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The Analysis of Local Regression of Industrial Agglomeration on the Economic Growth in Indonesia

Edy Santoso[1], Silvia Anggraini[2], Teguh Hadi Priyono[3], Duwi Yunitasari[4], Vebry Eka Kusumawardhani[5]

Department of Economic Development, Faculty of Economic and Business, Universitas Jember, Indonesia[1,2,3,4,5]

Corresponding Author: Edy Santoso (edysantoso@unej.ac.id)

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ABSTRACT

Economic growth is caused by various structural factors, including agglomeration industries and regional spending. This study aims to analyze the influence of industrial agglomeration on economic growth in Indonesia using the Geographically Weighted Panel Regression (GWPR) method. This method analyzes the spatially and temporally varied relationships between dependent and independent variables. This study considers spatial variation to investigate the variability of the economic growth model of each province in Indonesia. This study uses panel data with 34 provinces in Indonesia. Time range from 2017 to 2022. The results of the analysis show that the impact of industrial agglomeration on economic growth varies, with industrial agglomeration having a negative and significant effect on economic growth. Regional spending has a positive and significant influence on economic growth. These findings highlight the importance of policies adapted to regional conditions to maximize the benefits of industrial agglomeration and regional expenditure allocation in supporting sustainable economic growth in various provinces. This research provides important insights for policy makers and academics in designing more effective development strategies based on in-depth spatial analysis.

Keywords: Agglomeration industry, Economic growth, SMEs, GWPR.

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INTRODUCTION

Economic development is a very important process in an effort to improve the quality of life of society and strengthen the economic structure of a country. One of the factors that influences economic development is economic growth, which reflects an increase in economic capacity and community welfare. According Wahyuni & Striawan (2023), the parameters of successful economic development are reflected in economic growth. Economic growth is an increase in the output of goods and services produced by the economy of a country or region in a certain period. The increase in production capacity is reflected in the increase in Gross Domestic Product (GDP) or GDP per capita (Mankiw, 2007). Economic growth is usually measured in percentages and shows how fast a

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country's economy is developing. Many things can be done to accelerate economic growth, one of which is through industrial agglomeration.

Empirically, industrial agglomeration causes economic growth in the region to be more significant than that outside the industrial agglomeration. According to Alfred Marshall (1890) that industrial agglomeration creates a positive external. This means that when many companies in the same industry gather in one geographical location, they will get external benefits, i.e. benefits created from the surrounding environment rather than from within the company itself. Companies that gather in an area can benefit from the knowledge, technology, and experience gained from the existence of other industries around them. This accelerates the innovation process and increases production efficiency, which will boost economic growth. Marshall's (1990) opinion regarding the "cluster competitive advantage" that industrial agglomeration allows neighboring firms to compete and collaborate effectively, which in turn encourages innovation and stronger economic growth in the region. However, this is not in line with the view of J. Vernon Henderson (1977) in his work "Externalities and Urban Concentration" that there are externalities of industrial concentration that can affect economic growth and quality of life in large cities. Some areas that experience heavy agglomeration experience rapid growth, while others may face problems related to negative externalities that hinder economic development.

