Graph Modeling of Arterial Roads and Collector Roads in the City of Manado, North Sulawesi as an Indicator for Determining the City Center

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ABSTRACT

The city of Manado is one of the cities that is developing rapidly, so the crowd center, residential center and office center are also experiencing shifts. The government is expected to always be present closer to the community, to create effectiveness and efficiency in administering government in a developing city like the city of Manado, vital infrastructure and public service centers must be in a position that is easily accessible to all people wherever they are in the city of Manado. Departing from this problem, an approximation is needed to determine the point in the city of Manado that has the closest distance or access to all points in the city of Manado. This research uses data in the form of sections of Primary Arterial Roads and Primary Collector Roads which are modeled in the form of a connecting graph with 61 nodes representing these road sections, which will then be carried out measuring the diameter and center of the graph. From this research, the results show that the center of the graph is at node 16 with a graph diameter of 9. From this indicator it can be concluded that the center point of Manado City is currently on Jalan Rumambi, Wenang District, Manado City. This research can be developed and more accurate results will be obtained by involving more measurement parameters.

General Terms

Artificial Intelligence, Discrete Mathematics.

Keywords

Graph, Node, Centre, Manado.

1. INTRODUCTION

A graph is a diagram that contains certain information if interpreted correctly, in everyday life graphs are used to describe various existing structures, the aim is to visualize objects so that they are easier to understand, some examples of graphs that are often used in everyday life include organizational structure, flow charts, electrical circuits, maps and others. Each diagram contains a group of objects along with lines connecting these objects, the lines can be directed or not [1]. A city can be represented in the form of a spatial network and this spatial network is defined mathematically as a graph network, various types of graphs that describe urban networks have special characteristics, the most suitable model for discretizing urban space is a spatial network, this kind of spatial simplification represents a layout topology urban areas, apart from that the spatial network functions as a data structure for storing and connecting spatial data [2].

Determining the radius, diameter and center of a fuzzy graph begins with determining the fuzzy distance. Then, look for the fuzzy eccentricity of each node in G with the maximum value of fuzzy distance. After the fuzzy eccentricity is obtained, the fuzzy radius is determined, namely the minimum value of fuzzy eccentricity, the fuzzy diameter, namely the minimum value of fuzzy eccentricity, and the central point, namely the point that has the minimum eccentricity value. Centers are in the form of different subgraphs, namely trivial graphs, empty graphs and connected graphs. The direction of the $W4$-directed wheel fuzzy graph affects the radius, diameter and center [3].

Manado City as the capital of North Sulawesi Province is experiencing rapid growth. In the spatial layout of Manado City there are service centers spread across several areas. From the results of the analysis, it was found that the distribution of social, economic and government facilities in Manado City was quite adequate, especially in sub-districts with Order I status such as Malalayang District, Mapanget District, Wanea District, Wenang District and Tuminting District. All of these sub-districts have quite complete and adequate facilities. The results of the analysis of the regional hierarchy of Manado City are divided into 4 Orders, namely Order I which consists of Malalayang, Wanea, Mapanget, Tuminting and Wenang Districts. The sub-districts in Hierarchy II are Singkil, Paal Dua, Bunaken, Sario sub-districts. And those in Hierarchy III are Tikala District, and Hierarchy IV namely Bunaken Islands District. Based on the results of the analysis, there is a mismatch between the service centers in the Manado City RT-RW in 2014-2034 and the existing conditions in 2019. [4].

Departing from the conditions as stated, the main problem is how to formulate the conditions of the city of Manado in a graph model, how to determine the center of the graph as an approach to the center point of the city of Manado. This research aims to take an approach in determining the central point of the city of Manado where along with the development of the city the position of the central point always changes from time to time using a graph model approach formulated from the main roads in the city of Manado. This research is a theoretical study in determining the center of Manado city so that it can provide input as decision support for policy makers in determining strategic positions in the city of Manado both in terms of the placement of government offices, public services such as hospitals/health centers, and even the placement of vital agencies. such as fire brigade units, anti-riot troops and so on who demand fast access to all points in Manado City quickly

2. RESEARCH METHOD

2.1 Study of literature

To obtain a theoretical basis, the sources of information used are articles, journals, reference books, and various information obtained from literature books and the internet. The main reference regarding road data used in this research is taken from the decree of the Minister of Public Works and Public Housing (PUPR) No: 430/KPTS/M/2022 concerning the determination of road sections in the primary

road network according to their function as Primary Arterial Roads (JAP) and Primary Collector Road-1 (JKP-1), [5] especially Manado City, as shown in Figure 1.

