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Mapping the Distribution of High Buildings in West Medan Subdistrict Using Geographic Information System (GIS)

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ABSTRACT

Cities are one of the main centers for the development of urban areas. The opportunity for investment activities in a city is one of the biggest pull factors for migration. Medan's rapid development can be seen from the construction of many tall buildings such as malls, apartments, and offices. The granting of permits for the construction of these high-rise buildings is closely related to urban spatial planning. Medan City does not yet have a 3D map of the distribution of high-rise buildings, there is only data on the number and location of high-rise buildings. Therefore, urban spatial mapping of high-rise buildings is needed. The model in this research uses a GIS computer model integrated in Arcgis software by taking the object of West Medan sub-district. The results of this study are the suitability of the distribution of tall buildings with a fairly dense uniform pattern in the West Medan sub-district where this sub-district is indeed a service center for trade/business, services and provincial and municipal government activities, and the economy.

I. Introduction

Medan is the third largest city in Indonesia after DKI Jakarta and Surabaya, and is also the capital of North Sumatra province. Medan is the largest city outside Java and also the largest on the island of Sumatra. Medan is the gateway to western Indonesia with Belawan Port and Kuala Namu International Airport which is the second largest airport in Indonesia. Bordering the Malak Strait, Medan is a very important trade, industry and business city in Indonesia [1]. Medan consists of 21 sub-districts and 151 villages with an area of 265.00 km² and a population of approximately 2,494,512 people (2022) with a population density of 9,413 people/km² [2]. The rapid development of Medan City can be seen from the construction of many tall buildings such as malls, apartments, and offices. The granting of permits for the construction of these high-rise buildings is closely related to the city's spatial planning. Medan City does not yet have a 3D map of the distribution of tall buildings, there is only data on the number and location of tall buildings. Therefore, the mapping of urban spatial planning of high-rise buildings is needed. Based on this background, the researcher is interested in conducting a study to create a map of the distribution of tall buildings and zones of Medan city.

Based on the background above, the problem formulations in this study are as follows:

1. How is the distribution of tall buildings in West Medan Sub-district?
2. How is the suitability of high-rise building development in West Medan Sub-district to the division of service center zone of Medan City?

In the research, there are several problem limitations, namely:

1. In data processing, the high-resolution image used is SAS Planet.
2. The sub-district that becomes the object of research is West Medan
3. The object of research is only tall buildings more than 4 floors.

A. High Building

High Building is a term for a building that has a tall structure. A building is commonly referred to as a tall building if it has a height between 75 feet and 492 feet (23 m to 150 m). Buildings that have a height of more than 492 feet (150 m) are called skyscrapers. The average height of one level is 13 feet (4 m), so if a building is 79 feet (24 m) tall then it should ideally have 6 levels [3].

B. Regional Spatial Structure Plan of Medan City

The City Spatial Structure Plan is a plan that includes the urban system of the city area within its service area and the city area infrastructure network developed to integrate the city area in addition to serving city-scale activities, including transportation network systems, energy and electricity network systems, telecommunications network systems, water resource systems and other network systems [4].

Table 1. Structure Plan of Medan City Service Center in 2030

No	Ministry Center	Function	Service Region
A	City Service Center in the City Center	• Center for trade/business activities • Service centers and provincial and municipal government activities	• Kota Medan, Kec. Medan Polonia, Kec. Medan Baru, Kec. Medan Petisah, Kec. Medan Timur, Kec. Medan Barat, Kec. Medan Kota • Provinsi Sumatera Utara • Internasional
B	Municipal Service Center in the North	• Regional trade and service center • Transportation service center • Socio-cultural Activity Center • Industrial Activity Center	• Kota Medan bagian Utara • Provinsi Sumatera Utara • Internasional
	1. Medan Belawan city service sub-center	• Sea transportation service center • Center for loading and unloading and export-import activities • Industrial activity center • Center for fishery activities	• Kec. Medan Belawan
	2. Medan Labuhan city service subcenters	• Service and trade center • Transportation service center • Health service center	• Kec. Medan Labuhan
	3. Medan Marelan Sub-city service center	• Center for trading of basic needs (wholesale market); • Center for recreation and tourism activities	• Kec, Medan Marelan; • Kabupaten Deli Serdang
	4. Medan Perjuangan Sub-city service center	• Center for trade/business activities • Sports service center	• Kec. Medan Perjuangan dan Kec. Medan Tembung
	5. Medan Area city service sub-center	• Economic service center • Transportation service center	• Kec. Medan Area, Kec. Medan Kota, Kec. Medan Denai, Kec. Medan Amplas
	6. Medan Helvetia city service sub-center	• Economic service center • Western transportation service center • Center for socio-cultural activities	• Kec. Medan Helvetia, Kec. Medan Petisah, Kec. Medan Sunggal

