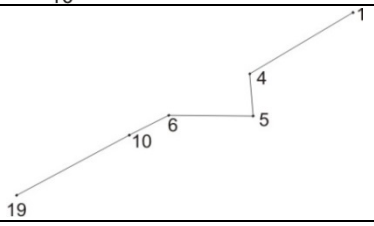
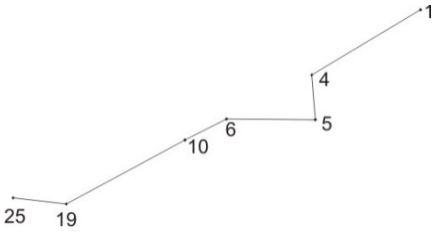
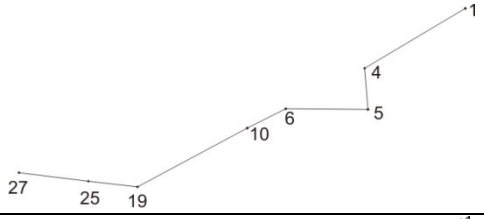
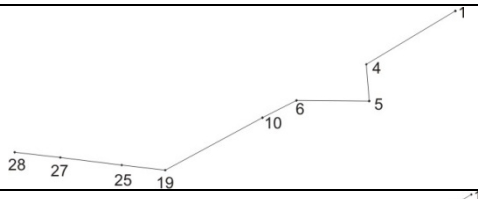
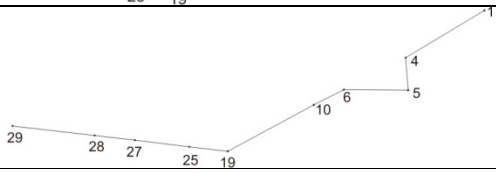
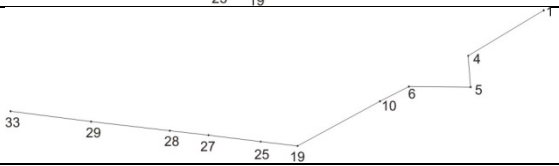
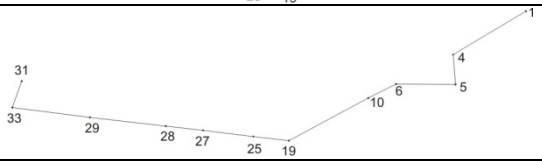
Figure 2. Road traffic from *Cicaheum* bus station to *Cibeureum* bus station.

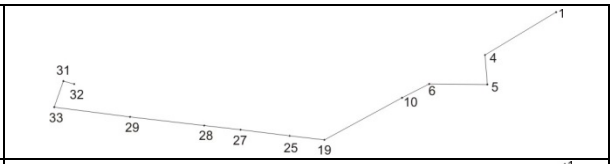
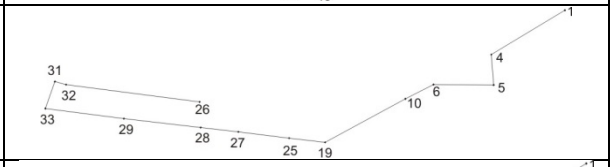
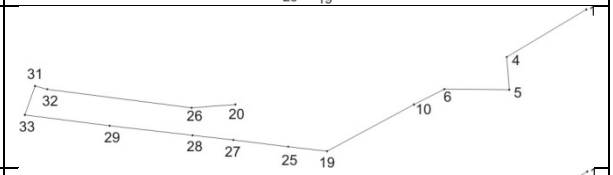
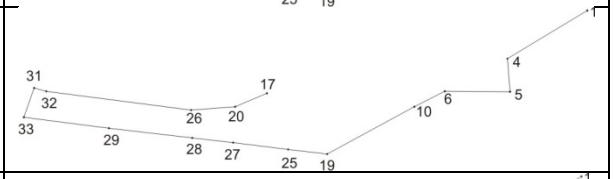
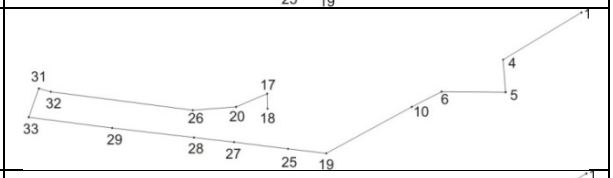
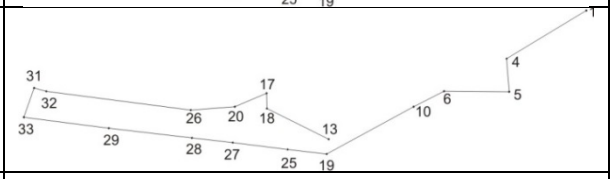
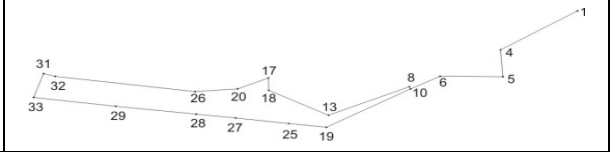
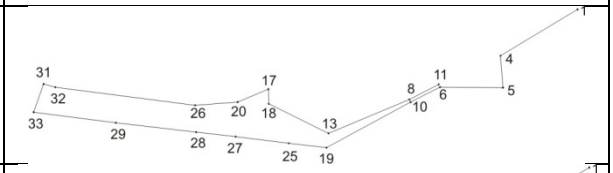
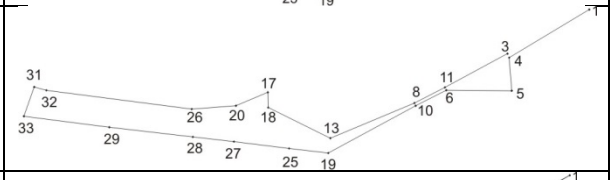
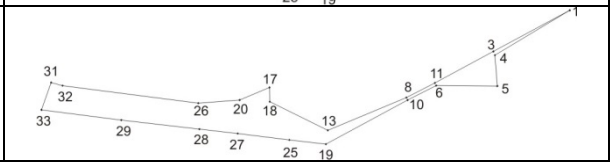
3. 3. Completion of *Trans Metro Bandung* Route with Nearest Neighbor

