International Journal of Society and Law
Volume 2, Issue 3 December 2024
E-ISSN 3031-4763 (Online)
https://doi.org/10.61306/ijsl

A Study on the Phenomenon of Land Use Change in the Suburbs (*Urban* Periphery) of Medan City and Its Influence on the Spatial Pattern Plan Case Study of Medan Marelan District

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ABSTRACT

This study aims to analyze land use changes in Medan Marelan District in 2004, 2014, and 2024 and identify the suitability of existing land use with the Medan City Regional Spatial Plan (RTRW) policy. The research method used is qualitative descriptive with a spatial approach based on Geographic Information System (GIS). Data was collected through primary and secondary surveys, including satellite imagery, administrative maps, and demographic data. The results of the study showed that there was a significant change in land use in Medan Marelan District during the study period, especially the increase in residential and industrial areas. The *superimpose analysis* shows that most of the existing land use is in accordance with the RTRW, although there are some irregularities. Factors such as the number of population, land value, distance to the city center, and the number of public facilities contribute significantly to the development of the area. In accordance with the results of the SWOT analysis, there are several strategies in this study, one of which is utilizing the power of technology and data to design a more accurate and sustainable spatial plan policy that considers the history of the area in Medan Marelan District. The conclusion of this study is the importance of Regional Space (RTRW) periodically to effectively manage the development of *peri-urban* areas. It is also recommended that there be community involvement in spatial planning to increase the suitability of land allocation with the Regional Spatial Plan policy.

Keywords:

land use change, peri-urban, Geographic Information System (GIS), Regional Spatial Plan (RTRW), Medan Marelan.

I. INTRODUCTION

Urban transformation is a complex phenomenon that occurs in various parts of the world along with economic growth, urbanization, and changes in people's lifestyles. This development has a major impact on infrastructure, the environment, and the quality of life of the population. Rapid and dynamic urban development requires the strategic role of regional planning in carrying out urban transformation. Rapid population growth and urbanization have put enormous pressure on cities to accommodate the needs of infrastructure, housing, and public services (Feby, 2023).

According to Chapin (1996), land use change is an interaction caused by three components that form land use, namely the development system, the activity system and the environmental system. In the activity system, the economic context of urban activities can be grouped into production and consumption activities. Production activities require land to be located where it will support the above production activities.

Population growth in urban areas in general has implications, namely increasing demands on land use and land change, so that it has an impact on increasing the need for land, while on the other hand the land area is relatively fixed and will even continue to decrease. The construction of urban *built up areas* is a clear line to observe how the acceleration of urban expansion outwards. Outside *the built up areas* there are *fringe zones* which in time will be a new location for the development of urban functions, especially settlement, service and trade functions (Marbun, 1994).

The emergence of spreading, disorderly, and unintegrated growth in the suburbs will eventually create a lot of empty space between regions and between regions and existing city centers (Christiawan, 2019). Based on the issues above, it is very closely related to *the urban sprawl phenomenon*. Urban sprawl refers to the negative impact of urban development that develops in a spreading, non-centralized, and effort to form a new urban center (Andadari et al., 2021).

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II. LITERATURE REVIEW

A. Urban Elf

Kurtz and Eicher (1958) proposed that an urban fairy area is an area that is outside the official city boundaries (directly bordered). Then Smith (1937) in Pryor (1970) proposed the definition of *an urban fairy* area , which is a built area that is outside the administrative boundaries of a city. Then along with its development, various definitions *of urban fairy areas appeared.* Johnson (1974) in Adell (1999) defines that an urban fairy area is an area that belongs to the urban functional area, where *sub-urban* development occurs and is a zone of urban and rural functions mixed and forms a transition zone between urban and rural areas. Then Yunus (2000) tried to re-reveal in his research that the urban fairy area is an area that is directly adjacent to the city, has a high population density compared to the surrounding population density.

B. Urban Development

According to Patrick Gaddes, the characteristics of a settlement as an area have the following elements: Place; Work (workplace); Folk (a place of community). In Indonesia, Kus Hadinoto (1970s) adapted it into 5 main elements (Nia K Potoh and Iwan Kustiwan, 2008). Urban transportation is the backbone of economic and social activities of a city, therefore, the development of urban transportation is a very strategic main policy for increasing urban development activities. The main

elements of urban transportation include aspects of the transportation system, characteristics of urban transportation, capital and types of urban transportation and the general system of the city, the main target is to provide transportation facilities to serve the community in supporting the urban economy (Sjafrizal, 2012).

The development of population growth and very rapid economic and social activities are the main reasons for the emergence of a very urgent need for the development of a good urban transportation system. The main goal is to be able to provide transportation facilities to serve the movement of people and passengers in order to support the economic and social development of the urban area concerned (Sjafrizal, 2012). In the urban economy, housing and settlements are an important aspect. Because housing and settlement activities are one of the main activities in one urban economic activity. The progress of the level of civilization of a society or region can be seen from the development of housing in settlements which reflects the development of the city (Sjafrizal, 2012).

C. Land Use Change

Land use change is an interaction caused by three components that form land use, namely the development system, the activity system and the environmental system. In the activity system, the economic context of urban activities can be grouped into production and consumption activities. Production activities require land to be located where it will support the above production activities. Meanwhile, production activities require land to be located in order to fulfill satisfaction (hapin, 1996).

D. Factors affecting built-up land

Factors that affect the development of built land are carried out with the aim of finding out what factors affect urban development in Medan City. The factors that are used as variables in the study are obtained based on literature review and the availability of numerical data for further data processing. Based on Kaiser (1995), *Cullingworth* (1997) and Kusrini (2011), Bayusukmara (2019) obtained 4 factors that were used as variables in the study, namely, the number of population, land value, distance to the city center and public facilities (Zahra, P A A; Yesiana, R; Anggraini, P; Harjanti, I M. 2021).

E. Phenomenon of the suburbs

The consequence caused by urban development is the tendency of shifting urban functions to suburban areas (*urban fringe*) which is called the process of permeation of the physical appearance of the city to the outside (*urban sprawl*). The next consequence in suburban areas will be to experience a spatial transformation process in the form of a settlement densification process and socio-economic transformation as a further impact of the spatial transformation process. The process of densification of settlements that occur in suburban areas is the realization of the increasing need for space in urban areas. Urban *fringe* as an area for urban development activities has been the concern of many experts in various fields of science such as geography, social, and urban since the 1930s when the term urban fringe was first proposed in literature. The amount of attention is mainly focused on various problems caused by the process of urban expansion to the suburbs which results in physical changes such as changes in land use, demographics, ecological balance, and socio-economic conditions (Mas Pratono, 2022).

One of the issues that needs attention is related to the phenomenon of suburban areas and the process of spatial and socio-economic change in this area. Urban *fringe* is defined as a suburban area

that is in the process of transitioning from rural to urban. As a transition area, this area is under increasing pressure from urban activities that have an impact on physical changes including the conversion of agricultural and non-agricultural land with various impacts. According to Howard in the 1990s, among urban areas, rural areas, and suburban areas, it turned out that suburban areas provided the greatest opportunities for productive businesses as well as the most pleasant opportunities to live. Humans as residents of suburban areas always adapt to their environment. These adaptations and activities reflect and also result in social, economic, cultural, and other changes (Mas Pratono, 2022).

