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The impact of industrial agglomeration on air quality from a regional development perspective

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Abstract
This study examines the impact of industrial agglomeration on air quality, economy, and social aspects in the Medan City area. The findings reveal that industrial agglomeration in the Medan Deli District significantly influences air quality parameters, such as Nitrogen Dioxide (NO2), Sulfur Dioxide (SO2), Carbon Monoxide (CO), Hydrocarbons (HC), Ozone (O3), and Particulate Matter (PM10 and PM2.5). As industrial agglomeration increases, air quality deteriorates compared to non-agglomeration areas. Furthermore, industrial agglomeration has notable effects on the economy and social well-being of the community, leading to job opportunities and a favorable business climate. To mitigate the negative impact on air quality, it is crucial for industrial stakeholders, the community, and the government to actively monitor and regulate emission sources, such as combustion engines, while conducting routine ambient air quality monitoring around the Medan Industrial Area. These measures will contribute to improving both the environmental and socio-economic conditions in the region.

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Introduction

Air is a vital component for the survival of humans and other living organisms. The level of air pollution in Medan City is quite high. Air pollution refers to a condition in which there are physical, biological, or chemical substances in the Earth's atmosphere that are harmful to human health and other living beings (Siburian, 2020) [4]. The composition of air is a mixture of gases present on the Earth's surface. Dry air contains 78% nitrogen, 21% oxygen, and 1% water vapor, carbon dioxide, and other gases. Carbon monoxide emissions originate from vehicle exhaust and industrial combustion processes. Sulfur dioxide emissions stem from heat and power generation facilities (Siburian, 2020) [4].

On the other hand, industrial development plays a crucial role in supporting economic growth in a region. However, if industrial development fails to consider the environment, significant issues will arise (Machdar, 2018). It is known that a significant portion of air pollution comes from industrial emissions through boiler combustion processes and transportation emissions, namely Carbon Monoxide (CO), Nitrogen Dioxide (NO2), Sulfur Dioxide (SO2), Hydrocarbons (HC), and Particulate Matter (PM). The air quality in a region (Ambient Air Quality) is determined by the levels of these factors mentioned above. Generally, industries consume 37% of energy and produce 50% carbon dioxide, 90% sulfur dioxide, and various toxic chemicals (Machdar, 2018).

According to Kuncoro (2012) [2], the influx of people into cities can lead to issues such as "over urbanization" and "urban primacy." "Over urbanization" refers to an excessive population that surpasses the city's carrying capacity. This phenomenon is indicative of the increasing attractiveness of large cities, resulting in dysfunctional conditions. This can be observed through regional disparities and the growing burden on city governments. On the other hand, urban primacy refers to the dominance of major cities over smaller ones, causing the latter to stagnate. This dominance can be seen in economic concentration, resource allocation, market centers, governance centers, and socio-political values.

Over urbanization and urban primacy pose problems that affect the development of a city, including issues such as unemployment, moral degradation and crime, slum settlements, and transportation/traffic.

In measuring air quality within a monitoring area, there are several methods: (1) Ambient Air Quality measurement using Passive Samplers, (2) simple air quality measurement using Active Manual methods, and (3) automated Air Quality measurement using SPKUA/AQM devices. Therefore, the objectives of this research are to analyze the impact of industrial agglomeration on air quality in the Medan City area and to analyze the impact of industrial agglomeration on the economy and social well-being of the community in the Medan City area.

Literature

Medan City generates the second-highest Gross Regional Domestic Product (GRDP) in North Sumatra, following Deli Serdang. It is also the city with the highest emissions in the province. In 2020, Medan City emitted a total of 3,609.80 Gg (gigagrams), and when compared to the emissions of North Sumatra Province in 2019, which amounted to 91,850 Gg, Medan City's contribution to the province's emissions reaches 38%. Generally, a region, including a city, develops due to agglomeration. The development of cities and regions cannot occur without agglomeration. Agglomeration allows companies to achieve production with lower average costs, known as agglomeration economies.