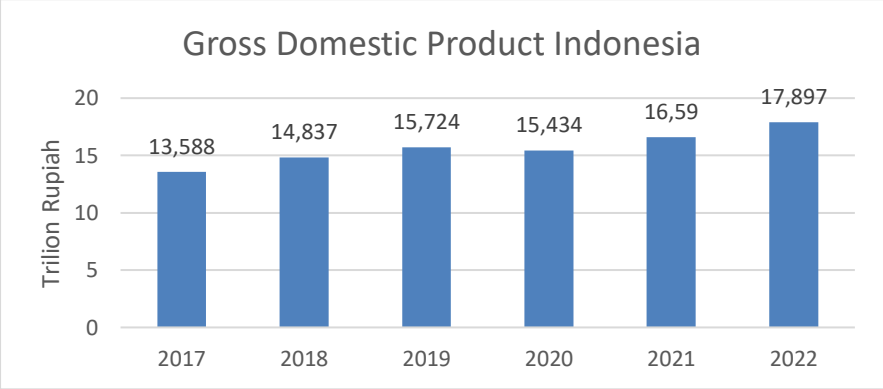

Figure 1. Indonesia's Gross Domestic Product
Source: Badan Pusat Statistik

In Figure 1. Indonesia's economic growth fluctuates from year to year. In 2017-2019 Indonesia's economic growth conditions show significant stability, reflected in consistent Gross Domestic Product (GDP) growth. In 2017 it reached 13,588 trillion, in 2018 GDP increased to 14,837 trillion. In 2019, despite global challenges affecting the economy, Indonesia's GDP still recorded 15,724 trillion. In 2020, the Indonesian economy experienced a decline with GDP reaching 15,434 trillion. The impact of the pandemic has caused many sectors to experience a decline in activity.

Entering 2021, the economy is starting to show signs of recovery with GDP increasing to 16,590 trillion. At its peak in 2022, economic growth will soar with GDP reaching 17,897 trillion. This surge reflects the strong economic recovery and success of the industrial sector in supporting growth, as well as increased investment and infrastructure development that supports continued economic expansion.

Indonesia's GDP growth in the 2017-2022 period was consistently dominated by contributions from Java Island, which is the main center of industrial activity in this country. According to data from the Badan Pusat Statistik (BPS), Java Island contributed around 58% to 59% of the total national GDP during that period. This contribution is driven by the high concentration of processing and manufacturing industries in this region, including sectors such as textiles, electronics, automotive, and food and beverages. The concentration of similar industries in a geographical area leads to the

emergence of industrial agglomeration. Agglomeration is an important phenomenon accompanied by a large concentration of various factors of production. In 2020, when Indonesia experienced an economic contraction due to the COVID-19 pandemic, the island of Java continued to make a significant contribution of 58.75% to the national GDP, strengthening its industrial sector to survive and recover faster than other regions. In 2022, Java's contribution even reached 59.31%, showing its central role in supporting national economic growth through integrated industrial clusters and high production efficiency (BPS, 2022). On the Java island, industrial clusters or agglomerations have grown rapidly with many industrial estates operating. Meanwhile, on other islands such as Sumatra, Kalimantan and Sulawesi, even though there is industrial development, the agglomeration is not as dense as on the Java island. As a result, economic growth resulting from industrial agglomeration also varies significantly between Java and outside Java (Lu et al., 2023).

When companies in the same industry are located in the same geographic location, they will benefit from externalities, such as innovations that are easier to spread through interaction between companies, the availability of supporting inputs that are more affordable and more accessible, and so on. Industrial agglomeration allows neighboring companies to compete and collaborate effectively, which can then drive stronger economic growth in the region. Research by Li and Li (2018); Hardjoko et al., (2021); Liu et al., (2022); Song et al., (2023) that aglomeration of industries it creates a significant spillover effect, in which areas adjacent to industrial centers experience increased economic growth. This is due to increased access to technology, improved labor quality, and increased production efficiency in the region. Industrial agglomeration has a positive influence on economic growth in China, where companies synergize with each other to improve the efficiency of resource utilization which then encourages economic development potential (Yuan et al., 2019; and Ding et al., 2022). The results of research from Gunarto et al., (2023) show that areas with higher industrial concentrations tend to have higher GDP, suggesting that the presence of large industries is able to encourage local economic growth through increased production output. However, this is not in line with research from Andiaskiton (2019); Agustin et al., (2021); Sukmawati and Robertus (2023) that industrial agglomeration has a negative and significant effect on economic growth. This is because when many companies gather in one area, often the existing infrastructure cannot keep up with the increasing needs. So that there is traffic congestion, increased air pollution, and others (Rajé et al., 2018).

In addition to large industrial agglomerations, micro and small industries (SMEs) also play a role in driving economic growth. Research from Agustin et al., (2021); Adelina et al., (2021); Bao et al., (2023) say that micro and small industries have a positive effect on economic growth. This is because micro and small industries can benefit from industrial agglomerations such as better access and knowledge to the market, service providers for larger companies, and so on (Cohen et al., 2019). Industrial agglomeration creates the dissemination of knowledge among companies that are in one region. This makes it easier for micro and small industries to access new technologies. However, a different study found Purwanto et al., (2019); Tobing et al., (2019); Juminawati et al., (2021) that micro and small industries have a negative effect on economic growth. This is due to the low level of industrial agglomeration in the region so that micro and small industries also do not get great benefits (Yanah, 2019). Economic inequality also causes SMEs to be limited in accessing technology, thus affecting production productivity (Sapthu et al., 2024).