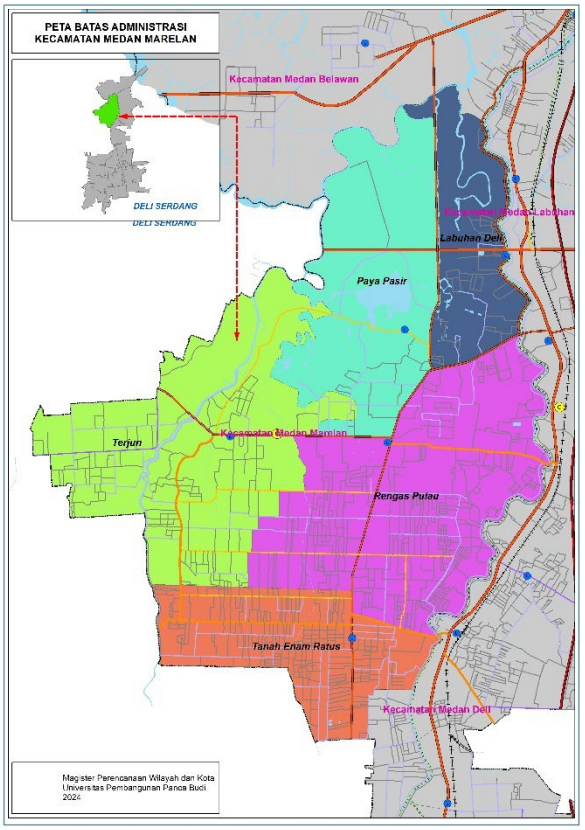
F. Remote sensing

Remote sensing is defined as the acquisition of information of an object without any physical contact with the object. Information in remote sensing is obtained by detecting and measuring changes in objects that are generalized to the surrounding optical conditions, including electromagnetic, acoustic and potential. Electromagnetic fields are emitted and then reflected by objects, acoustic waves are reflected or scattered by objects (Rahmatsyah M.S, Juliani R, and Tampubolon T. 2020). The Landsat 8 satellite is a remote sensing satellite that is able to provide low-resolution satellite images sourced from the *usgsearth* website which provides *time series* data according to needs. However, this satellite image is not easy to obtain and has a large enough data capacity. *Google Earth (*GE) is one of the companies engaged in the spatial field for the creation of virtual earth programs that have been widely used by the community. (Noorlaila H and M. Taufik 2011), imagery obtained from Google Earth can be used for detailed mapping even though the mapping location depends on updates from *Google Earth*. *Google Earth* satellite imagery was used in this study because it has a fairly high resolution, easy to obtain and a small relative data capacity. (Damsir, Ansyori, Yanto, Setrian, E., Bambang Purwanto 2023).

III. METHOD

A. Research Area

The study area of this research study covers the administrative area of Medan Marelan District. (Medan Marelan District in Numbers, 2023) Medan Marelan District has an area of 3,000.03 Ha and there are 5 Urban Villages.



Gambar. 1 Research Study Area

B. Research Approach

This research was carried out using a qualitative descriptive method that uses a spatial-based spatial approach to produce remote sensing information based on vector data and tabular data.

C. Data Collection Techniques

The data in the research serves to obtain data that will later be used as material for analysis. This study uses 2 data collection methods, namely: primary survey, and secondary survey. The following is a table of data needs in the study as follows.

Tabel. 1 Research Data Needs

It	Research Objectives	Data Type	Data Source	Data Analysis Techniques	Expected Results
1	Identifying how the	Google earth imager	Literature Study,	Analysis meth	The phenomenon

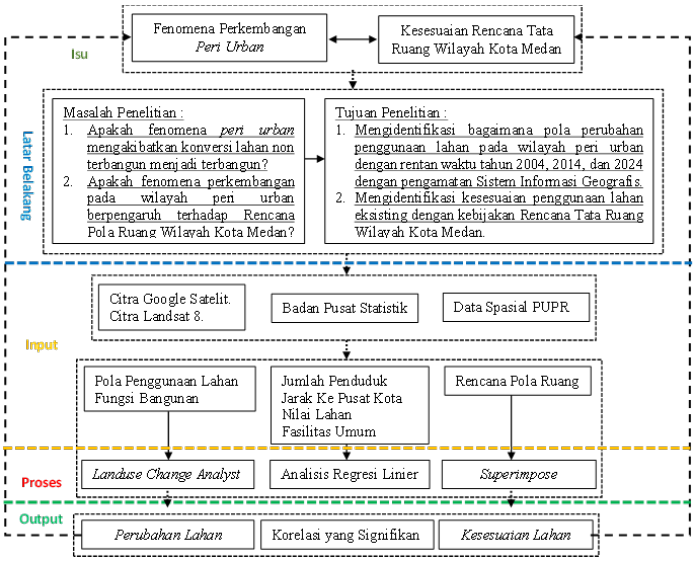
It	Research Objectives	Data Type	Data Source	Data Analysis Techniques	Expected Results
	pattern of land use change in urban *fairy areas* with vulnerable time in 2004, 2014, and 2024 by observing the Geographic Information System.	y, SAS Planet, Landsat 8 imagery	Basemap	od of Land *Use Change Analyst*	of the development of *Urban Elves*
		Administrative map	Medan City Bappeda, Medan City Bappeda		
		Land use maps	PUPR Office, Interpretation		
		Map of the distribution of developed areas			
		Population	Bps Medan City	Linear Regression Analysis	To find out whether the independent variable
		Distance to City Center	Bps/Spatial Data		
		Niali Land	Medan City		

It	Research Objectives	Data Type	Data Source	Data Analysis Techniques	Expected Results
			PUPR Office		studied has a significant correlation with the bound variable
		Number of Public Facilities	Medan City BPS, Medan City PUPR Office		
2	Identify the suitability of existing land use with the Medan City Regional Spatial Plan policy.	Medan City RTRW Spatial Pattern Plan, Administrative Map	Medan City Bappeda Medan Medan City PUPR Office	Superimpose *analysis method*	Suitability of Space allocation

Source : Researcher, 2024

D. Data Analysis

The analysis method in this study uses several analysis of investigation and decomposition of a subject. In accordance with the purpose of the research, the researcher studied how the phenomenon of Urban *Elf development,* knowing whether land conversion occurred due to *Urban Ellips*. This study uses 3 data analysis methods such as: *Land Use Change Analyst* analysis method, linear regression, and *superimpose analysis.*



Gambar. 2 Research Flow Diagram

1. Land Use Change Analyst *Analysis*

Land change analysis is a study that examines how land use and land cover change over time. These changes can be caused by various factors such as urbanization, deforestation, agriculture, population growth, and climate change. Land use change analysis uses 2 raster data that are available for free based on the suitability of the desired time according to needs. This study uses 2 data sources (satellite imagery), one of which is satellite imagery which provides data based on the year of recording such as satellite imagery *Landsat* which can be accessed on the https:// pageEarthExplorer.usgs.gov. The second source of data is google satellite imagery with data availability in 2024.