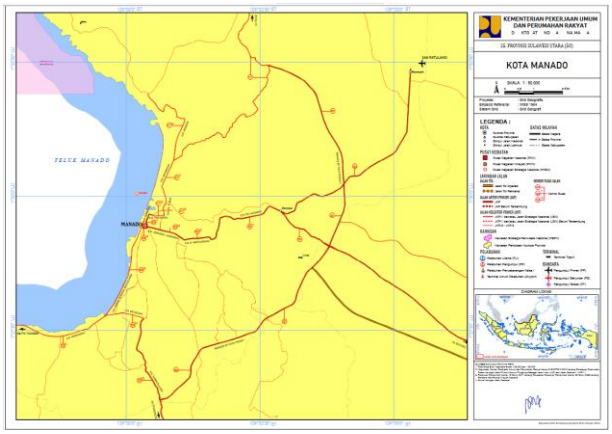


Figure 1. National Road Map of Manado City

Apart from the data before, another data source that supports this research is Manado City geospatial data [6]. which is accessed from https://geoportal.Manadokota.go.id/catalogue/#/dataset/673 in the form of a data set which is then adjusted to suit needs as can be seen in figure 2. below:

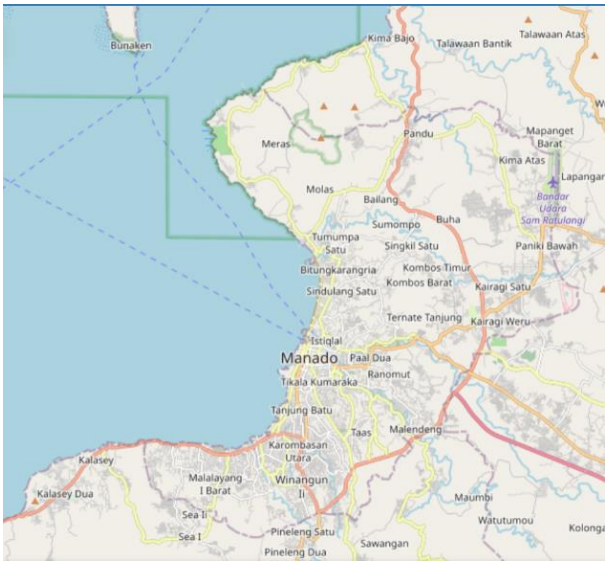


Figure 2. Geospatial Map of Manado City

2.2 Experimental Method

This experimental method was carried out by collecting data and labeling the road sections that were the object of this research, which are visible to the naked eye in Figure 2. in the form of a red, orange and yellow road map. In its implementation, this research method focuses on graphs representing the main roads in the city of Manado and then representing them in the form of numbers for more accurate data processing.

2.3 Quantitative Analysis Method

Quantitative Methods are research that will be carried out systematically, structured and in detail. In its implementation, this research method focuses on graphs representing the main roads in the city of Manado and then representing them in the form of numbers for more accurate data processing.

Table 1. Labeling of Primary Arterial Road (JAP) and Primary Collector Roads (JKP-1, JKP-2 and JKP-3)

No/ Label	Road Name	Information
1	A.A. Maramis	Follows the name on the map
2	Manado By Pass Phase II	Follows the name on the map
3	Arie Lasut	Follows the name on the map
4	Santiago	Follows the name on the map
5	Wori - Likupang	Follows the name on the map
6	Jalan Pandu	Follows the name on the map
7	Molas - Tongkaina	Follows the name on the map
8	Bailang Raya	Follows the name on the map
9	Hasanuddin I	Labeled
10	Hasanuddin II	Labeled
11	Boulevard II	Follows the name on the map
12	ST Tubun	Follows the name on the map
13	Sutomo	Follows the name on the map
14	Sisingamangaraja	Follows the name on the map
15	Lembong	Follows the name on the map
16	Rumambi	Follows the name on the map
17	Jenderal Sudirman I	Labeled
18	Jenderal Sudirman II	Labeled
19	Jenderal Sudirman III	Labeled
20	Jenderal Sudirman IV	Labeled
21	Jenderal Sudirman V	Labeled
22	Pierre Tendean	Follows the name on the map
23	RE Marthadinata	Follows the name on the map
24	Yos Sudarso	Follows the name on the map
25	MW Maramis	Follows the name on the map
26	Manado By Pass Phase IIa	Labeled
27	Manado By Pass Pahse Ia	Labeled
28	Manado By Pass Phase Ib	Labeled
29	Daan Mogot I	Labeled
30	Manado By Pass Phase Ic	Labeled
31	Daan Mogot II	Labeled
32	Daan Mogot III	Labeled
33	Daan mogot IV	Labeled
34	Daan Mogot V	Labeled
35	TNI Raya	Follows the name on the map
36	Tikala Ares	Follows the name on the map
37	Balai Kota	Follows the name on the map

