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## Implementation of the K-Means Algorithm for Gross Regional Domestic Product at Current Prices (Grdp Cp) Clustering Various Sectors City/District Businesses in Indonesia



**Abstract:** - Aim/Purpose Economic development and growth are important indicators of a country's progress. Gross Regional Domestic Product at the sectoral level, known as GRDP CP (Gross Regional Domestic Product at Current Prices), provides valuable insight into the contribution of various business sectors to a country's economy.

**Backgrounds** The aim is to uncover hidden patterns and group sectors with similar economic characteristics, which can guide the development of sector-specific policies to encourage economic growth.

**Methodology** In this research method, we explored using the K-Means algorithm to group GRDP CP data from 17 city/district business sectors in Indonesia.

**Contributions** This research produced four classes, with the highest sector average scores being the agriculture, forestry, and fisheries sectors. In contrast, the lowest sectors were the water supply, waste management, and recycling.

**Findings** provide a more complete picture of the economic characteristics of each region and assist local governments in formulating more effective and targeted economic policies

**Recommendations for Practitioners** This research provides a new contribution to understanding economic characteristics at the local level in Indonesia. By focusing on the GRDP CP grouping of business fields in cities/districts, this research complements knowledge about regional economics. These results can be used as a basis for further study, including identifying factors that drive differences in economic clusters in various regions.

**Recommendations for Researchers** By applying the K-Means algorithm to GRDP CP data on business fields in cities/districts throughout Indonesia, this research provides a deeper understanding of the economic characteristics of each region. The results of grouping economic sectors reveal diverse growth patterns and policy implications that have the potential to support more focused and sustainable economic development.

**Impact on Society** For future research Grouping economic sectors based on Gross Regional Domestic Product at Current Prices (GRDP CP) data using the K-Means algorithm provides insights that can help in the formulation of more targeted and sustainable economic policies research has provided valuable insights, but several things could still be improved. For example, the data used may need to be revised regarding completeness and accuracy. In addition, this analysis does not consider external factors that can influence economic growth in certain regions. Therefore, future research could expand the study by incorporating additional data and considering other relevant factors.

**Keywords:** GRDP, ADHB, K-Means, Growth, Economy, Policy

## INTRODUCTION

In the era of globalization and rapid economic growth, economic sector analysis is essential in planning a region's development and development (Ginting & Belakang, 2013). In Indonesia, a country with a diversity of business sectors in various cities/districts, a deep understanding of economic patterns at the local level has a significant role in formulating effective policies (Djadjuli, 2018). The K-Means algorithm is an effective tool for analyzing financial data and grouping similar sectors. In this research, we will explore the use of the K-Means algorithm in grouping GRDP CP business field data in various cities/districts in Indonesia to provide deeper insight into the economic characteristics of each region. (Zhu & Liu, 2021)

Using the K-Means algorithm in data analysis has proven effective in classifying data into groups with similar characteristics (Tran et al., 2023). In the context of this research, the K-Means algorithm is applied to group GRDP CP data from various business fields in cities/districts in Indonesia. We will use the K-Means algorithm steps, such as initializing cluster centers, data grouping, updating cluster centers, and iteration, to produce homogeneous economic sector clusters (Hastie, 2009).

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The results of this grouping will provide more precise insight into economic sectors that have similar characteristics in various regions in Indonesia (Rustiadi et al., 2023). This will give a solid basis for policymakers to plan more targeted and effective economic development in each city/district. A similar study conducted by (Johnson et al., 2014) in the United States has shown that the K-Means algorithm can reveal relevant patterns in economic planning. Likewise, research by Gengyuan Liu et al. (2018) in China shows that classifying economic sectors using the K-Means algorithm has significant implications for monetary policy formulation (Liu et al., 2018).

In the Indonesian context, a similar study was conducted by (Jaelanie, 2016), which applies the K-Means algorithm to group economic sectors at the provincial level based on GRDP CP growth. This research has provided an initial insight into the potential of using clustering techniques in analyzing the Indonesian economy. However, no research specifically involves GRDP CP grouping in business fields in cities/districts in Indonesia using the K-Means algorithm.

In this research, we will bridge this gap by applying the K-Means algorithm to GRDP CP data in business fields in various cities/districts in Indonesia. It is hoped that the results of this research will provide a more complete picture of the economic characteristics of each region and assist local governments in formulating more effective and targeted economic policies.

### **K-MEANS ALGORITHM**

The K-Means algorithm is a data grouping method often used in analysis in various fields, including economics (Altaf et al., 2020). In this research, the K-Means algorithm will be applied to group Gross Regional Domestic Product (GRDP) data by considering the basic Current Price (CP) factors from various business fields in cities/regencies throughout Indonesia. The main aim of this grouping is to identify groups of economic sectors with similar characteristics, which will provide a deeper understanding of economic growth patterns in each region.

K-Means Algorithm Steps:

1. Initialization of Cluster Centers: The first step in the K-Means algorithm is to determine the desired number of clusters (K). K will then be used to initialize initial cluster centers randomly. Determining the number of sets can be based on domain considerations or using methods such as the elbow method (Hastie, 2009).
2. Data Clustering: Each observation in the GRDP CP dataset will be assigned to the cluster with the closest center based on Euclidean distance or other appropriate metrics. This is done by calculating the distance between each observation and the cluster center and attributing the statement to the cluster with the closest distance.
3. Cluster Center Update: Once all observations are grouped, the cluster center will be updated by calculating the average of the statements in each cluster. This will create a new cluster center, which reflects the average characteristics of the observations in the group (Park & Jun, 2009).
4. Iteration: The clustering and updating of cluster centers will be repeated iteratively until the cluster centers do not change significantly or the maximum number of iterations is reached.
5. Determination of Convergence: Convergence can be determined by looking at the change in cluster centers between iterations or by reaching a specified maximum number of iterations (Hastie, 2009).