No	Ministry Center	Function	Service Region
7.	Medan Selayang city service sub-center	• Center for trade/business activities • Education Center	• Kec. Medan Tuntungan, kec. Medan Baru, Kec. Medan Selayang, kec. Medan Johor
8.	East Medan city service sub-center	• Trade/business activity center • Transportation service center (TOD); • Center for socio-cultural activities	• Kec. Medan Deli, Kec. Medan Timur, Kec. Medan Barat

Based on the Structure Plan Table of Medan City service centers [4], the main function development plan of each Service Area can be grouped as follows:

a) Trade/business, services and provincial and municipal government activities, and economy are located at Kec. Medan Polonia, Kec. Medan Baru, Kec. Medan Petisah, Kec. Medan Timur, Kec. Medan Barat, Kec. Medan Kota, Kec. Medan Labuhan, Kec. Medan Perjuangan, Kec. Medan Tembung, Kec. Medan Tuntungan, kec. Medan Baru, Kec. Medan Selayang, kec. Medan Johor, Kec. Medan Deli, Kec. Medan Area, Kec. Medan Kota, Kec. Medan Denai, Kec. Medan Amplas, Kec. Medan Helvetia, Kec. Medan Petisah, Kec. Medan Sunggal, Kec. Medan Belawan
b) Land, sea transportation services are located in Kec. Medan Amplas, Kec. Medan Belawan, Kec. Medan Labuhan, Kec. Medan Helvetia, Kec. Medan Petisah, Kec. Medan Sunggal, Kec. Medan Deli, Kec. Medan Timur, Kec. Medan Barat
c) Fisheries and import-export loading and unloading are located at Kec. Medan Belawan
d) Health resides in Kec. Medan Labuhan
e) Education is in Kec. Medan Tuntungan, kec. Medan Baru, Kec. Medan Selayang, kec. Medan Johor
f) Socio-culture resides in Kec. Medan Deli, Kec. Medan Timur, Kec. Medan Barat, Kec. Medan Helvetia, Kec. Medan Petisah, Kec. Medan Sunggal
g) Sports are in Kec. Medan Perjuangan, Kec. Medan Tembung
h) Recreation and tourism are located in Kec, Medan Marelan

C. Map

Based on PP No. 10 of 2020, Map is an image of natural and / or man-made elements, which are above or below the surface of the earth depicted on a flat plane with a certain scale. Conventional images of part or all of the earth's surface depicted on a flat plane that is reduced to a certain scale. A map is a picture of natural and / or man-made elements, which are above or below the surface of the earth depicted on a flat plane with a certain scale [5].

D. Geographic Information System

Geographic Information System (GIS) contains information, system, and geography. Geographic information studies the position of the earth's surface, the position of an object on the earth's surface, and information on the earth's surface. The system is a unity of several components that are connected to become a goal. Interactions between subsystems are similar, so that integration or unification of integration can be achieved. Information is the result of data processing to obtain meaningful information for the recipient in decision making [6]. Geography has two branches of study, namely human geography and human geography and physical geography, besides that there are technical geography and regional planning. Human geography is concerned with the study of people and their societies, cultures, economies, and interactions with the environment by studying their relationships with and between spaces and places. Physical geography is concerned with the study of processes and patterns in the natural environment such as the atmosphere, hydrosphere, biosphere, and geosphere [7]. The difference between GIS and other information systems is a clear advantage, most

of these systems focus on attribute data, while GIS directly links attribute data with spatial data. It is this spatial form and associated attributes that underlie the development of GIS in meeting various needs [8].

E. SAS Planet

High Resolution Satellite Imagery is a remote sensing system that describes the recording of an observed object to produce image data with a sharp and clear level of resolution so that it can be used as a necessity for the object classification process, as well as the process of making mapping used as geospatial information [9]. One of the programs used to display and download high-resolution satellite images is SAS Planet. Images from SAS Planet are sent from Google Guides, Bing Guides, Yandex Maps, Open Road Guide, ESRI, and others. SAS Planet programming is needed in making maps with easy operation and small document size. Some output designs from SAS Planet programming include .jpeg, .png, .bmp, .ecw, jpeg 200, .kmz for garmi, and GeoTIFF. In addition, the images produced by SAS Planet have a magnification of up to 24 times and can be downloaded according to the resolution required by the user.