38	Pumorow	Follows the name on the map
39	14 Februari I	Labeled
40	14 Februari II	Labeled
41	Diponegoro	Follows the name on the map
42	Manado By Pass Phase Id	Labeled
43	Manado By Pass Phase Ie	Labeled
44	Sam Ratulangi I	Labeled
45	Sam Ratulangi II	Labeled
46	Sam Ratulangi III	Labeled
47	Sam Ratulangi IV	Labeled
48	Ahmad Yani	Follows the name on the map
49	R.W. Mongisidi I	Labeled
50	R.W. Mongisidi II	Labeled
51	Bethesda	Follows the name on the map
52	ST. Joseph I	Labeled
53	ST. Joseph II	Labeled
54	Sulawesi I	Labeled
55	Sulawesi II	Labeled
56	Sulawesi III	Labeled
57	Maluku	Follows the name on the map
58	R.W. Mongisidi III	Labeled
59	R.W. Mongisidi IV	Labeled
60	R.W. Mongisidi V	Labeled
61	Sea	Follows the name on the map

The center of the graph is the node that has the smallest distance to all the nodes in the graph. The node that is the center of the graph can be obtained with an indicator located at the smallest value of the sum of the squares of the distances between nodes in the connected graph, mathematically it can be formulated as follows:

$$P = \min \sum_{i=1}^{61} (J(x_{i-1}, x_i))^2 \quad \text{.....(1)}$$

Where

P = Graph Center Indicator

x_i = Node -i

$J(x_{i-1}, x_i)$ = Distance of node x_{i-1} to node x_i

Meanwhile, to determine the diameter of the Manado City connection graph, it is obtained by taking the highest value of the distance between nodes in the graph, mathematically it can be formulated as follows:

$$D = \max J(x_{i-1}, x_i) \quad \text{.....(2)}$$

Where

D = Diameter of graph

$J(x_{i-1}, x_i)$=Distance node x_{i-1} to node x_i

3. RESULT AND DISCUSSION

3.1 Model of Graph

Modeling results from data on Primary Arterial Roads (JAP) and Primary Collector Roads (JKP-1, JKP-2 and JKP-3) for the city of Manado obtained a connecting graph as in Figure 3.