There are two types of agglomeration. First, localization economies occur when the average production costs for similar companies within the same industry in the same location decrease as the total production of that industry increases. Second, urbanization economies occur when the total average production costs for each company decrease as the total production of various industries in the same location increases (Sugiyono, 2003).

The development of concepts and ideas regarding agglomeration shows that every study or theory on agglomeration can be classified into classical or modern perspectives. The classical perspective believes that agglomeration is a spatial form associated with the concept of "economies of agglomeration" through externalities. On the other hand, the modern perspective highlights several weaknesses in classical theories of agglomeration. In this context, three lines of thought can be identified: first, new theories on dynamic externalities; second, the urban growth paradigm; and third, the transaction cost-based paradigm (Sjafrizal, 2014) [5].

Industries tend to agglomerate in areas where the potential and capabilities of the region meet their needs, and they benefit from the proximity of other companies. The attractiveness of cities for industries lies in the various advantages they offer in terms of productivity and higher income, attracting new investments, new technologies, and a larger pool of educated and skilled workers compared to rural areas. As a result, unlike resource-based industries, manufacturing industries tend to locate within and around cities.

The rapid development in industries and technology, as well as the increasing number of vehicles using fossil fuels, has led to air pollution caused by combustion emissions (Siburian, 2020) [4]. Good air quality is not only crucial for human survival but also important for plants, animals, soil, and water. Declining air quality not only affects human health but also has physiological implications for plants, resulting in varying levels of sensitivity, susceptibility, and resistance, ultimately leading to changes in the environment, particularly air quality. In general, monitoring environmental quality, especially air quality, is part of efforts to mitigate and prevent environmental pollution. Several indicators are used in monitoring air quality, including chemical, physical, and biological indicators.

Air pollution is a condition where the air is contaminated with foreign substances or other components that cause a disruption in the air composition due to human activities or natural processes, resulting in a decrease in air quality or its inability to function according to its intended purpose. The testing of air quality is conducted in accordance with Government Regulation No. 45 of 1997 and Minister of Environment and Forestry Regulation of the Republic of Indonesia No. 14 of 2020 regarding the Air Pollution Index Standards:

Table 1: Air Pollution Index Standards

No	Parameter	Unit	Method
1	NO_2	ug/Nm^3	The Griess Saltzmant
2	SO_2	ug/Nm^3	Pararosaniline
3	CO	ug/Nm^3	CO Analyzer
4	HC	ug/Nm^3	Flame Ionization
5	O_3	ug/Nm^3	Chemilimenecent
6	$PM_{2,5}$	ug/Nm^3	Gravimetric
7	PM_{10}	ug/Nm^3	Gravimetric

The approaches used in manual sampling to obtain average hourly or daily data are as follows

1. For parameters SO2, NO2, and CO, daily data values are obtained by arithmetic averaging.
2. For parameter O3, one-hour data values are obtained by measuring during a one-hour interval between 12:00 and 13:00 or during peak hours when O3 levels are at their maximum.
3. For parameter HC (non-methane hydrocarbon), it is preferable to measure HC values automatically to obtain average values. If automated equipment is not available, manual measurements can be conducted.
4. For parameters PM10 and TSP (total suspended particulate matter), monitoring is conducted for one hour each.
5. For parameter Pb (lead), monitoring is conducted for one hour to obtain daily values.

Research Method

The research is conducted in the vicinity of the Medan Industrial Area in the Medan Deli District. The Medan Industrial Area was chosen as the research location because it is an integrated industrial zone that has significant impacts on the economy, society, and air quality in the Medan Deli District. The scope of this study is to analyze the impact of industrial agglomeration on the air quality of Medan City and assess the impact of industrial agglomeration on the economy and social aspects of the community, as well as the air quality in the Medan Industrial Area.

The data used in this research includes primary and secondary data. Primary data is obtained from the community by distributing questionnaires to respondents regarding the impact of industrial agglomeration on the air quality of Medan City. Secondary data is obtained from relevant institutions such as the Medan Deli District Office, Medan

Industrial Area Office, and other related agencies involved in this research.