II. Method

The parameters in this study used Ground control points (GCP), building height, and building location coordinates. The process of collecting data by conducting field surveys for taking GCP points of tall buildings in West Medan District. Image data was obtained through SAS Planet. After data collection, data processing was carried out using ArcGIS software to obtain a map of the distribution of tall buildings in West Medan Sub-district. And analysis was conducted on the suitability with the service center of Medan city. The model in this study uses high-resolution satellite image data and then modeled with GIS computer integrated in ArcGis software.

A. Research location

West Medan sub-district is a sub-district in the city center area located at 3.607817°N 98.668232°E with an area of 533 Ha. The area is a trade and service area, provincial and city government activities, and economic service center where the availability of land for development is very limited.

Fig. 1. Map of West Medan Subdistrict

B. Research Data

The data used in this study are as follows:

1. Administrative Map of West Medan Sub-district
2. Coordinate data of tall buildings: Coordinate data (GCP) of tall buildings in West Medan sub-district was obtained using GPS.
3. High resolution image data obtained from SAS Planet 4.

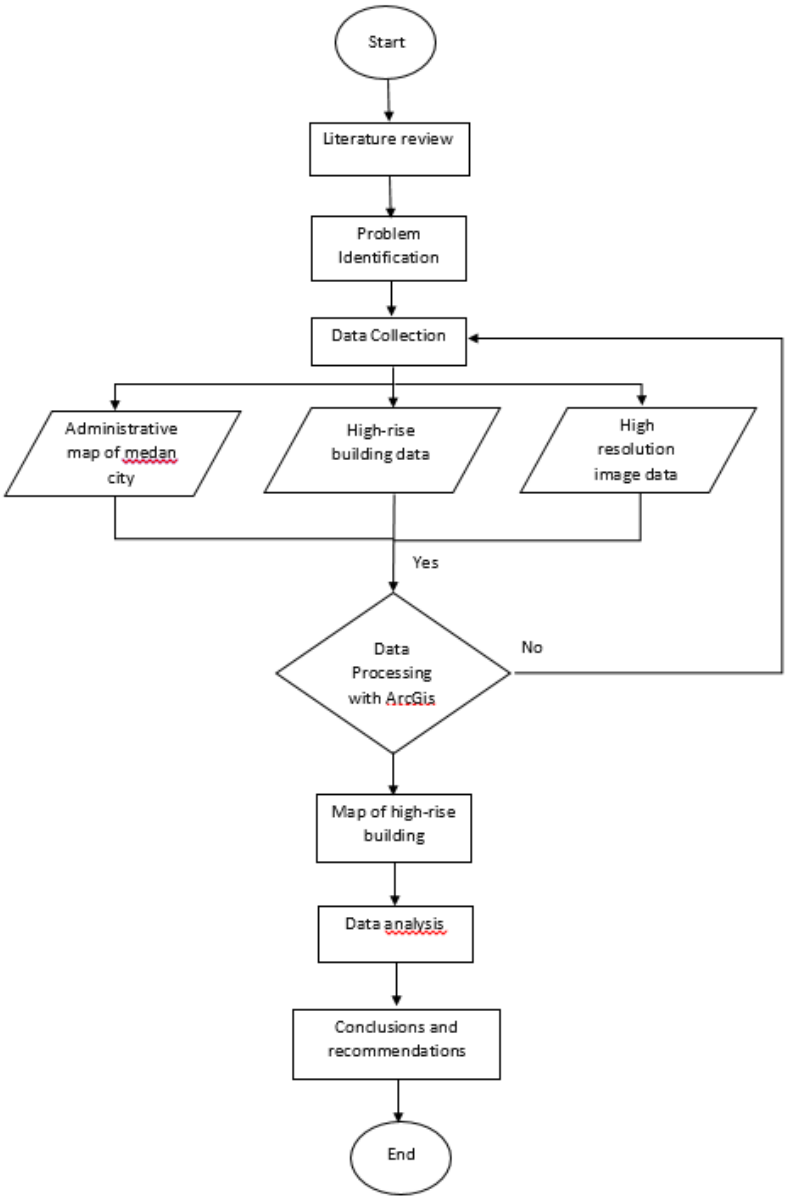

Fig. 2. Research flow

III. Results and Discussion

A. Coordinates (GCP) of High buildings in West Medan Sub-district

GCP coordinate data collection was carried out on all tall building data located in West Subdistrict using GPS. There are 23 tall building data scattered in the West Medan sub-district. GCP Coordinate data can be seen in table 2 below.