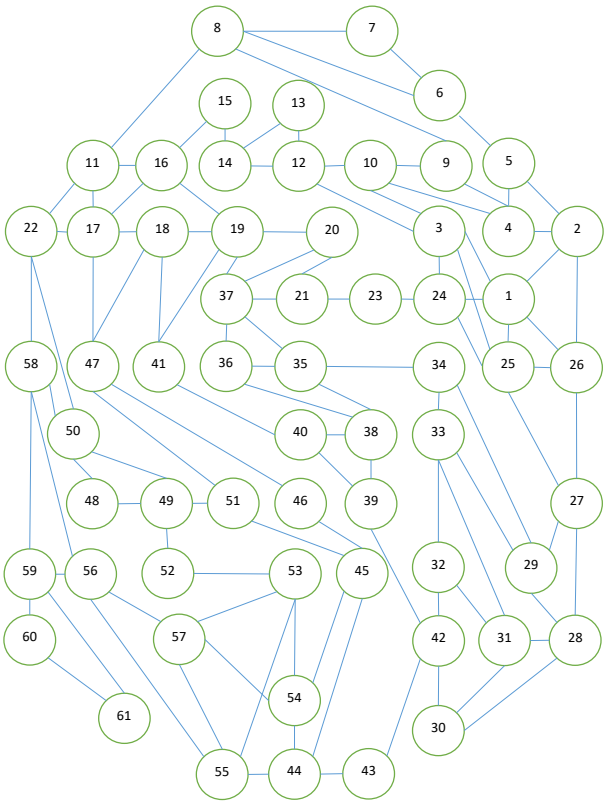
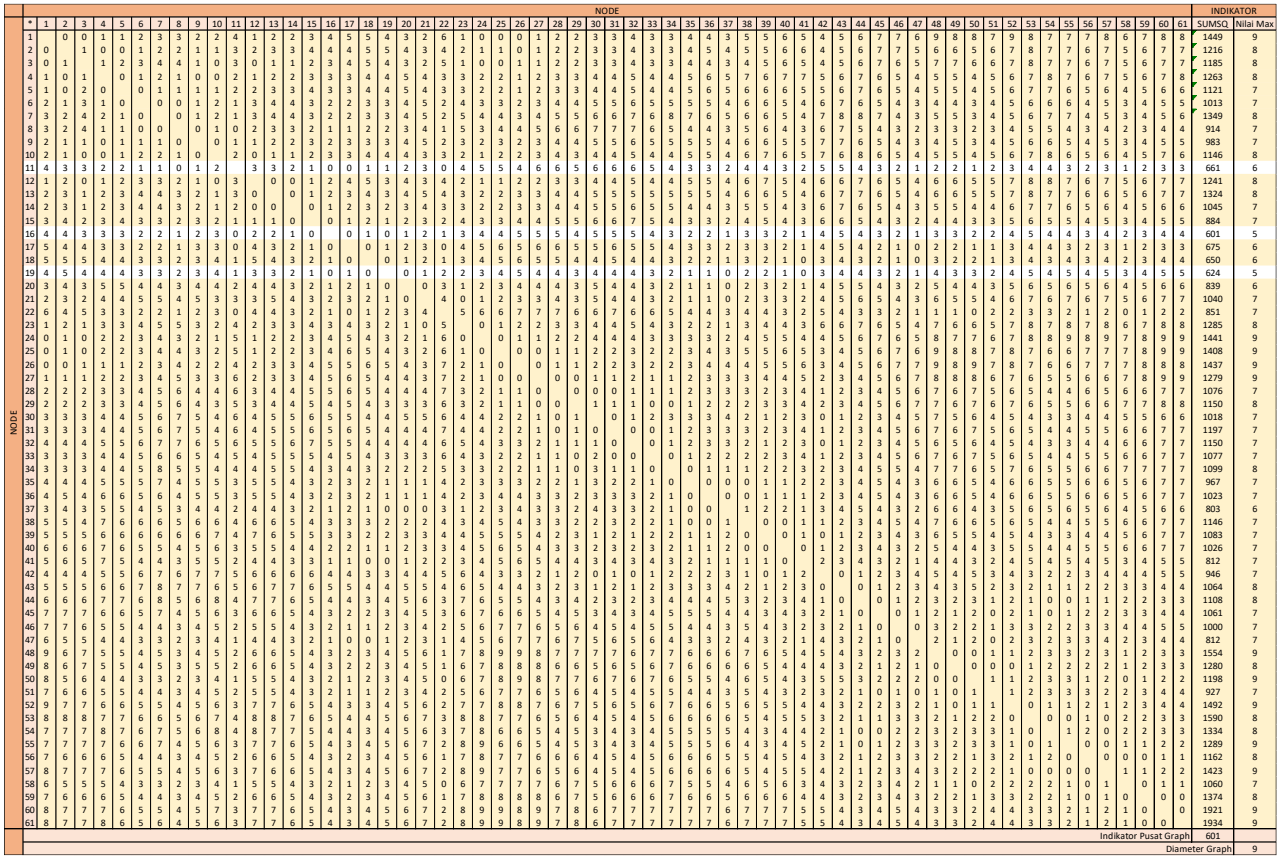


Figure 3. JAP and JAK connection graph model for Manado city

3.2 Graph Connected

The distance between nodes in the graph as in Figure 3. is then transformed into a tabulated form as in Table 2. as follows :

Table 2. Tabulation of distances between nodes in the Manado city link graph



Calculations using the python program it was found that the least squares sum ($P = \min \sum_{i=1}^{61} (J(x_{i-1}, x_i))^2$) for all data in table 3.1 was obtained at node 16 so it can be concluded that node 16 is the center of the graph. Node 16 corresponds to Jalan Rumambi in Manado City. From the connections between nodes, than the largest value/distance between nodes is 9 ($D = \max J(x_{i-1}, x_i)$) so it can be concluded that the diameter of the graph is 9

4. CONCLUSION

The Manado city graph model formulated from Primary Arterial Roads (JAP) and Primary Collector Roads (JKP-1, JKP-2 and JKP-3) in this research gives the approach result that the center of Manado city is on Rumambi Street (Jalan Rumambi) in Manado City. This research is a pilot so it still needs to be developed and to obtain more accurate results it needs to involve more parameters such as residential centers, economic activity centers, office centers and others.

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3. Head of the Electrical Engineering Department

4. Research Team (Lecturers and Students)

Hope that the cooperation that has been well established can be continued and even improved in the future.

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