2.* Superimpose *Analysis

The analysis method used in this study is the superimpose analysis method which is often called analysis (Overlap). With the superimpose analysis method, several analysis tools are included in the superimpose analysis such as intersect tools, unions, spatial joins and others. To determine the influence of Urban Peri with the Spatial Pattern of the City of Medan, several variables that will later be overlayed are the variables of existing land use and the Spatial Pattern Plan of the City of Medan.

3. Linear Regression Analysis

The data analysis technique used in this study is a linear regression analysis technique. In this study, the researcher tries to take into account the aspects of the Number of Population, Land Value, Distance to the City Center, and the number of facilities that are estimated to affect the development of the area that massively leads to Medan Marelan District using indicators that are estimated to affect the development of the area in Medan Marelan District.

$$P=\beta 0+\beta 1Jp+\beta 2Nl+\beta 3Jk+\beta 4Jf$$

Where:

P = Regional Development

Jp = Total Population

N1 = Land Value
Jk = Distance to City Center
Jf = Number of Facilities
β0 = Intercept
β1,β2,β3,β4 are coefficients that show the influence of each factor on the development of the region.
Interpretation:

- A constant (*intercept*) of 2 indicates that if all factors are zero, the development of the region will have a base value of 2.
- A coefficient of 0.5 in population indicates that every increase in population by one unit will increase the development of the area by 0.5 units.
- The coefficient of 0.3 in land value shows that every increase in land value by one unit will increase the development of the area by 0.3 units.
- A coefficient of -0.2 in the distance to the city center indicates that every increase in the distance to the city center will reduce the development of the area by 0.2 units.
- The coefficient of 0.4 in the number of facilities shows that every increase of one unit in the number of facilities will increase the development of the area by 0.4 units.

4. SWOT Analysis

In the context of land use change in Medan Marelan District, SWOT analysis can be used to understand internal and external conditions that affect the development of the area. Strengths such as strategic location and government support can be leveraged to attract investment. Weaknesses such as inadequate infrastructure need to be overcome to avoid the negative impact of irregular development. Opportunities such as increased housing demand and infrastructure investment must be optimally utilized, while threats such as environmental degradation and land conflicts must be properly managed. Thus, SWOT analysis theory provides a systematic framework for evaluating internal and external conditions, as well as formulating effective strategies in facing challenges and taking advantage of existing opportunities.

IV. DISCUSSION

The discussion in this study the researcher tries to see the phenomenon of suburban development resulting from the results of remote sensing analysis that utilizes satellite images as the main object in interpreting, so that it is expected that from the phenomenon of regional development in Medan Marelan District, the researcher tries to apply it to spatial data and narrate it into tabular data according to the predetermined year. From the results of the analysis carried out, the researcher tried to see the results of the identification of the land use obtained will overlap with existing policies such as the Medan City Regional Spatial Plan based on Regional Regulation No. 1 of Medan City concerning the Spatial-based Medan City Regional Spatial Plan. The researcher tries to describe the factors that affect

urban development that continuously leads to the northern part of Medan City by using the liner regression analysis method.

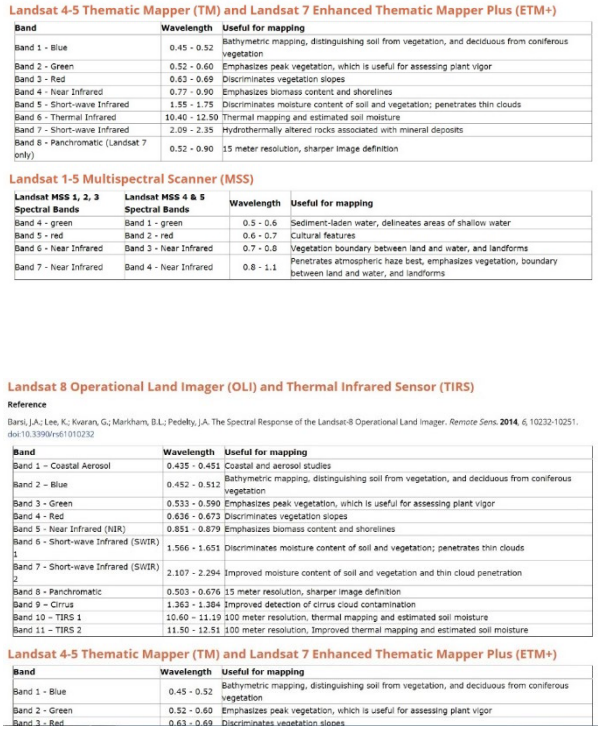
A. PHENOMENON OF LAND CHANGE

Land change is the process of transforming the use and closure of land in an area due to human activities or natural processes. Several factors that are thought to affect land change in an area such as urbanization, intensive agriculture, deforestation, and infrastructure development are the main factors driving this change. One example that encourages the transfer of land in an area is the movement of villagers who lead to cities so that they are required to convert agricultural land or open land into residential and industrial areas.

1. Land Use in 2004

In the analysis of land use in Medan Marelan District, the researcher used a low-resolution satellite image data source sourced from the website page: https;//EarthExplorer.usgs.gov which provides remote sensing recording with past data years.

Landsat is one of the remote sensing vehicles that was first launched in 1972.The Landsat satellite has two sensors, namely the Multi Spectral Scanner (MSS) and the Tematic Mapper (TM). The TM sensor has a resolution of up to 30 x 30 m, and works to collect data on the earth's surface and a swept area of 185 km x 185 km. While the radiometric resolution is 8 bits, which means that each pixel has a data range value from 0-225. TM sensors are very complex systems that require very small manufacturing tolerances, so it is not possible to make improvements in the future to reduce the spatial resolution to below 20 meters.



Landsat 4-5 Thematic Mapper (TM) and Landsat 7 Enhanced Thematic Mapper Plus (ETM+)

Band	Wavelength	Useful for mapping
Band 1 - Blue	0.45 - 0.52	Bathymetric mapping, distinguishing soil from vegetation, and deciduous from coniferous vegetation
Band 2 - Green	0.52 - 0.60	Emphasizes peak vegetation, which is useful for assessing plant vigor
Band 3 - Red	0.63 - 0.69	Discriminates vegetation slopes
Band 4 - Near Infrared	0.77 - 0.90	Emphasizes biomass content and shorelines
Band 5 - Short-wave Infrared	1.55 - 1.75	Discriminates moisture content of soil and vegetation; penetrates thin clouds
Band 6 - Thermal Infrared	10.40 - 12.50	Thermal mapping and estimated soil moisture
Band 7 - Short-wave Infrared	2.09 - 2.35	Hydrothermally altered rocks associated with mineral deposits
Band 8 - Panchromatic (Landsat 7 only)	0.52 - 0.90	15 meter resolution, sharper image definition

