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The Utilization of Geographic Information System for Damaged Roads in Medan Selayang District

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ABSTRACT

Medan Selayang District is one of the sub-districts with the most populous activity center in Medan City where there is transportation infrastructure in the form of highways with various conditions, both roads with stable and unstable conditions so that they are vulnerable to roads damage. This study aims to map the level of potential road damage and analyze the level of potential road damage in Medan Selayang District using the Geographic Information System (GIS) application. The method used in this study is a data collection and data processing method using Quantum GIS. Data processing methods are in the form of georeferencing and digitization, parameter appreciation and overlap or overlay. The parameters used include slope, rainfall, soil type, traffic volume and the availability of drainage. From the results of data processing, it is obtained that the slope of 60.86% is classified as gentle, the classification of fine soil texture is 96.28%, rainfall is classified as high with an interval of 3000 mm / year - 3500 mm / year, and there is drainage in all road sections of the study area. The map of the potential level of road damage in Medan Selayang sub-district has 3 categories of potential damage levels, namely low damage along 4,714 km (20.01%) medium damage along 13,922 km (59.12%) and high damage along 4,916 km (20.87%). The distribution of the potential level of road damage in Medan Selayang sub-district is spread for each category of damage level.

I. Introduction

Transportation services, especially land transportation, are currently the focus of the government that must be developed gradually. One of the land transportation infrastructures, such as road, has an important role in the social, economic, and cultural fields [1]. Apart from being a transportation, roads also function as a medium of socialization and accessibility for the community [2]. Roads are a means of land transportation that plays an important role in the transportation sector for connecting one city to another, between cities and villages, between villages and villages [3]. Other Road conditions that are traversed by high and repeated traffic volumes can reduce the quality of the road surface, making it uncomfortable to pass. Road damage will cause many losses that can be felt by users directly because of course it will hinder the speed and comfort of road users and cause many accidents. Accidents can be caused by several factors, including vehicle safety, human negligence, environmental conditions, and also road geometry [4]. In addition, the rate of traffic accidents is greatly influenced by human factors such as vehicle speed [5]. Factors that cause road damage include water, temperature changes, weather, air temperature, pavement construction materials, unstable soil conditions, and road damage processes [6].

Many provincial roads and regency/city roads still need to be repaired. This causes Indonesian economic growth falls behind other ASEAN countries. Based on data from the World Economic Forum, Indonesia's competitiveness was ranked 50th out of 144 countries in 2020. The competitiveness index is measured against 12 pillars, one of which is Infrastructure. This is where it is necessary to strengthen the competitiveness of infrastructure, because quality infrastructure will support the smooth operation of other development sectors.

Medan Selayang District is one of the areas with the most populous activity center in the city of Medan. Of course, there are various road conditions, both roads with stable and unstable conditions,

so they are vulnerable to road damage. Based on data from the Central Statistics Agency of Medan City in 2017, Medan Selayang sub-district has a National Road of 12.4 Km, with a total road length of 167.8 Km [7].

One of the road damages in Medan Selayang District is Flamboyan Raya Street, this road is a provincial road and the authority to repair it is the Government of North Sumatera, so this road seems to be left unattended by the Regional Government. Road damage in the area resulted in traffic jams and many potholes that endangered road users.

One way to support road management is to create spatial maps of road damage. One solution for presenting spatial data is to use a Geographic Information System [8]. With the existence of a geographic information system, it is hoped that it will make it easier to create maps that can provide information with a wide range [9]. In making road damage maps, it is influenced by slope factors, traffic volume data, rainfall data, drainage data, and land type. This road damage map makes it easy to find out the type and location of road damage that occurs on the review road section [10]. Apart from that, making this map is intended to make it easier to determine the intensity of road management that must be carried out frequently or infrequently, so that road management anticipation and planning can be easily prepared.

II. Method

A. Research Location

The research was carried out by taking objects from Medan Selayang District which are located between 3^0 31' 46.33" E and 98^0 36' 24.23" N – 3^0 34' 38.31" E and 98^0 39' 45.29" N. Medan Selayang District borders Deli Serdang Regency to the west. To the north it is bordered by Medan Sunggal District. To the east it is bordered by Medan Johor and Medan Polonia. Meanwhile, to the south, Medan Selayang District borders Medan Tuntungan.