Although previous literature has helped provide information on industrial agglomeration, however, previous research has tended to focus on the linear relationship between industrial agglomeration and economic growth without considering spatial variation. Many studies rely on aggregate national or regional data without taking a closer look at local dynamics that could provide deeper insights into variations in agglomeration influences at the regional level. Therefore, this research aims to analyze the varying spatial relationships between industrial agglomeration and economic growth in Indonesia using the Geographically Weighted Panel Regression (GWPR) approach. This model was chosen because it is able to capture spatial variations in the relationships between the variables studied in each research location, thereby providing a more comprehensive understanding of the

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impact of industrial agglomeration on economic growth in each province. The GWPR approach identifies local differences in the influence of industrial agglomeration on economic growth, which cannot be revealed by panel regression models. Through this analysis, it is hoped that it can be revealed how industrial agglomeration interacts with various local factors to influence economic growth, and how regional policies can be adjusted to maximize the economic benefits of industrial agglomeration in various regions in Indonesia.

METHODS

This research consists of 34 provinces in Indonesia from Sabang to Merauke with a time series of 6 years in the range of 2017 to 2022. The type of data in this study is secondary data obtained through official publications of the Central Statistics Agency (BPS) and other institutions related to the research topic. The dependent variable in this study is economic growth (GROWTH). Meanwhile, the independent variables consist of the output of micro and small industries (SMESs), output of large and medium industries (IND), and regional expenditure (SPEND). This study uses a quantitative method with an explanatory research approach to examine the spatial relationship between industrial agglomeration and economic growth in Indonesia. According to (Sugiyono, 2012) explanatory research is research that aims to find out the causal relationship between variables. The population in this study is Indonesia, with a sample consisting of 34 provinces. The analysis method in this study uses a spatial panel data model. To analyze the spatial relationship between industrial agglomeration and economic growth, this study uses the Geographically Weighted Panel Regression (GWPR) model.

Geographically Weighted Panel Regression (GWPR) is a method that combines the concepts of Geographically Weighted Regression (GWR) and Panel Data Regression (Deta et al., 2024). GWR is a regression method that relies on geographical location as an observation. GWR can detect spatial heterogeneity problems. In this model, parameter estimation can be done using the Weight Least Square (WLS) approach, where each observation location is assigned a weighting element (Wu et al., 2019). While the Regression Panel is used to analyze the panel data. According to Rusgiyono & Prahutama (2021), the GWPR regression analysis method takes into account spatial variations in the panel data, providing more relevant results in different geographic contexts. This model analyzes data that has two dimensions, namely spatial (geographical location) and temporal (time). So the regression coefficient of each location and time period can vary. The steps to analyze the data of this study are:

1. Selection of global regression models
   Used to find out the right regression model for research.
2. Estimate the GWPR model by determining the best or optimal bandwidth
   Determining the best bandwidth is an important step in analyzing GWPR. This is because bandwidth affects how much influence one location has on other locations in the GWR model. Too little bandwidth can make the model too sensitive to local variation, while too much bandwidth can reduce the model's ability to capture local spatial patterns and produce models that are too general.
3. GWPR model conformity test
   This step is used to evaluate the extent to which the model matches the existing data. This test is also used to ensure that the GWPR model not only provides good hasik, but also provides results that are relevant to the geographical context.
4. Comparison of global models and GWPR models
   This step is used to assess which models are better at analyzing spatial data, especially those that have spatial heterogeneity. By comparing these models, researchers can determine which model is more accurate in explaining the relationship between dependent variables and independent variables.