Landsat 1-5 Multispectral Scanner (MSS)

Landsat MSS 1, 2, 3 Spectral Bands	Landsat MSS 4 & 5 Spectral Bands	Wavelength	Useful for mapping
Band 4 - green	Band 1 - green	0.5 - 0.6	Sediment-laden water, delineates areas of shallow water
Band 5 - red	Band 2 - red	0.6 - 0.7	Cultural features
Band 6 - Near Infrared	Band 3 - Near Infrared	0.7 - 0.8	Vegetation boundary between land and water, and landforms
Band 7 - Near Infrared	Band 4 - Near Infrared	0.8 - 1.1	Penetrates atmospheric haze best, emphasizes vegetation, boundary between land and water, and landforms

Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)

Reference

Barsi, J.A.; Lee, K.; Kvaran, G.; Markham, B.L.; Pedelty, J.A. The Spectral Response of the Landsat-8 Operational Land Imager. *Remote Sens.* **2014**, *6*, 10232-10251. doi:10.3390/rs61010232

Band	Wavelength	Useful for mapping
Band 1 – Coastal Aerosol	0.435 - 0.451	Coastal and aerosol studies
Band 2 – Blue	0.452 - 0.512	Bathymetric mapping, distinguishing soil from vegetation, and deciduous from coniferous vegetation
Band 3 - Green	0.533 - 0.590	Emphasizes peak vegetation, which is useful for assessing plant vigor
Band 4 - Red	0.636 - 0.673	Discriminates vegetation slopes
Band 5 - Near Infrared (NIR)	0.851 - 0.879	Emphasizes biomass content and shorelines
Band 6 - Short-wave Infrared (SWIR) 1	1.566 - 1.651	Discriminates moisture content of soil and vegetation; penetrates thin clouds
Band 7 - Short-wave Infrared (SWIR) 2	2.107 - 2.294	Improved moisture content of soil and vegetation and thin cloud penetration
Band 8 - Panchromatic	0.503 - 0.676	15 meter resolution, sharper image definition
Band 9 – Cirrus	1.363 - 1.384	Improved detection of cirrus cloud contamination
Band 10 – TIRS 1	10.60 – 11.19	100 meter resolution, thermal mapping and estimated soil moisture
Band 11 – TIRS 2	11.50 - 12.51	100 meter resolution, Improved thermal mapping and estimated soil moisture

Landsat 4-5 Thematic Mapper (TM) and Landsat 7 Enhanced Thematic Mapper Plus (ETM+)

Band	Wavelength	Useful for mapping
Band 1 - Blue	0.45 - 0.52	Bathymetric mapping, distinguishing soil from vegetation, and deciduous from coniferous vegetation
Band 2 - Green	0.52 - 0.60	Emphasizes peak vegetation, which is useful for assessing plant vigor
Band 3 - Red	0.63 - 0.69	Discriminates vegetation slopes

Gambar. 3 Characteristics of Landsat Imagery

From the results of remote sensing interpretation using landline satellite imagery as the initial data in this study, the researcher translated the existing land use in Medan Marelan District into 11 land uses, namely: water bodies/rivers, lakes, mangrove forests, industries, fields, trade and services, settlements, green open spaces, rice fields, shrubs, and ponds. The following are the results of the identification of land use in Medan Marelan District in 2004 as follows:

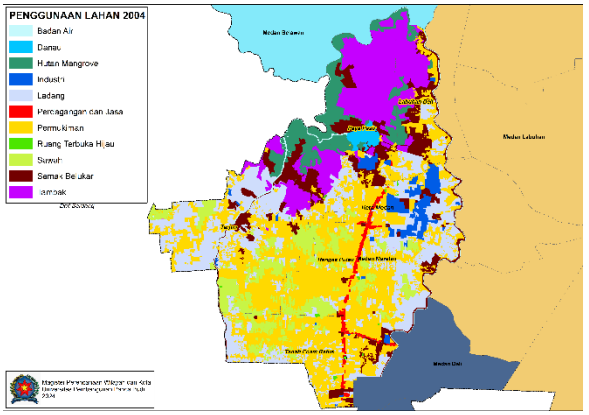
Tabel. 2 Land Use of Medan Marelan District in 2004

		Neighborhoods					
It	**Land Use**	**Labuhan Deli**	**Sands Swamp**	**Rengas Island**	**Six Hundred Land**	**Plunge**	**Total Area**
1	Water Bodies	5,63	5,32	6,69	1,80	12,33	4,00
2	Lake		25,38				25,38
3	Mangrove Forest	34,01	104,23			58,31	196,54
4	Industry	1,66	11,67	72,26	1,05	2,86	89,50
5	Field	39,79	33,43	223,77	96,38	266,67	660,06
6	Trade and Services	0,33	3,30	21,96	10,84		36,43
7	Settlements	72,82	75,50	381,45	239.56	250,99	1.020,32
8	Green Open Space		0,34	1,56	0,94	0,43	3.27
9	Paddy		3,00	106,37	44,23	119,53	273.13
10	Bush	56,78	84,32	41,93	25,12	61,11	269,26
11	Pond	99,99	244,09			53,27	397,35

It	Land Use	Neighborhoods					Total Area
		Labuhan Deli	Sands Swamp	Rengas Island	Six Hundred Land	Plunge	
Total Area (Ha)		311,00	590,59	855,99	419,93	825,49	3.003,01

Source : Analysis Results, 2024

From the above results, it can be described how the physical condition of Medan Marelan District is based on the results of land use interpretation in 2004. One of the dominant land uses in 2004 was the use of residential land with an area of 1,020.32 hectares, plantations of 660.06 hectares, pond bushes of 397.35 hectares, and rice fields of 273.13 hectares. For more details, you can see the land use map in Marelan Distric



Gambar. 4 Land Use in 2004

2. Land Use in 2014

Analysis of remote sensing in Medan Marelan District in 2014 researchers using aerial photo data sources of Medan City in 2014. The difference in data sources in 2004 researchers obtained data sources with a very high level of map accuracy. For more details, you can see the table below for the results of interpretation using aerial photo data sources in 2014.