The population in this study consists of all residents in the Medan Deli District. Sampling is done using probability sampling, which is a sampling technique that gives equal chances for each element (member) of the population to be selected as a sample member (Sangadji and Sopiah, 2010) [3]. The sampling of respondents who are native residents of Medan is done proportionally to three sub-districts in the Medan Deli District, namely Mabar Sub-district, Mabar Hilir Sub-district, and Kota Bangun Sub-district, as these three sub-districts are close to the Medan Industrial Area. The total number of households in these three sub-districts is 16,344 households (Medan Deli District in Figures, 2022), and the sample size is 99 respondents.

To analyze the first hypothesis regarding the influence of industrial agglomeration on air quality in the Medan Industrial Area, multiple regression analysis is used:

$$\mathbf{Y = a + bX_1 + bX_2 + \mu}$$

Explanation:
Y = Air quality
X1 = Agglomeration (number of industries)
X2 = Air quality parameters (PM10 and SO2)
a = Constant
b1, b2 = Coefficients of variables
μ = Error effect

To analyze the second hypothesis regarding the impact of industrial agglomeration on the economy and social aspects of the community in the Medan Industrial Area, multiple linear regression analysis is used:

$$\mathbf{Y = a + bX1 + bX2 + bX3 + \mu}$$

Explanation:
Y = Economy and social aspects of the community
X1 = Agglomeration (number of industries)
X2 = Income obtained
a = Constant
b1, b2, b3 = Coefficients of variables
μ = Error effect

Result and Discussion

PT. (Persero) Kawasan Industri Medan is a State-Owned Enterprise (SOE) engaged in the management of Industrial Areas. The industrial area was established on October 7, 1988, with its share composition consisting of the Government of Indonesia (central) 60%, the Government of North Sumatra Province 30%, and the Government of Medan City 10%. PT. Kawasan Industri Medan (Persero) was established as a State-Owned Enterprise (SOE) through Deed of Notary Soeleman Ardjasasmiota, SH, No. 9 on October 7, 1988, in Jakarta, as amended and supplemented by Deed of Notary Ny. Asmara Noer SH, No. 8 and 9 on March 10, 198, as a result of the Extraordinary General Meeting of Shareholders on January 14, 1998. It has been further amended by Deed of Notary Erita Wagewali Sitohang, SH No. 12 on April 7, 2005, and most recently amended by Deed of Notary Titiek Irawati S.S.H No. 42 on September 12, 2008, in accordance with the decisions of the Shareholders of the Company PT. Kawasan Industri Medan Kep-114S.MBU2008, No. Kep-23D2.MBU2008, No. 5752836K2008, and No. 570106522008 on August 13, 2008. Since its establishment, due to the high interest of investors to invest in North Sumatra, PT. KAWASAN INDUSTRI MEDAN has continued to develop its land. Until now, it has an area of 780 hectares and will continue to be developed through its own efforts or in collaboration with experienced and professional private parties in industrial area development.

The Medan Industrial Area (Phase I), with an area of +200 hectares, is located west of the toll road, and the area east of the toll road is referred to as the Medan Industrial Area (Phase II) with an area of +325 hectares. The spatial planning of Phase II is well-planned and beautiful, with a main entrance and exit road made of concrete measuring 2 x 17.5 meters, and secondary roads measuring 12 meters wide. On both sides of the road, there are clean water pipes, wastewater pipes, fire hydrants, gas pipes, and underground electrical and telephone cables. (Data from Kawasan Industri Medan)

There are various industrial products produced in North Sumatra, relying on the potential and natural resources available in the region. These include the Palm Oil Industry (CPO) and its derivatives such as Fatty Acid, Stearic Acid, Palmitic Acid, Isopropyl Palmitate, Glycerin, and other types of oleochemicals. Additionally, there are industries related to rubber, cocoa, coffee, tea, as well as agricultural products from the highlands of North Sumatra, including vegetables and fruits.

In addition to monitoring and sampling the air quality in the Medan Industrial Area, air quality monitoring samples are also taken at four other locations for comparison purposes. The selection of air quality monitoring locations is based on the Regulation of the Ministry of Environment and Forestry of the Republic of Indonesia No. P.14/MenLHK/Setjen/Kum.1/7/2020, which classifies monitoring locations into urban centers, urban backgrounds, suburban areas, industrial areas, and rural areas.