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The specifications of the Geographically Weighted Panel Regression (GWPR) model in this study are as follows:

$GROWTH_{it} = \beta_0(u_{it}, v_{it}) + \beta_1(u_{it}, v_{it})\ SMEs_{it} + \beta_2(u_{it}, v_{it})IND_{it} + \beta_1(u_{it}, v_{it})SPEND_{it} + \varepsilon_i$

GROWTH	: Economic growth in province (i) in period (t),
(u_i, v_i)	: geographic location coordinates (longlat) in province (i) in period (t)
SMESs	: output of micro and small industries in province (i) in period (t)
IND	: output of large and medium industries in province (i) in period (t)
SPEND	: regional expenditure in province (i) in period (t)
β_0	: intercept province (i) in period (t)
β_k	: parameters in province (i) in period (t) which are related to the independent variable
t	: times series
I	: cross section
ε_i	: erorr term

RESULTS AND DISCUSSION

Table 1. Regression Model Results (FEM)

Variable	Coefficient	*Std.Error*	Statistics	*p-value*
SME	−0.0028596	0,00043509	-6,5725	0,0000000006047
IND	-0,000000061184	0,0000000087609	-6,9838	0, 00000000006492
SPEND	0,13438	0,13052	1,0296	0,3047
CONSTANT	242513	25253,48	9,60	0,000
R2	30,96%			

Source: Data processed, Author

Table 1 shows that the spatial variations in industrial agglomeration that are significant for economic growth in 34 provinces in Indonesia are the IND and SMEs variables with a p-value of less than 0.05. Meanwhile R^2 30,96% can be seen when there is an increase in economic growth of one unit in the second observation-iand time range to-*t* caused by independent variables. Meanwhile, 69.04% of economic growth was influenced by other variables that were not in the model.

Table 2. Bandwith and CV Value

Kernel-weighted functions	Bandwidth	CV Value
Square	0,7319864	4535,214
Gaussian	0,5937157	4613,504
Tricube	0,7540677	4527,148

Source: Data processed, Author

The weight that has the optimal CV value is the tricube compared to the bisquare and Gaussian weighting functions. The selected tricube weighting function results in variations in bandwidth values in each province. Differences in bandwidth values to determine parameter estimates from the GWPR model in each province. Although bandwidth varies between provinces, these values remain consistent each year because GWPR uses panel data.

Table 3. Bandwith Value in 34 Provinces

Province	Bandwith	Province	Bandwith
Aceh	57,79089	Nusa Tenggara Barat	32,83097
Sumatera Utara	54,42336	Nusa Tenggara Timur	38,75171

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Sumatera Barat	51,97176	Kalimantan Barat	37,81113
Riau	50,38881	Kalimantan Tengah	34,44329
Jambi	48,82661	Kalimantan Selatan	31,53897
Sumatera Selatan	46,74544	Kalimantan Timur	30,85187
Bengkulu	49,20852	Kalimantan Utara	32,07766
Lampung	45,55250	Sulawesi Utara	37,57208
Kep Bangka Belitung	43,58441	Sulawesi Tengah	33,61747
Kepulauan Riau	45,79729	Sulawesi Selatan	33,24726
DKI Jakarta	43,15030	Sulawesi Tenggara	35,86722
Jawa Barat	42,17107	Gorontalo	34,78387
Jawa Tengah	38,70554	Sulawesi Barat	31,67010
DI Yogyakarta	38,46419	Maluku	46,16553
Jawa Timur	35,36192	Maluku Utara	41,79362
Banten	44,14804	Papua Barat	49,51377
Bali	32,26606	Papua	57,79089

Source: Data processed, Author

Table 3 shows the existing bandwidth in each province. Bandwidth between provinces has different values from each other. This is why the GWPR model parameters are also different in each province.

Table 4. GWPR Model Conformity Test

F	***Table F***	***P-Value***	**Result**
29,9	2,4168	5.1643e-16	Subtract H0

Source: Data processed, Author

The model that has been formed for each province needs to be partially tested for suitability (goodness of fit) from the GWPR model. Table 4. P-value is less than 0.05 so it rejects the null hypothesis (H0) at the 5% significance level. This shows that the GWPR model have goodness of fit which is better than the global regression model.