Tabel. 3 Land Use of Medan Marelan District in 2014

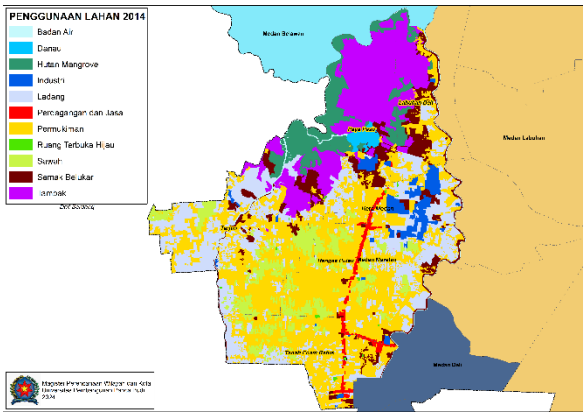
It	Land Use	Neighborhoods					Total Area
		Labuhan Deli	Sands Sw	Rengas Isl	Six Hundred Land	Plunge	

			amp	**and**			
1	Water Bodies	5,63	5,32	6,69	1,80	12,33	31,77
2	Lake		25,38				25,38
3	Mangrove Forest	35,41	105,94			64,47	205,82
4	Industry	1,66	11,67	72,58	1,98	3,64	91,53
5	Field	39,79	33,49	201,02	93,35	271,15	638,81
6	Trade and Services	0,33	3,30	22,24	17,99		43,86
7	Settlements	72,82	75,50	412,43	248,34	283,15	1.092,24
8	Green Open Space		0,34	1,56	0,94	0,65	3,49
9	Paddy		3,00	98,52	39,29	94,62	235,42
10	Bush	55,38	55,32	40,95	16,26	34,93	202,84
11	Pond	99,99	271,32			60,56	431,87
Total Area (Ha)		311,00	590,59	855,99	419,93	825,49	3.003,01

Source : Analysis Results, 2024

From the results above, it can be described how the physical condition of Medan Marelan District is based on the results of land use interpretation in 2014. One of the land uses that dominated in 2014 and experienced an increase or expansion of the area was the use of residential land to an area of 1,092.24 hectares. One example of an increase in land use other than residential areas is industrial land use of 91.53 Ha, and trade and services 43.96 Ha.

From the results of remote sensing carried out by researchers, there is a decrease in land use or it can be said that there is a change in built land to built-up. One of the land uses that has decreased is the use of rice fields of 235.42 hectares and shrubs of 202.84 hectares. For more details, you can see the map below.



Gambar. 5 Land Use in 2014

3. Land Use in 2024

Remote sensing analysis in Medan Marelan District in 2024 researchers used data sources from Google Satellite with recording in 2024. Google is until now one of the providers that provides a very high-resolution data source with a very *up-to-date* recording year. For more details, you can see the results of remote sensing using Google satellite data sources in 2004.

Tabel. 4 Land Use of Medan Marelan District in 2024

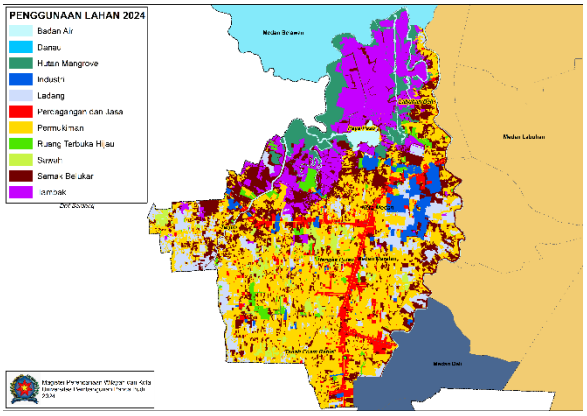
It	Land Use	Neighborhoods					Total Area
		Labuhan Deli	Sands Swamp	Rengas Island	Six Hundred Land	Plunge	
1	Water Bodies	22,33	43,03	7,87	2,28	18,34	93,85
2	Lake		0,01				0,01
3	Mangrove Forest	41,78	96,25			40,94	178,97
4	Industry	10,28	12,41	74,83	5,04	12,36	114,92
5	Field	7,30	4,31	109,72	35,75	120,22	277,31

6	Trade and Services	8,06	13,37	85,25	41,88	30,51	179,08
7	Settlements	69,18	69,93	407,86	266,94	281,29	1.095,20
8	Green Open Space	10,99	14,53	7,79	4,93	23,80	62,04
9	Paddy			33,73	12,72	32,47	78,92
10	Bush	60,45	80,90	127,19	50,26	193,13	511,93
11	Pond	80,63	255,84	1,76	0,13	72,42	410,78
Total Area (Ha)		**311,00**	311,00	590,59	855,99	419,93	825,49

Source : Analysis Results, 2024

From the results above, it can be described how the physical condition of Medan Marelan District is based on the results of land use interpretation in 2024. There are several land uses that dominate in 2024 and experience an increase or expansion of the area, namely the use of residential land to an area of 1,095.20 hectares. One example of an increase in land use other than residential areas is industrial land use of 114.92 Ha, trade and services of 179.08 Ha, and Green Open Space of 62.04 Ha.

From the results of remote sensing carried out by researchers, there is a decrease in land use or it can be said that there is a change in built land to built-up. One of the land uses that has decreased is the use of 78.92 hectares of rice fields and 410.78 hectares of ponds. For more details, you can see the map below.



Gambar. 6 Land Use in 2024

Overall, the change of land in Medan Marelan District, which every time it is known, changes in open land use to built land is increasingly massive so that it is estimated to affect the structure and economy of the area in Medan Marelan District. For more details, you can see the phenomenon of land change in Medan Marelan District tabularly below.

Tabel. 5 Results of Analysis of Land Use Change in Medan Marelan District

It	Land Use	Area in 2004	Area in 2014	Area in 2024
1	Water Bodies	31,77	31,77	93,85
2	Lake	25,38	25,38	0,01
3	Mangrove Forest	196,54	205,82	178,97
4	Industry	89,50	91,53	114,92
5	Field	660,06	638,81	277,31
5	Trade and Services	36,43	43,86	179,08
6	Settlements	1.020,32	1.092,24	1.095,20
7	Green Open Space	3,27	3,49	62,04
8	Paddy	273,13	235,42	78,92
9	Bush	269,26	202,84	511,93
10	Pond	397,35	431,87	410,78
	Total Area (Ha)	**3.003,01**	**3.003,01**	**3.003,01**

Source : Analysis Results, 2024

B. LAND SUITABILITY

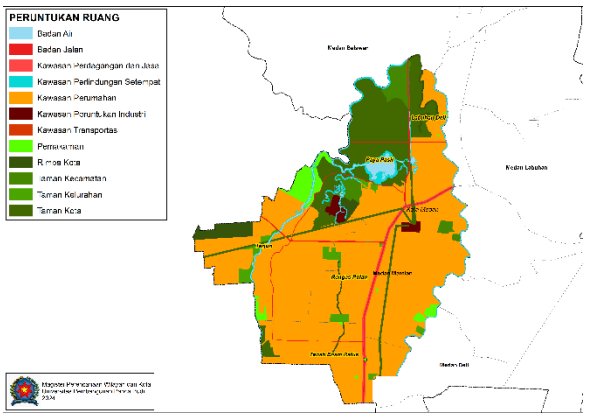
The suitability carried out in this study uses spatial data analysis of the superimpose *method* (overlap) which uses data on the polar plan of regional money in accordance with Regional Regulation No. 1 concerning the Spatial Pattern Plan of the City of Medan for 2022 – 2042. For more details, you can see the allocation of space in Medan Marelan District below.