The analysis aims to establish the causal relationship between the number of industries in a monitoring area and the air quality in its surroundings, specifically focusing on the parameters of Particulate Matter (PM10) and Sulfur Dioxide (SO2). These two parameters are considered to have the most significant impact on overall ambient air quality. The data for analysis were collected from March to July 2022 at five monitoring locations: the Medan Industrial Area, around AH. Nasution Road, around Gatot Subroto Road, around Letda Sujono Road, and around MT. Haryono Road. The results of the analysis are as follows: [Please provide the specific results or data for further discussion.

Table 2: Air Quality Testing Data in Kawasan Industri Medan (March - July 2022)

Month	Air Quality Parameter Data								
	SO_2	**CO**	**NO_2**	**O_3**	**NMHC**	**TSP**	**PM_{10}**	**PM2,5**	**Pb**
March	38.6333	114.5	43.9667	68.4	42.6667	150.667	50.6	36.4667	0.01
April	39.36667	114.5	45.5667	71.9333	40.5	141.333	48.7333	33.2	0.01
May	37.26667	114.5	35.0667	47.7667	39.76667	139	44.5667	32.3333	0.01
June	44.3	114.5	37.5667	54.4333	41.1333	149.333	50.2	36.3667	0.01
July	46.1	114.5	38.1667	48.8	38.5333	136.533	44.6	32.3667	0.01
Average	**41.1333**	**114.5**	**40.0667**	**58.26667**	**40.52**	**143.373**	**47.74**	**34.1467**	**0.01**
Std	150	10000	200	150	-	-	-	-	-

***Source*:** Air Quality Monitoring Data from Dinas Lingkungan Hidup Medan City

Table 3: Air Quality Testing Data in AH Nasution, St Medan (March - July 2022)

Month	Air Quality Parameter Data								
	SO_2	**CO**	**NO_2**	**O_3**	**NMHC**	**TSP**	**PM_{10}**	**PM2,5**	**Pb**
March	34.1333	114.5	33.9667	36.9333	35.8667	85.4667	28	20.2	0.01
April	30.9667	114.5	30.7	29.7333	34.4333	117	37.4667	27.4667	0.01
May	31.4333	114.5	31.6333	30.8667	34.8333	104.2	33.7	24.3333	0.01
June	31.8667	114.5	30.2333	32.0333	35.5333	107.8	34.3667	25.2667	0.01
July	34.8	114.5	31.4	35.9667	36.4333	102.267	33.2	24.4333	0.01
Average	**32.64**	**114.5**	**31.5867**	**33.1067**	**35.42**	**103.3467**	**33.34667**	**24.34**	**0.01**
Std	150	10000	200	150	-	-	-	-	-

***Source*:** Air Quality Monitoring Data from Dinas Lingkungan Hidup Medan City

Table 4: Air Quality Testing Data in Gatot Subroto, St Medan (March - July 2022)

Month	Air Quality Parameter Data								
	SO_2	CO	NO_2	O_3	NMHC	TSP	PM_{10}	PM2,5	Pb
March	37.53333	114.5	32.13333	58.9	38.16667	101.7333	32.8	24.23333	0.01
April	33.1	114.5	34.06667	41.3	35.3	91.5	29.23333	21.8	0.01
May	31.26667	114.5	33.4	34.8	34.2	79.93333	25.56667	18.8	0.01
June	34.56667	114.5	32.9	39.1	37.36667	80.1	25.76667	18.68	0.01
July	35.06667	114.5	33.9	37.86667	37.43333	80.4	25.96667	19.19333	0.01
Average	**34.30667**	**114.5**	**33.28**	**42.39333**	**36.49333**	**86.73333**	**27.86667**	**20.54133**	**0.01**
Std	150	10000	200	150	-	-	-	-	-

***Source*:** Air Quality Monitoring Data from Dinas Lingkungan Hidup Medan City

Table 5: Air Quality Testing Data in Letda Sujono St, Medan (March - July 2022)