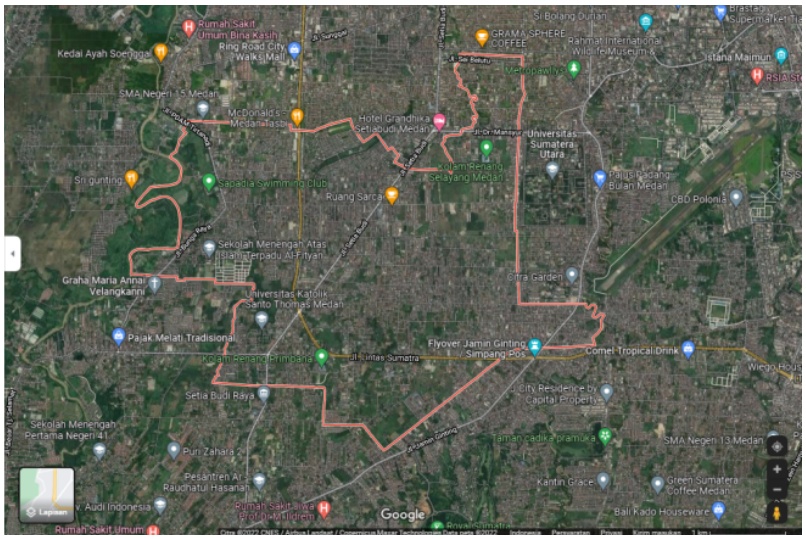

Fig 1. Research Location

B. Data Collection Method

The data used in the research from primary data in the form of traffic volume data for road sections used are from direct observation.

The secondary data is consisting of:

1) Medan Selayang District Administrative Map
2) Medan City Road Network Map (Source: *Dinas Pekerjaan Umum dan Perumahan Rakyat*)
3) Slope Slope Map (Source: *DEM Nasional*)
4) Soil Type Map (Source: *GeoNetwork FAO PBB*)
5) Rainfall Map (Source: *Badan Meteorologi, Klimatologi, dan Geofisika*)
6) Traffic Volume Data (Source: Transportation Department)

7) Drainage Map (Source: Google Earth Satellite Imagery and Google Map)

C. Data processing methods

The stages of data processing in this study use spatial data processing techniques with Quantum GIS software with the following stages:

- *Georeferencing and Digitization*

  Drainage map data and road network maps were georeferenced and digitized in the form of polygons using Google Earth and Google Maps image data. Drainage maps and road network maps in the plot use the Quantum GIS application to produce the desired spatial map.

- *Scoring*

  In making a road damage map there are five factors that influence the parameters in the following section :

  - Slope slope with scoring as follows

    Table 1. Table of slope scoring

No	Class	Slope	Scoring
1	Flat	0-2%	1
2	Sloping	2-8%	2
3	Slightly sloping	8-15%	3
4	Oblique	15-40%	4
5	Steep	>40%	5

  - Soil texture with scoring as follows

    Table 2. Modified Soil Texture scoring

No	Type of soil	Texture Class	Scoring
1	Litosol	Very rough	1
2	Regosol	Rough	2
3	Alluvial	Currently	3
4	Latosol	Fine	4
5	Mediteran	Fine	4
6	Grumusol, Andosol	Very smooth	5
7	Renzina	Very smooth	5

  - Rainfall with scoring as follows

    Table 3. Rainfall scoring

No.	Rainfall (mm/Year)	Class	Scoring
1	1500 - 2000	Very low	1
2	2000 - 2500	Low	2
3	2500 – 3000	Currently	3
4	3000 – 3500	Tall	4
5	3500 – 4000	Very high	5

  - Traffic volume scoring as follows

    Table 4 . Traffic volume scoring

No	Traffic Volume (SMP/hour)	Class	Scoring
1	≤ 1000	Very low	1
2	1000 – 1500	Low	2
3	1500 – 2000	Currently	3
4	2000 – 2500	Tall	4
5	≥ 2500	Very high	5

- Road drainage scoring as follows
  Table 5 . Road drainage scoring

No	Availability of Drainage	Scoring
1	available	1
2	Un available	5

- Overlay

  The data analysis stages are in the form of an overlay of primary data and secondary data from the scoring of each data. then the overlay results are scored with the following conditions which can be seen in table 6, thus producing a Road Damage Map in Medan Selayang District..