Tabel. 6 Regional Spatial Pattern Plan Medan City

It	Space Pattern Plan	Neighborhoods					Total Area
		Labuhan Deli	Sands Swamp	Rengas Island	Six Hundred Land	Plunge	
1	Water Bodies	8,86	39,24	6,67	1,61	12,81	69,20
2	Road Bodies	5,70	15,04	10,42	8,57	13,05	52,79
3	Trade and Service Zone	2,89	2,49	17,20	9,11		31,70
4	Local Protected Areas	8,77	40,26	9,05	2,42	15,20	75,70
5	Residential Areas	187,79	120,92	735,41	373,75	570,15	1.988,02
6	Industrial Allocation Area		17,56	9,44		0,12	27,12
7	Transportation Area		0,06				0,06
8	Funeral	0,54		12,55	0,87	62,89	76,86
9	City Forest	14,15	12,68	4,34	2,82	45,59	79,58
10	District Park	8,71	59,79	13,36			81,85
11	Village Park		6,22	15,24	2,48	30,33	54,28
12	City Park	73,59	276,31	22,31	18,30	75,34	465,85
	Total Area (Ha)	**311,00**	**590,59**	**855,99**	**419,93**	**825,49**	**3.003,01**

Source : Regional Regulation No. 1 concerning the Medan City Regional Spatial Pattern Plan for 2022 – 2042

It can be seen from the table above that 12 space allocations in Medan Marelan District based on Regional Regulation No. 1 concerning the Medan City Regional Spatial Pattern Plan for 2022 – 2042. According to the table above, the most dominating space allocation is the spatial allocation of residential areas with an area of 1,988.02 Ha. There are several adjustments between the results of the interpretation of land use and the polar money plan for the Medan Marelan District area, such as the designation of trade and service areas and the designation of industrial areas. For more details, you can see the map of the spatial pattern plan in Medan Marelan District below.



Gambar. 7 Regional Spatial Pattern Plan Medan Marelan District

To see the results of the conformity between land use in Medan Marelan District, the researcher tried to translate it into 3 classification of conformity such as: suitable, less suitable, and inappropriate. For more details, you can see the table below translating the results of conformity in Medan Marelan District.

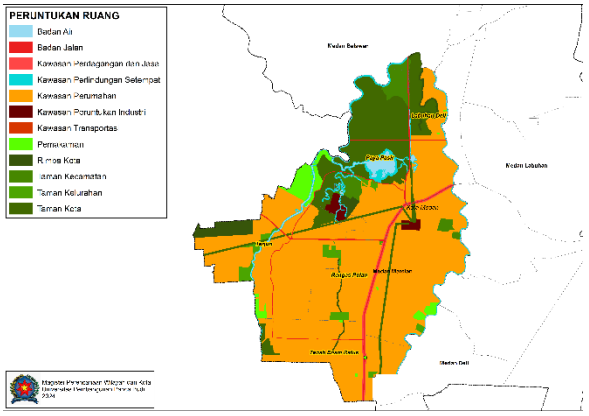
Tabel. 7 Results of land suitability analysis in Medan Marelan District

It	Neighborhoods	Suitability Area (Ha)			Conformance Percentage (%)
		Less Suitable	Appropriate	Not Suitable	
1	Labuhan Deli	176,46	103,59	30,95	3,45
2	Sands Swamp	341,28	226,66	22,65	7,55
3	Rengas Island	346,30	450,79	58,90	15,01
4	Six Hundred Land	111,58	284,41	23,94	9,47
5	Plunge	349,48	407,08	68,93	13,56
Total Area (Ha)		**1.325,10**	**1.472,53**	**205,37**	**49,04**

Source : Analysis Results, 2024

From the table above, it shows that 49.04% of the level of suitability of land use to the demolition of existing space in Medan Marelan District, 44.13% is not suitable, and 6.84% is not suitable. From the results carried out as a whole, Renggas Pulau Village has the highest level of suitability with a percentage of 15.01% and there is Labuhan Deli Village which is the Village with the lowest

percentage of around 3.45%. For more details, you can see the map of the distribution of land suitability in Medan Marelan District below.



Gambar. 8 Land Suitability in Medan Marelan District

C. REVIEW OF MEDAN CITY SPATIAL PLAN POLICY

Spatial planning strategy

To realize the policy of realizing the city's green open space of 20% (twenty percent) for Public RTH and 10% (ten percent) for Private RTH from the area of Medan City as referred to in Article 5 letter h, the strategy carried out is:

- Developing RTH on the land of the former Terjun Landfill in Medan Marelan District;
- Medan Marelan city service sub-center (SPPK) which functions as a center for basic necessities trading activities and a center for tourism activities;
- Marelan as an environmental service center (PPL);

Space Structure Plan

- Road Network System
- The Secondary Artery Network is located on the west side of the Marelan ring road
- The collector's road network is located on the Marelan Raya road section
- River, Lake and Crossing Network System
- River and lake ports
- Electricity infrastructure network
- Sicanang Gas Power Plant (PLTG) in Medan Belawan District, Paya Pasir Power Plant in Medan Marelan District, and Glugur Power Plant in West Medan District;
- Extra High Voltage Overhead Line (SUTET) that crosses Medan Belawan District, Medan Labuhan District, Medan Marelan District, Medan Deli District, Medan Amplas District and Medan Johor District; and
- The High Voltage Aerial Line (SUTT) crosses Medan Belawan District, Medan Marelan District, and Medan Labuhan District.
- Water Resources Network System

- Flood control buildings in the form of polder systems are located in Medan Johor District, Medan Tuntungan District, Medan Polonia District, Medan Marelan District and Medan Labuhan District;
- Water resource buildings in the form of reservoirs

• Urban Infrastructure

- Mini IPA drinking water supply system (SPAM) in West Medan District, Medan Denai District, Medan Marelan District, and Medan Helvetia District;
- Wastewater management system infrastructure (SPAL)
- Urban waste network system Final Processing Site (TPA) in Terjun Village, Medan Marelan District.
- The primary drainage network system is in the form of urban main drainage channels that are passed by rivers and/or tributaries of Belawan.

• Green Open Space

- There is a demolition of the urban forest green open space (RTH-1)
- Taman Kesub-district (RTH-3)
- Cemetery (RTH-7)

• Industrial allocation area (KPI)

- There is a zone to demolish industrial estates

• Transportation area

- There is a zone designated for transportation areas

Main Program Indications

• Realization of transportation network system

- Construction of the Siombak Bypass Road (Marelan – Sicanang);
- Improvement of the connecting road of Jalan Marelan Raya – Jl. Yos Sudarso;
- Construction of Marelan Type B Terminal;

• Realization of public and social facilities

- Improvement of educational facilities in Medan Marelan District, Medan Labuhan District, and Medan Belawan District;
- Improvement of facilities and infrastructure to support health facilities in Medan Marelan District, Medan Labuhan District, and Medan Belawan District;
- Urban spatial structure

General Provisions for Zoning of Local Protection Areas

• Conditions for the use of space

- KDB in the river/paluh border area in Medan Belawan District, Medan Marelan District, and Medan Labuhan District can reach a maximum of 5% (five percent) in the framework of security against the river/paluh channel;

D. FACTORS AFFECTING THE DEVELOPMENT OF THE AREA

The results of the analysis conducted by the researcher try to calculate 4 factors that affect land development in Medan Marelan District which will later be drawn as a whole by producing the value of each sub-district in Medan City.