Month	**Air Quality Parameter Data**								
	SO_2	**CO**	**NO_2**	**O_3**	**NMHC**	**TSP**	**PM_{10}**	**PM2,5**	**Pb**
March	36.9	114.5	32.06667	86.13333	47.26667	130.6	42.4	30.86667	0.01
April	38.66667	114.5	32.53333	74.66667	40	113.7333	36.36667	26.6	0.01
May	39.03333	114.5	34.16667	50.13333	35.4	109.7333	35.5	25.46667	0.01
June	41.03333	114.5	34.06667	47.83333	38.03333	132.1333	42.86667	31.26667	0.01
July	40.46667	114.5	35.7	48.93333	35.86667	124.4	40.4	29.56667	0.01
Avg	**39.22**	**114.5**	**33.70667**	**61.54**	**39.31333**	**122.12**	**39.50667**	**28.75333**	**0.01**
Std	150	10000	200	150	-	-	-	-	-

***Source*:** Air Quality Monitoring Data from Dinas Lingkungan Hidup Medan City

Table 6: Air Quality Testing Data in MT.Haryono,St (Medan Mall) (March - July 2022)

Month	**Air Quality Parameter Data**								
	SO_2	**CO**	**NO_2**	**O_3**	**NMHC**	**TSP**	**PM_{10}**	**PM2,5**	**Pb**
March	48.1	114.5	37.63333	63.9	50.86667	133.4667	43.86667	31.53333	0.01
April	43.06667	114.5	33.26667	63.23333	41.13333	126.5333	40.36667	29.36667	0.01
May	39.2	114.5	31.4	48.56667	38.86667	118.1	38.2	27.9	0.01
June	40.66667	114.5	33.76667	50.03333	38.56667	110.4333	35.63333	26.23333	0.01
July	41.43333	114.5	33.83333	48.33333	39.63333	109.3667	35.56667	25.86667	0.01
Avg	**42.49333**	**114.5**	**33.98**	**54.81333**	**41.81333**	**119.58**	**38.72667**	**28.18**	**0.01**
Std	150	10000	200	150	-	-	-	-	-

***Source*:** Air Quality Monitoring Data from Dinas Lingkungan Hidup Medan City

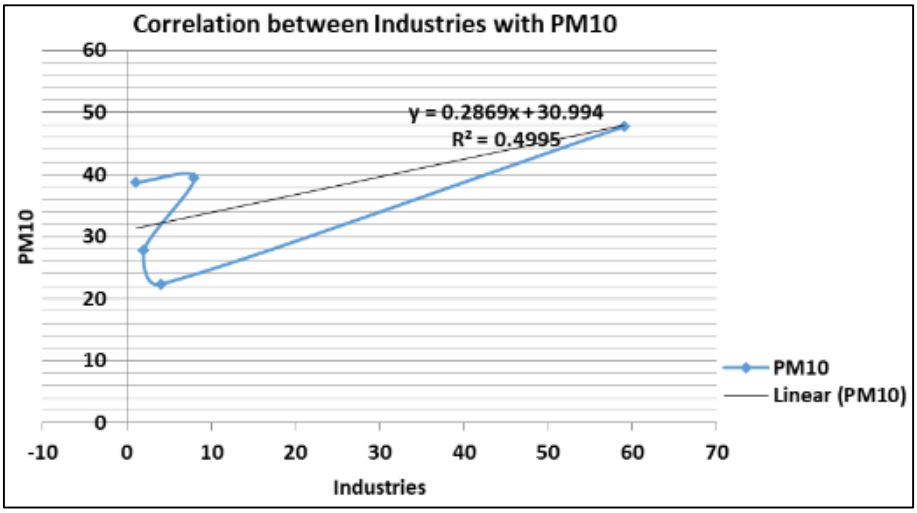

Fig 1: Correlation between Industries with PM10

The graph in the table clearly demonstrates a causal correlation between the concentration of Particulate Matter (PM10) and the number of industries in a monitoring area. It indicates that as the industrial activity increases in a given area, the level of PM10 also rises. This upward trend signifies a direct impact of industrial emissions on air pollution. Consequently, the higher the concentration of PM10 in the monitoring area, the greater the emission burden, leading to a decline in air quality within the monitored region.