Table 5. Comparison of Global Regression Models and GWPR

Regression Model	R2
GWPR	0,7540677
Global Regression	0,30962

Source: Data processed, Author

Table 5 shows a comparison between the global regression model and the GWPR model. Values from table 5 shows that the GWPR model is superior in analyzing the effect of agglomeration on economic growth. This is proven by the higher R^2 value, namely 0, 0.7540677 or 75.40% compared to the global regression model with an R^2 value of 0.30962 or 30.962%.

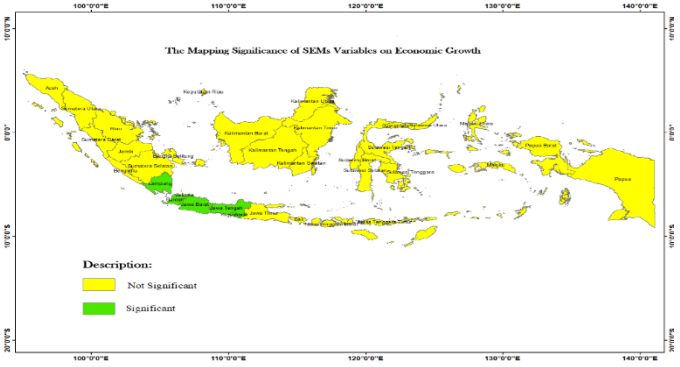

Figure 2. Mapping the Significance of SEMs Variables on Economic Growth in 2017-2022
Source: Data processed, Author

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The green color in Figure 2 shows that the SME variable is significant for economic growth spread across 5 provinces, namely Lampung, Banten, DKI Jakarta, West Java, and Yogyakarta. These 5 provinces have a significant negative impact on economic growth. These results are in line with the research of Shibia and Barako (2017); Bello et al., (2018); Tobing et al., (2019) that every time there is an increase in SEMs it will reduce the economic growth rate.

The SEMs variable is significantly negative on economic growth because the area is densely populated and economically active, such as DKI Jakarta and West Java. Based on data from BPS DKI Jakarta in 2022, there are at least 1,100,000 MSMEs in Jakarta, or around 98.78% of the total number of businesses in DKI Jakarta. Meanwhile, from West Java BPS in 2018, wholesale and retail trade, repair and maintenance of cars and motorbikes (Category G) dominated the number of MSEs with around 2.1 million businesses or reaching 47.44 percent. This data shows that these two regions do have a number of Small and Medium Enterprises (SMEs) that offer similar products or services, which results in intense competition. This can reduce profitability and suppress overall economic contribution (Nurhidayah and Muliansyah, 2023).

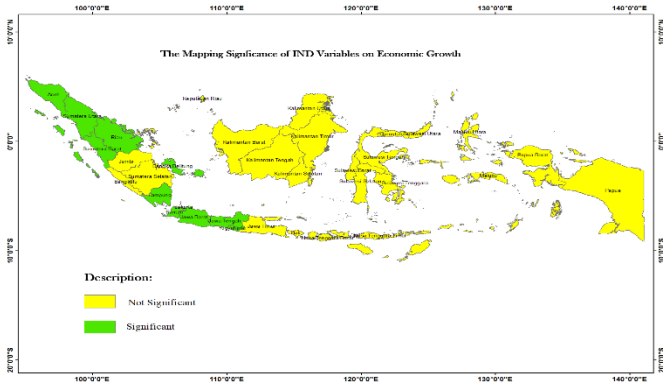

Figure 3. Mapping the Significance of IND Variables to Economic Growth 2017-2022
Source: Data processed, Author

Figure 3 map of the significance of the IND variable on economic growth in the province of Aceh,North Sumatra, West Sumatra, Riau, Lampung, Bangka Belitung Islands, DKI Jakarta, West Java, Central Java, Yogyakarta and Banten are represented in green. In this region, the IND variable has a negative and significant influence on economic growth. These results are in line with the research of Abbasi et al., (2021); Hardjoko et al., (2021); Liu et al., (2022). In other words, the large industrial growth in the province actually puts pressure on economic growth. In provinces such as Aceh, North Sumatra, West Sumatra and Riau, large industries often focus on mining and processing natural resources such as palm oil, coal and petroleum (Saragih, 2019; Farhas, 2020). Data from BPS shows that the contribution of the mining and quarrying sector to GRDP (Gross Regional Domestic Product) in these provinces is very high, but is often not accompanied by adequate economic diversification. Dependence on one or two dominant sectors makes regional economies vulnerable to fluctuations in global commodity prices, which can cause volatility in economic growth.