Tabel. 8 Linear Regression Analysis

Variable	Coefficient	Significance
Population	0.5	0.01
Land Value	0.3	0.05
Distance to City Center	- 0.2	0.02
Number of Facilities	0.4	0.03

Source : Analysis Results, 2024

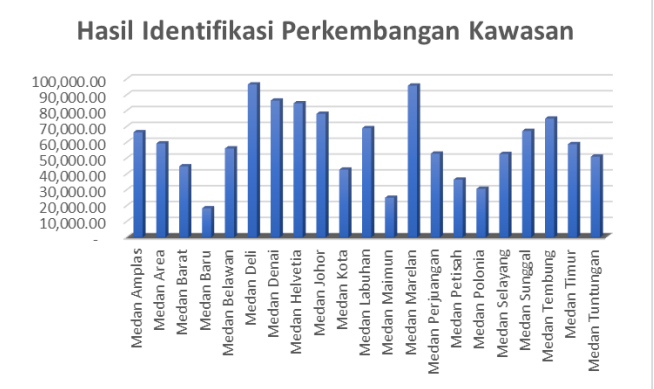
Based on linear regression analysis, it was found that the number of population, land value, and number of facilities had a significant positive influence on the development of the area in Medan Marelan District. The distance to the city center has a negative influence, which means that the farther the distance, the lower the level of development of the area.

Tabel. 9 Results of Analysis of Factors Affecting Regional Development Based on Land Value 1

It	District	Population	Land Value 100 Thousand - 2 Million	Distance to city center (km)	Total Number of Facilities	Prediction Value
1	Sandpaper Field	131.770	1.107,40	6,23	245	66.315,97
2	Medan Area	118.057	565,41	2,74	254	59.301,18
3	West Medan	89.248	389,53	3,49	222	44.830,96
4	Medan Baru	36.191	345,18	4,73	277	18.310,91
5	Medan Belawan	110.238	3.356,62	20,17	48	56.143,15
6	Medan Deli	191.743	1.952,39	7,27	148	96.516,96
7	Trail Terrains	171.896	981,10	4,59	229	86.335,01
8	Helvetia Field	168.292	1.271,81	5,59	265	84.634,43
9	Johor Field	154.868	1.389,84	6,18	312	77.976,52
10	Medan Kota	84.778	782,18	3,38	306	42.747,38
11	Medan Labuhan	135.622	3.559,22	13,54	131	68.930,46
12	Medan Maimun	49.708	258,20	1,58	113	24.978,35

It	District	Population	Land Value 100 Thousand - 2 Million	Distance to city center (km)	Total Number of Facilities	Prediction Value
13	**Medan Marelan**	**189.469**	**3.366,28**	**13,61**	**146**	**95.802,06**
14	Field of Struggle	105.317	431,42	2,83	123	52.838,56
15	Medan Petisah	72.432	278,71	1,92	316	36.427,63
16	Medan Polonia	60.679	668,28	4,06	160	30.605,17
17	Medan Selayang	104.144	1,495,28	5,84	176	52.591,82
18	Medan Sunggal	133.273	1,157,06	6,99	424	67.153,82
19	Medan Tembung	149.274	870,39	5,10	206	74.981,50
20	East Medan	117.035	687,17	1,31	231	58.817,79
21	Medan Tuntungan	100.132	2.680,43	10,65	195	50,948,00
Total Prediction Value		**2.474.166**	**27.593,91**	**131,78**	**4,527**	**1.247.148**

Source : Analysis Results, 2024



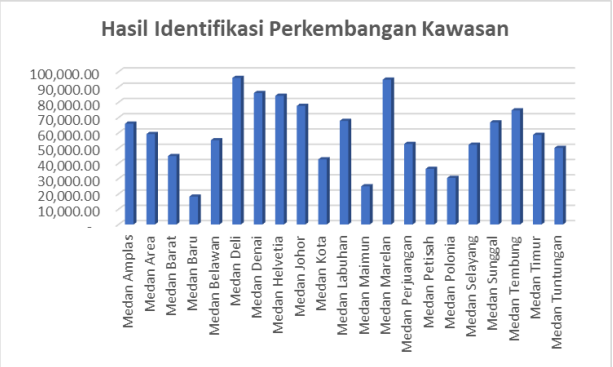
Gambar. 9 Graph of Estimated Regional Development in Medan Marelan District Based on Land Value 1

Tabel. 10 Results of Analysis of Factors Affecting Regional Development Based on Land Value 2

It	District	Population	Land Value 2 Million - > 20 Million	Distance to city center (km)	Total Number of Facilities	Prediction Value
1	Sandpaper Field	131.770	64.01	6.23	245	66.002,96
2	Medan Area	118.057	279.01	2.74	254	59.215,25
3	West Medan	89.248	252.86	3.49	222	44.789,96
4	Medan Baru	36.191	197.71	4.73	277	18.266,67
5	Medan Belawan	110.238	16.20	20.17	48	55.141,03
6	Medan Deli	191.743	55.48	7.27	148	95.947,89
7	Trail Terrains	171.896	56.45	4.59	229	86.057,62
8	Helvetia Field	168.292	48.67	5.59	265	84.267,48
9	Johor Field	154.868	334.37	6.18	312	77.659,87
10	Medan Kota	84.778	355.84	3.38	306	42.619,48
11	Medan Labuhan	135.622	-	13.54	131	67.862,69
12	Medan Maimun	49.708	327.28	1.58	113	24.999,07
13	**Medan Marelan**	**189.469**	**70.23**	**13.61**	**146**	**94.813,25**
14	Field of Struggle	105.317	28.50	2.83	123	52.717,68
15	Medan Petisah	72.432	249.31	1.92	316	36.418,81
16	Medan Polonia	60.679	208.95	4.06	160	30.467,37

It	District	Population	Land Value 2 Million - > 20 Million	Distance to city center (km)	Total Number of Facilities	Prediction Value
17	Medan Selayang	104.144	150.55	5.84	176	52.188,40
18	Medan Sunggal	133.273	172.62	6.99	424	66.858,49
19	Medan Tembung	149.274	72.34	5.10	206	74.742,08
20	East Medan	117.035	202.70	1.31	231	58.672,45
21	Medan Tuntungan	100.132	30.87	10.65	195	50.153,13
Total Prediction Value		**2.474.166**	**3.173.94**	**131.78**	**4,527**	**1.239.822**

Source : Analysis Results, 2024



Gambar. 10 Graph of Estimated Area Development in Medan Marelan District Based on Land Value 2

It can be seen from the table above that the results of linear regression analysis illustrate 4 indicators which are divided into 2 pictures based on land values of 100,000–2,000,000 and 2,000,000–20,000,000. From the results above, it shows that Medan Deli District is the highest district with the highest prediction value compared to other districts. Medan Marelan District is the district that has the 2nd highest positive value, so the researcher tries to relate it to the existing conditions in Medan Marelan District. From the table above, it shows the highest prediction value based on the land value of 200,000 - 2,000,000 which overall has the highest prediction value. If viewed from the two tables above, Medan Marelan District has a land value of 100,000 – 2,000,000 with an area of 3,366.28 Ha has a prediction value that is not much different when juxtaposed with data with a land value of 2,000,000–20,000,000 is not much different and gets the second highest overall.