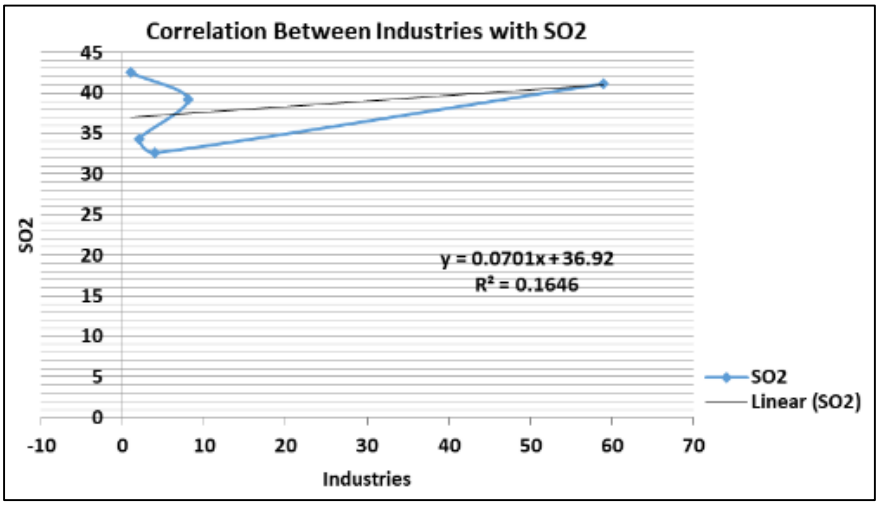

Fig 2: Correlation between Industries with SO_2

There is a correlation between the number of industries in a monitoring area and the level of Sulfur Dioxide (SO2) parameter. The data indicates a positive correlation, meaning that as the number of industries in a specific area increases, the concentration of Sulfur Dioxide (SO2) also tends to increase within that area. The higher the concentration of Sulfur Dioxide (SO2) in the monitoring area, the greater the emission burden and air pollution, leading to a deterioration in air quality within the monitored region.

Table 6: Partial Test Results of the Impact of Industrial Agglomeration on Air Quality in the City of Medan

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
1	(Constant)	-12,267	2,760		-4,445	,000
	Aglomerasi (X_1)	,234	,114	,259	2,043	,044
	Parameter kualitas udara (X_2)	,330	,105	,398	3,143	,002
a. Dependent Variable: Kualitas udara						

***Source*:** Primer Data processed, 2023

The variable "agglomeration factor" (X1) has a positive and significant impact on air quality, as indicated by a beta coefficient of 0.234. This means that for every unit increase in the agglomeration factor score, the air quality in Medan Deli District increases by 0.234 score units. Similarly, the variable "air quality parameter" (X2) also has a positive and significant impact on air quality, with a beta coefficient of 0.330. This implies that for every unit increase in the air quality parameter score, the air quality in Medan Deli District increases by 0.330 score units.

The multiple regression equation is as follows

Y = -12.267 + 0.234X1 + 0.330X2

where Y represents the air quality in Medan Deli District. As for the impact of industrial agglomeration on the economy and social aspects of the community in Medan, it is presented in Table 7.

Table 7: Partial Test Results of the Impact of Industrial Agglomeration on the Economy and Social Aspects of the Community in Medan City

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
1	(Constant)	28,424	3,384		8,399	,000
	Aglomerasi (X_1)	,396	,107	,472	3,717	,000
	Upah (X_2)	,274	,105	,330	2,598	,011
a. Dependent Variable: Perekonomian dan Sosial Masyarakat						