Table 6. Parameters of Potential Level of Road Damage

No	Potential Level	Total Dignity	Skoring
1	Very low	5 – 8	1
2	Low	9 – 13	2
3	Medium	14 – 17	3
4	High	18 – 21	4
5	Very high	22 – 25	5

In accordance with the stages of research that have been described, the research flow chart can be seen in the following Figure 2.

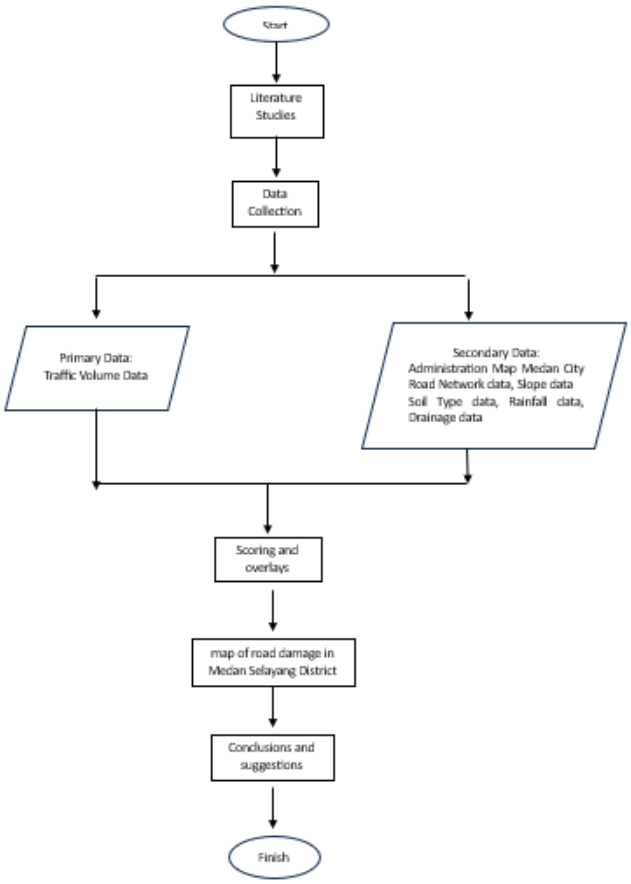

Fig 2. Research Design

III. Results and Discussion

The map of the level of potential road damage in Medan Selayang District is a spatial description of the location of possible road damage and the distribution of roads that are threatened with damage and are susceptible to road damage. The level of potential road damage in this study uses estimates and overlays of parameters that form the level of potential road damage, namely slope, soil type, rainfall, traffic volume and drainage availability.

Based on the results of the data processing obtained, the flat slope in Medan Selayang District has an area of 3,194 km2 or 21.52%, the gentle slope with a slope of 2-8% is the most dominant area with an area of 9,036 km2 or 60.86% of the total area. Medan Selayang sub-district, the slope with the Slightly sloping class is 8-15% with an area of 2,139 km2 or 14.41% and finally the slope with the sloping class has an area of 0.477 km2 or 3.21% of the total area in Medan Selayang District

In Medan Selayang District, the soil texture has two classes, namely fine and very fine. The road segment with the most dominant soil texture class is fine soil texture with 22.676 km or 96.28% of the total road length and 0.876 km or 3.72% of the total road length with very fine soil texture. Then, from the results of processing rainfall data in Medan Selayang sub-district, it was obtained that the rainfall value was around 3029.74 mm/year - 3164.20 mm/year. Based on the ranking table, the rainfall value for Medan Selayang sub-district is in the interval 3000 mm/year – 3500 mm/year. 100% of the Medan Selayang District area has a weight value of 4 with high rainfall class

Each road section in Medan Selayang District has a different amount of traffic volume. The very low class roads consist of 3 roads, namely Jl. Abdul Hakim, Jl. Bunga Cempaka and Jl. Bunga Wijaya Kusuma with a total length of 6.824 km or 28.97% of the total length of the road. The low class road section consists of 1 road section, namely Jl. Kenanga Flowers is 1,159 km long or 4.92% of the total road length. The medium road class consists of 5 roads, namely Jl. Black Crow, Jl. Jamin Ginting, Jl. Dr. Mansyur, Jl. New Harmonica, Jl. Kenanga Raya with a total road length of 7.016 km or 29.79% of the total road length. High traffic volume is only found on the Jl. Flamboyan Raya with a distance of 0.580 km or 2.46% and the very high road class consists of 2 road sections, namely Jl. Setia Budi and Jl. Ngumban Surbakti with a total road length of 7.973 km or 33.85% of the total length of arterial and collector roads in Medan Selayang sub-district. The availability of drainage channels in Medan Selayang District can be seen that all roads have drainage channels. From the results of observations in the field, all road sections already have drainage channels on each road section

As a result of the overlay of the constituent parameter parameters, the level of potential road damage in Medan Selayang District has 3 levels of potential damage, namely, Low, Medium and High potential road damage. The distribution of potential road damage levels in Medan Selayang District can be seen in the table 7.