Resolving the *Trans Metro Bandung* bus problem in Figure 2 using the Nearest Neighbor method with the following steps in table 2:

Table 2. Steps of the Nearest Neighbor Method on Corridor 2 TMB

STEP	NEAREST NEIGHBOR METHOD	RESULT
1	Take point 1 as a terminal	
2	Selected the first intersection close to point 1, which is point 4, with a distance of 1.6 km.	
3	Selected the second intersection close to point 4, which is point 5, with a distance of 1 km.	

4	Selected the third intersection close to point 5, which is point 6, from with a distance of 1.2 km.	
5	Selected the fourth intersection close to point 6, which is point 10, with a distance of 0.8 km.	
6	Selected the fifth intersection close to point 10, which is point 19, with a distance of 1.7 km.	
7	Selected the sixth intersection close to point 19, which is point 25, with a distance of 1 km.	
8	Selected the seventh intersection close to point 25, which is point 27, with a distance of 1.3 km.	
9	Selected the eight intersections close to point 27, which is point 28, with a distance of 1 km.	
10	Selected the ninth intersection close to point 28, which is point 29, with a distance of 1.6 km.	
11	Selected the tenth intersection close to point 29, which is point 33, with a distance of 2.2 km.	
12	Selected the eleventh intersection close to point 33, which is point 31, with a distance of 0.7 km.	

13	Selected the twelfth intersection close to point 31, which is point 32, with a distance of 0.2 km.	
14	Selected the thirteenth intersection close to point 32, which is point 26, with a distance of 2.4 km.	
15	Selected the fourteenth intersection close to point 26, which is point 20, with a distance of 1.5 km.	
16	Selected the fifteenth intersection close to point 20, which is point 17, with a distance of 1 km.	
17	Selected the sixteenth intersection close to point 17, which is point 18, with a distance of 0.6 km.	
18	Selected the seventeenth intersection close to point 18, which is point 13, with a distance of 1.3 km.	
19	Selected the eighteenth intersection close to point 13, which is point 8, with a distance of 1.9 km.	
20	Selected the ninteenth intersection close to point 8, which is point 11, with a distance of 0.8 km.	
21	Selected the twentieth intersection close to point 11, which is point 3, with a distance of 2.3 km.	
22	Selected the twenty one intersections close to point 3, which is point 1, with a distance of 1.55 km.	

The TMB corridor 2 routes are obtained from the initial route, which is 28.4 km and an alternative route is 27.65 km. If it is depicted in graph, the TMB travel route is in the form of a Hamilton cycle in the following figure 3 and 4:

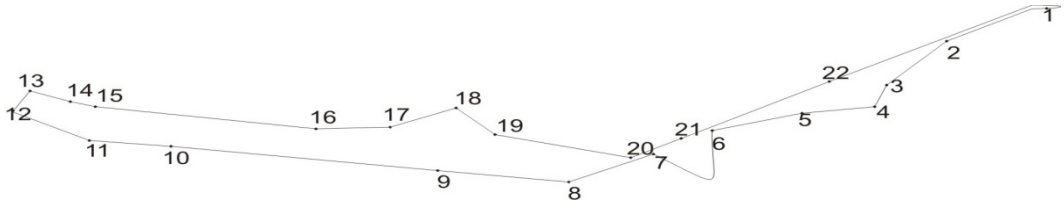


Figure 3. Road traffic TMB from *Cicaheum* bus station to *Cibeureum* bus station

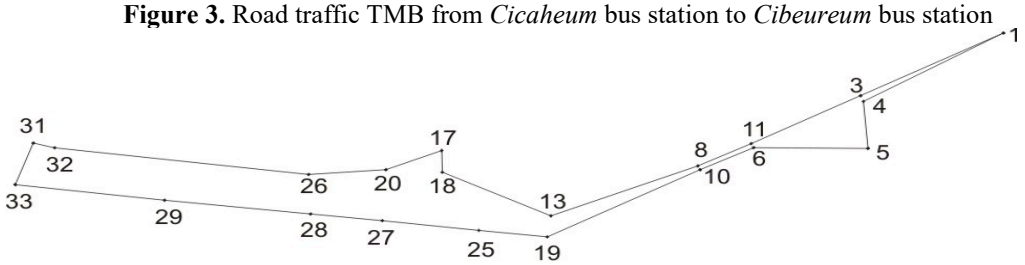


Figure 4. Road traffic TMB from *Cicaheum* bus station to *Cibeureum* bus station

3. CONCLUSIONS

Based on the description of the discussion, it can be concluded that obtained data points are 1-4-5-6-10-19-25-27-28-29-33-31-32-26-20-17-18-13-8-11-3-1 (St. *Ah. Nasution* - St. *Ahmad Yani* - St. *Ibrahim Adjie* - St. *Jakarta* - St. *Ahmad Yani* - St. *Asia Afrika* - St. *Sudirman* - St. *Rajawali Barat* - St. *Elang* - St. *Rajawali Timur* - St. *Kebon Jati* - St. *Perintis Kemerdekaan* - St. *Lembong* - St. *Ahmad Yani* - St. *AH. Nasution*) with a total mileage of 27.65 km. Because there are no bus stops twice at the same stop. The Hamilton cycle is formed on the Trans Metro Bandung route on corridor 2.

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