Table 2. Coordinates (GCP) of tall buildings in West Medan Sub-district

No	Building Name	Number of Floors	Coordinates
1	Podomoro City Deli Office Tower	50	3°35′43″N,98°40'33"E
2	Podomoro City Deli Premium Apartment I	40	3°35′40″N,98°40'23"E
3	Podomoro City Deli Premium Apartment II	40	3°35′40″N,98°40′24″E
4	Podomoro City Deli Condominium I	30	3.594525°N,98.675789°E
5	Podomoro City Deli Condominium II	30	3°35′42″N,98°40′28″E
6	Podomoro City Deli Apartment Liberty	30	3°35'37"N,98°40'30"E
7	Podomoro City Deli Apartment Lincoln	30	3.593928°N,98.674548°E
8	Podomoro City Deli Apartment Lexington	30	3°35'38"N,98°40'32"E
9	Reiz Condominium	30	3.592648°N,98.675921°E
10	Hotel JW Marriott and B&G Tower	28	3.595944°N,98.675584°E
11	Regale International Hotel & Convention	18	3.603875°N,98.669228°E
12	Hotel Grand Aston Medan	16	3.590022°N,98.677063°E
13	Royal Residence Apartment I	15	3.583446°N,98.677486°E
14	Royal Residence Apartment II	15	3.583539°N,98.677480°E
15	Menara BRI	15	3.593486°N,98.676572°E
16	Bank Mandiri Tower	13	3.589509°N,98.679641°E
17	Inna Darma Deli Hotel	10	3.591209°N,98.677229°E
18	Capital Building	10	3.593343°N,98.676318°E
19	Kantor Perwakilan Bank Indonesia Provinsi Sumatera Utara	10	3.590906°N,98.677237°E
20	Emerald Garden International Hotel	10	3.602448°N,98.673126°E
21	Graha Telkomsel	10	3.593069°N,98.676311°E
22	Menara Bank BCA	9	3°35′46″N,98°40'34"E
23	Gedung Grand Central	5	3.594317°N,98.677934°E

B. High Building distribution map

The high-resolution imagery data used in this study is SAS Planet, which allows access to various sources of satellite imagery data, including maps from various providers such as Google Maps, Bing Maps, and others [10]. The high-resolution image data obtained from the SAS planetary image was then digitized using the ArcGIS application. Furthermore, the verification process is carried out between field data through building coordinate data (GCP) contained in table 2 and data from image data digitization. After that, making a map layout to produce a map of the distribution of tall buildings.

The map of the distribution of tall buildings in West Medan Sub-district generated from the ArcGis application can be seen in the following figure.