Table 7. Distribution of Potential Road Damage Levels

No	Street Name	Potential Level	Road Length (m)
1.	Gagak Hitam Street	Medium (3)	1853
2.	Setia Budi Street	High (4)	1312
		Medium (3)	2411
3.	Ngumban Surbakti Street	High (4)	3604
		Medium (3)	646
4.	Flamboyan raya Street	Medium (3)	580
5.	Jamin Ginting Street	Medium (3)	876
6.	Dr. Mansyur Street	Medium (3)	760
7	Abdul Hakim Street	Low (2)	1307
		Medium (3)	508
8.	Harmonika Baru Street	Medium (3)	2143
9.	Bunga Cempaka Street	Low (2)	1019
		Medium (3)	1407
10.	Bunga Wijaya Kusuma Street	Low (2)	2388
		Medium (3)	195
11.	Kenanga Raya Street	Medium (3)	1384
12.	Bunga Kenangan Street	Medium (3)	1159

Based on the process and data processing, it was obtained that the level of potential road damage in Medan Selayang sub-district has a pattern of spreading. Roads are dominated by moderate damage

levels, namely with a road length of 13,992 Km or 59.12% of the total road length, which is 23,552 Km. Roads with a low potential level are 4,714 Km or 20.01% and High potential levels with a length of 4,916 Km or 20.87% of the total road length in Medan Selayang District. A map of the level of road damage in Medan Selayang District can be seen in the following figure 3.

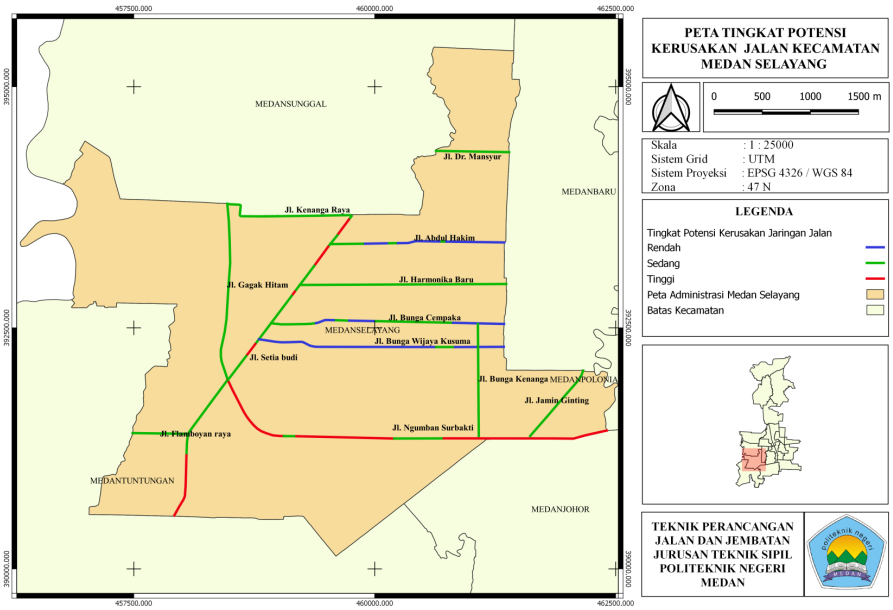

Fig 3. Map of the level of road damage in Medan Selayang District

IV. Conclusion

Based on the process and results obtained from this study, it can be concluded that:

- The use of a geographic information system application in the form of Quantum GIS facilitates data processing and data analysis in determining the level of potential road damage in Medan Selayang District.
- Based on the process and data processing, the results were obtained that the distribution of the level of potential road damage in Medan Selayang sub-district has a pattern of spreading. Roads are dominated by moderate damage levels, namely with a road length of 13,992 Km or 59.12% of the total road length, which is 23,552 Km. Roads with a low potential level are with a length of 4,714 Km or 20.01% and a high potential level with a length of 4,916 Km or 20.87% of the total road length in Medan Selayang District

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