E. SWOT ANALYSIS

The following is a SWOT analysis matrix adapted for the study of the phenomenon of land use change in the suburbs (*urban fairies*) of Medan City and its influence on spatial pattern planning, with a case study of Medan Marelan District.

Tabel. 11 SWOT Data as a Strategic Model of the Land Change Phenomenon and Its Influence on Spatial Pattern Planning

Strengths - Remote sensing data provides an accurate and comprehensive picture. - The spatial-based spatial approach improves the precision and relevance of the analysis. - Powerful methodology with a combination of various analysis methods.	**Weaknesses** - The limitations of secondary data that may not always *be up-to-date* or of varying quality. - Dependence on external data sources such as satellite imagery. - Limited resources and technical expertise for data processing and spatial analysis.
Opportunities - Advances in remote sensing technology and *Geographic Information Systems* (GIS) open up opportunities for more in-depth and accurate analysis. - Increased awareness about environmental issues could increase support for this research. - The results of the research can be used to formulate more effective spatial planning and land use policies in the future.	**Threats** - Changes in government policies related to spatial planning and land use. - Economic changes such as changes in land prices or infrastructure investment. - Unexpected climate change can change land use dynamics and affect research results.

Source : Analysis Results, 2024

Tabel. 12 SWOT Analysis Matrix

SWOT	Strengths	Weaknesses
	SO Strategy	**WO Strategy**
Opportunities	- Using remote sensing data and *Geographic Information System* (GIS) technology to consider more accurate and sustainable spatial pattern plan policies. - Leverage government and related institutional support to obtain data and funding for research.	- Increasing the capacity of human resources through training and education to address technical skills shortages. - Improving access and quality of data through collaboration with government and private agencies.

	- Increase cooperation with universities and research institutes to strengthen databases and analysis.	- Take advantage of funding opportunities from governments and donor agencies to improve infrastructure and technology.
	ST Strategy	**WT Strategy**
Threats	- Using the results of the research to provide input to the government in making policies that can overcome uncontrolled land use changes. - Develop a prediction and monitoring system to identify and address the impacts of climate change on land use. - Use technology and data to create mitigation scenarios that can mitigate the impact of policy changes and uncertain economic conditions.	- Create contingency plans to cope with unexpected policy changes and economic fluctuations. - Develop a monitoring and evaluation system to ensure that the data used remains relevant and accurate. - Collaborate with relevant experts and institutions to improve understanding and mitigation of the impacts of climate change.

Source : Analysis Results, 2024

Strategy Explained

1. **SO (Strengths - Opportunities) Strategy:**
   - Harnessing the power of technology and data to design more accurate and sustainable spatial policies.
   - Use support from the government and related institutions to strengthen research and obtain funding.
   - Increase cooperation with universities and research institutions to improve databases and analysis.

2. **WO (Weaknesses - Opportunities) Strategy:**
   - Addressing internal weaknesses by increasing the capacity of human resources through training and education.
   - Improving data quality and access by collaborating with government and private agencies.
   - Take advantage of funding opportunities to improve infrastructure and technology.

3. **ST (Strengths - Threats) Strategy:**
   - Using the results of the research to provide input to the government in dealing with land use change and the impact of climate change.
   - Develop a prediction and monitoring system to deal with the impact of climate change and uncertain economic conditions.
   - Create mitigation scenarios to mitigate the impact of policy and economic changes.

4. **WT (Weaknesses - Threats) Strategy:**

- Develop contingency plans to deal with policy changes and unexpected economic fluctuations.
- Develop a monitoring and evaluation system to maintain the relevance and accuracy of data.
- Collaborate with relevant experts and institutions to improve understanding and mitigation of climate change impacts.

With this SWOT matrix, strategies can be designed to take advantage of strengths and opportunities, while addressing weaknesses and threats that may be faced in the phenomenon of land use change in Medan Marelan District.

V. CONCLUSIONS AND SUGGESTIONS

A. Conclusion

This study has identified and analyzed land use changes and factors affecting the development of the area in Medan Marelan District during the period 2004 to 2024. The conclusions that can be drawn from this study are as follows:

1. Land Use Change
   There is a significant change in land use in Medan Marelan District, especially from agricultural land and vacant land to housing and commercial areas. This development reflects rapid urbanization and the need for housing and commercial facilities. According to the results of an analysis conducted based on satellite image observations in 2004, the use of commercial and service land in Medan Marelan District was 36.43 Ha and in 2024 it will increase to 179.08 Ha.
2. Compatibility with RTRW
   Most of the land use developments are still in accordance with the Regional Spatial Plan (RTRW) of Medan City. However, there are some irregularities in the area that was previously used for agriculture, which has now been transformed into a residential and commercial area. According to the results of the land suitability analysis carried out, there was a percentage of land suitability in Medan Marelan District of around 49.04%, 44.13% Less, and 6.84% Inappropriate.
3. Factors Affecting Regional Development
   Based on linear regression analysis, it was found that the number of population, land value, and number of facilities had a significant positive influence on the development of the area in Medan Marelan District. The distance to the city center has a negative influence, which means that the farther the distance, the lower the level of development of the area. According to the results of the analysis carried out, it is known that the prediction value of Medan Marelan District is the second highest sub-district after Medan Deli District.
4. Regional Management
   Urban transformation in Medan Marelan District shows the need for better management of land use development to remain in accordance with the RTRW and avoid deviations that can disrupt the ecological and social balance.
5. Strategy
   By leveraging strengths, overcoming weaknesses, pursuing opportunities, and anticipating threats, this strategy is expected to effectively manage land-use change and contribute to better spatial planning in Medan Marelan District.

B. Suggestion

Based on the results of the research, there are several suggestions that can be given for regional management and planning in Medan Marelan District

1. RTRW Enforcement
   The Medan City Government needs to tighten the supervision and enforcement of the RTRW to ensure that the development of the area remains in accordance with the plan that has been set. This is important to avoid land use irregularities that can be detrimental to the environment and society.
2. Infrastructure Development
   To support the rapid development of the region, it is necessary to develop adequate infrastructure, including roads, waterways, and other public facilities. This will improve the quality of life of the population and support local economic growth.
3. Agricultural Land Conservation
   The government needs to consider policies that protect agricultural land from conversion to non-agricultural land. One way is to provide incentives to farmers to continue to manage their farmland and ensure the sustainability of local food production.
4. Sustainable Planning
   In development planning, it is important to adopt a sustainable approach by considering environmental and social impacts. This can be achieved through community participation in the planning and decision-making process.
5. Improving the Quality of Public Facilities
   To support rapid population growth, it is necessary to improve the quality and quantity of public facilities such as schools, health centers, and recreational places. These facilities will help improve the welfare of the community and attract more investment to the region.

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