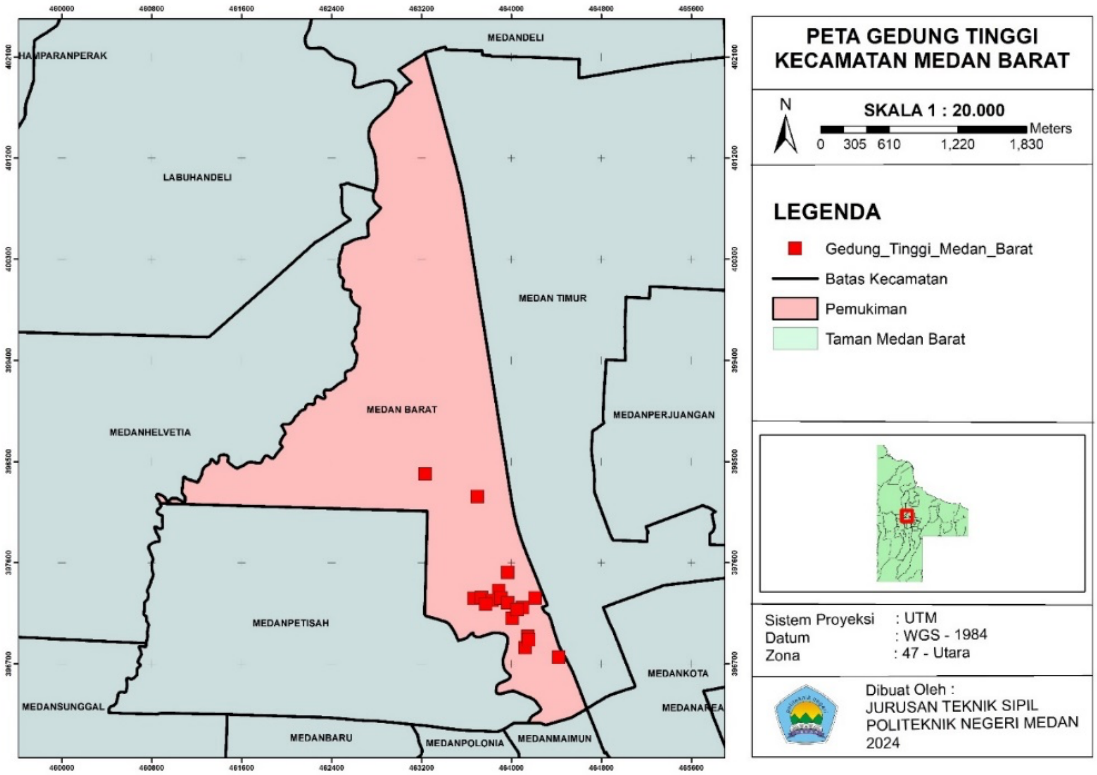

Fig. 3. Distribution Map of High Buildings in West Medan Sub-district

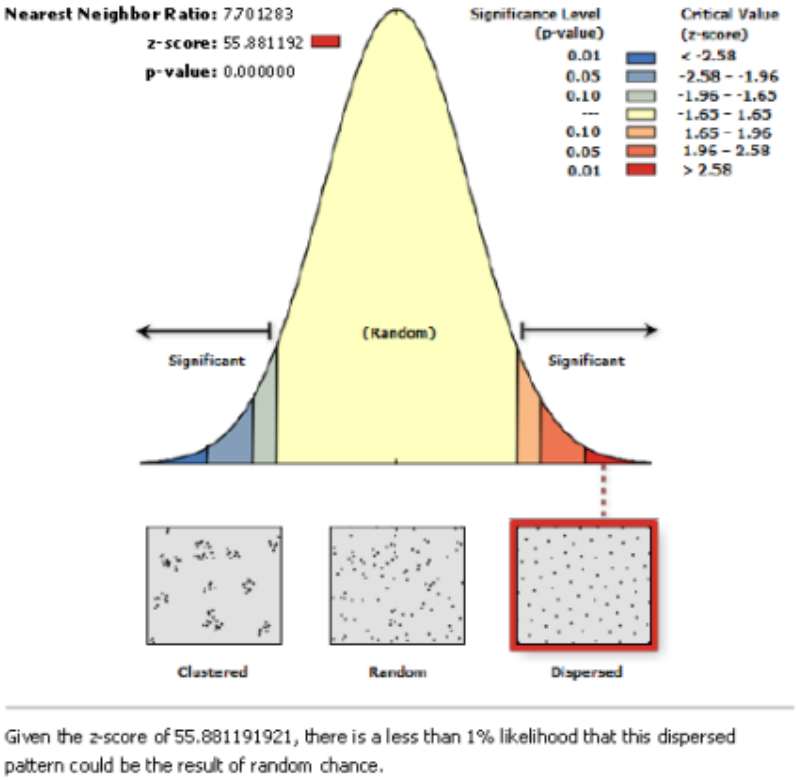

Fig. 4. Map Distribution Pattern in ArcGis

Based on the figure above, the Distribution Map of Tall Buildings in West Medan Sub-district shows a pattern of evenly distributed tall buildings that are quite dense. When compared with the Structure Plan of Medan City's service center, it shows that there is an area of conformity between the Structure Plan of Medan City's service center and the high-rise building distribution map where the West Medan area is a service center for trade/business, services and provincial and city government activities, and economy with a scattered high-rise building pattern. This is indicated by the presence of tall buildings that are evenly distributed in the sub-district area.

IV. Conclusion

In the picture of the Distribution Map of Tall Buildings in West Medan Sub-district, it can be seen that the pattern formed is a fairly dense dispersed pattern where this sub-district is indeed a service center for trade/business, services and provincial and municipal government activities, and the economy.

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