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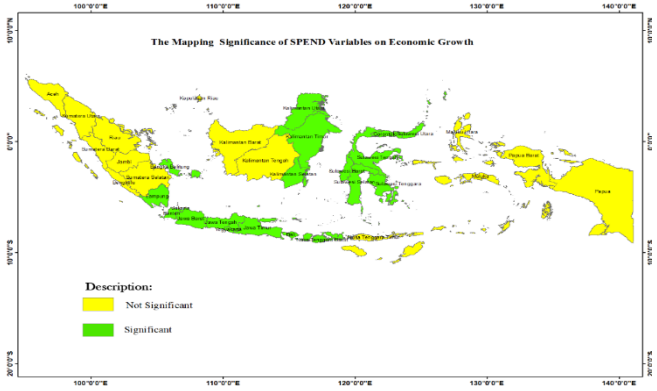

Figure 4. Mapping the Significance of SPEND Variables to Economic Growth 2017-2022
Source: Data processed, Author

The SPEND variable is significant for economic growth spread across the provinces of Lampung, Bangka Belitung Islands, Dki Jakarta, West Java, Central Java, Yogyakarta, East Java, Banten, Bali, NTB, South Kalimantan, East Kalimantan, North Kalimantan, North Sulawesi, South Selawesi, Sulawesi Southeast, Gorontalo, West Sulawesi. The SPEND variable has a positive influence on economic growth. The results of this study are in line with Arini and Kusuma (2019); Mamuka et al. (2019); Celli et al., (2024) that an increase in the amount of SPEND will increase economic growth.

Based on the regional expenditure allocation from the province, it has quite high value, where the allocation for infrastructure development such as roads, bridges, ports and other public facilities can increase connectivity between regions, reduce logistics costs and open access to wider markets. Good infrastructure encourages economic activity by facilitating the movement of goods and services, as well as attracting new investment to the area, which in turn increases economic growth (Magazzino and Maltese, 2021). On the other hand, the provinces of Bali, Yogyakarta and North Sulawesi use regional budgets to develop the tourism sector, including development of supporting infrastructure, tourism promotion and cultural preservation (Masteriarsa, 2023). Tourism development increases tourist flows, creates jobs, and boosts the regional economy. With the combination of these factors, regional spending plays an important role in increasing economic activity and community welfare as well as encouraging economic growth in various provinces.

CONCLUSION

From the research results, there is significance of the independent variable on economic growth different in each province. It can be seen that the SEMs variable has a negative and significant effect on economic growth spread across the provinces of Lampung, Banten, DKI Jakarta, West Java, DI Yogyakarta. On the other hand, the IND variable has a negative and significant effect on economic growth spread across the provinces of Aceh, North Sumatra, West Sumatra, Riau, Lampung, Bangka Belitung Islands, DKI Jakarta, West Java, Central Java, Yogyakarta and Banten. Meanwhile, regional spending has a positive and significant influence on economic growth spread across the provinces of Lampung, Bangka Belitung Islands, Dki Jakarta, West Java, Central Java, Yogyakarta, East Java, Banten, Bali, NTB, South Kalimantan, East Kalimantan, North Kalimantan, Sulawesi North, South Selawesi, Southeast Sulawesi, Gorontalo, West Sulawesi. Overall, although SEMs and IND can have a negative impact on economic growth in some regions, regional spending remains an effective instrument in encouraging more inclusive and sustainable economic growth in various provinces in Indonesia. The results of this research recommend that the government provide different treatment in each province to spur economic growth. The form of recommendation that can be made is to reduce dependence on the large industrial sector by encouraging economic

diversification to create jobs and broader economic opportunities. In addition, it pays special attention to less developed or remote areas to ensure a more equitable distribution of economic benefits. Special development programs can be implemented to reduce the gap between more developed and disadvantaged areas.

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