***Source*:** Primer Data Processed, 2023

With the multiple regression equation as follows

Y = 28.424 + 0.396 X1 + 0.274 X2

The research findings indicate that the variable of agglomeration factor (X1) has a beta coefficient of 0.396, which is positively signed. This means that each unit increase in the score of the agglomeration factor variable will increase the economic and social aspects of the community in Medan Deli by 0.396 score units. Meanwhile, the variable of wage factor (X2) has a beta coefficient of 0.274, also positively signed. This implies that each unit increase in the score of the wage factor variable will increase the economic and social aspects of the community in Medan Deli by 0.274 score units.
The data analysis reveals that the air quality in the Medan Industrial Area is the worst compared to four other locations that are not industrial agglomeration areas. The poor air quality in the Medan Industrial Area is evident from the monitoring results, where the Particulate Matter (PM10) and Sulfur Dioxide (SO2) parameters are the highest compared to other residential and commercial areas.
The influence of agglomeration and wages has a positive relationship with the economy and social aspects of the community. The improvement in the community's economy can be attributed to the fact that the Medan industrial area is an attractive destination for migrants seeking better employment and income in the city compared to staying in rural areas. Additionally, for the local population, the Medan industrial area provides opportunities to start businesses such as food and beverage establishments, boarding houses for temporary residents, and trading facilities.
The presence of labor force participation, both in rural and urban areas, is one of the main driving factors for agglomeration. The labor force's participation in seeking employment in a company or industry influences the growth of agglomeration. When labor force participation increases, both in formal and informal sectors, it allows for increased growth of agglomeration in a region. This is because one of the factors contributing to agglomeration growth is having a sufficient workforce for economic activities, especially production. The causative factor of labor force participation influencing agglomeration growth is the increase in labor force participation rates, which can enhance agglomeration growth and subsequently increase productivity. As a result, the output also experiences an increase, which ultimately affects agglomeration growth.
Agglomeration that creates clusters will increase urbanization. This is influenced by the abundance of labor supply on one side. Meanwhile, the available job opportunities are inadequate and unevenly distributed across regions on the other side. The concentration of economic activities in a specific area will lead to significantly higher development compared to surrounding areas. If this influence spreads to several neighboring cities, it will result in different administrative regions having similar patterns and regional functions. When further processed and planned, this can lead to the creation of a larger city that combines several smaller cities, known as a megacity (Greenwood, 1995).

Conclusion and Recommendation

The impact of industrial agglomeration significantly affects the air quality in the Medan City area. Thus, industrial agglomeration in the Medan Deli District can influence air quality parameters such as Nitrogen Dioxide (NO2), Sulfur Dioxide (SO2), Carbon Monoxide (CO), Hydrocarbons (HC), Ozone (O3), and Particulate Matter (PM10 and PM2.5). As industrial agglomeration increases, it can negatively affect air quality, resulting in poorer air quality compared to non-industrial agglomeration areas. Additionally, industrial agglomeration has significant effects on the economy and social aspects of the community in the Medan City area. Therefore, industrial agglomeration in the Medan Deli District can influence the economy and social conditions, and as industrial agglomeration increases, it can impact the economy and social well-being of the community. This is due to the multiplier effect of industrial agglomeration on economic and social life around the Medan Industrial Area, leading to an increase in job opportunities and a favorable business climate in the vicinity.
Industrial agglomeration in the Medan Industrial Area, Medan Deli District, has a significant relationship with air quality. Therefore, it is essential for industrial stakeholders, the community, and the government to play a role in improving air quality. The government should continue monitoring and supervising all businesses/activities located in the Medan Industrial Area, particularly regarding stationary emission sources, such as external combustion engines, and internal combustion engine emissions, in accordance with relevant regulations. Regular monitoring of ambient air quality around the Medan Industrial Area should also be conducted.

References

1. Greenwood Michael J. Research on Internal Migration in the United States: A Survey. Journal of Economic Literature, 1995.
2. Kuncoro Mudrajad. Regional Planning: How to Build Local Economy, Cities, and Regions? Salemba Empat.

Jakarta, 2012.
3. Sangadji EM, Sopiah. Research Methodology: Practical Approaches in Research. Andi. Yogyakarta, 2010.
4. Siburian Saidal, MM MMar. Air Pollution and Greenhouse Gas Emissions. Kreasi Cendekia Pustaka Publisher. Jakarta, 2020.
5. Sjafrizal. Regional and Urban Economics. Rajawali Press. Jakarta. www.bps.go.id. Official Website of the Central Statistics Agency, 2014.