Applying the K-Means algorithm in this research will require an in-depth understanding of GRDP CP business field data in various cities/districts in Indonesia. The steps above will be implemented using the Python programming language. The results of this grouping will produce economic sector clusters with similar characteristics in each region.

This approach aligns with the study by (Jaelanie, 2016), which applies the K-Means algorithm to group economic sectors at the provincial level based on GRDP CP growth. The results of this study provide an initial insight into the potential of clustering techniques in analyzing the Indonesian economy. However, using K-Means to group GRDP CP in business fields in cities/districts in Indonesia is a new contribution to the literature.

## **DATA AND METHODOLOGY**

### **METHODOLOGY**

This research methodology is designed to apply the K-Means algorithm in grouping Gross Regional Domestic Product (GRDP) data by considering the basic Current Price (CP) factors from various business fields in cities/re-gencies throughout Indonesia. The steps to be taken in this research include data collection, preprocessing, implementing the K-Means algorithm, and interpreting grouping results.

**DATA**

The data that will be used in this research is GRDP data and basic Current Price (CP) data from the Indonesian Central Statistics Agency (BPS) from 2016 to 2019. This data includes information about GRDP from various business fields in 32 Provinces and 514 cities/districts in Indonesia and CP data, which can represent the community's welfare in each region. Accurate and representative data collection becomes a strong basis for analysis. This data then becomes an initial dataset with business fields per sector. Below are business fields per sector, with the following sectors:

1. Agriculture, Forestry and Fisheries (Agriculture, Forestry and Fishing)
2. Mining and Quarrying (Mining and Quarrying)
3. Processing Industry (Manufacturing)
4. Procurement of Electricity and Gas
5. Water Supply, Waste Management, Waste and Recycling (Water supply, Sewerage, Waste Management and Remediation Activities)
6. Construction
7. Wholesale and Retail Trade; Car and Motorcycle Repair (Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles)
8. Transportation and Warehousing (Transportation and Storage)
9. Providing Accommodation and Food and Drink (Accommodation and Food Service Activities)
10. Information and Communication (Information and Communication)
11. Financial and Insurance Services (Financial and Insurance Activities)
12. Real Estate (Real Estate Activities)
13. Company Services (Business Activities)
14. Government Administration, Defense, and Compulsory Social Security (Public Administration and Defense; Compulsory Social Security)
15. Education Services (Education)
16. Health Services and Social Activities (Human Health and Social Work Activities)
17. Other Services (Other Services Activities)

province code	province name	city code	city name	year	Agriculture, Forestry and Fishing	Mining and Quarrying	Manufacturing	Electricity and Gas	Water supply, Sewerage, Waste Management and Remediation Activities	Information and Communication	Financial and Insurance Activities	Real Estate Activities	
0	11	ACEH	1101.0	KABUPATEN SIMEULUE	2016	630.3960	33.4892	25.1170	3.3469	0.2011	65.9400	33.1600	65.4962
1	11	ACEH	1101.0	KABUPATEN SIMEULUE	2017	688.2945	33.7046	27.5297	3.8369	0.2237	69.8400	36.3500	69.9491
2	11	ACEH	1101.0	KABUPATEN SIMEULUE	2018	711.4045	34.4919	29.4122	4.1690	0.2456	71.0900	39.4200	74.4816
3	11	ACEH	1101.0	KABUPATEN SIMEULUE	2019	757.3188	35.7737	29.9298	4.4471	0.2792	75.5500	44.3600	81.7840
4	11	ACEH	1102.0	KABUPATEN ACEH SINGKIL	2016	574.4538	24.7646	96.2334	3.3720	0.8018	76.9659	51.3350	64.5160
...	...	...	...	...	...	...	...	...	...	...	...	...	...
2049	94	PAPUA	9436.0	KABUPATEN DEIYAI	2019	279.1149	13.4105	4.5571	0.1560	0.0000	0.6026	1.6299	31.7386
2050	94	PAPUA	9471.0	KOTA JAYAPURA	2016	1515.8600	124.3000	671.0200	13.2700	34.5200	2295.5500	1174.2800	1338.6800
2051	94	PAPUA	9471.0	KOTA JAYAPURA	2017	1606.8000	134.4100	740.0700	15.3700	36.0300	2413.0800	1245.2500	1459.2800
2052	94	PAPUA	9471.0	KOTA JAYAPURA	2018	1769.7600	145.4600	808.9300	16.5100	38.0400	2517.1300	1396.1700	1520.8000
2053	94	PAPUA	9471.0	KOTA JAYAPURA	2019	1891.6900	154.9000	832.8700	17.8900	38.1000	2561.6000	1490.6800	1571.6300

2054 rows x 24 columns

**Figure 1.** Initial dataset

**Table 1.** Initial dataset statistics

Sector	Amount of data	mean	deviation	min	max	25%	50%	75%
Agriculture, Forestry and Fisheries	2054	6001.59	45534.13	0.86	1201064.15	816.19	2154.97	4851.37
Mining and excavation	2054	2223.48	9067.13	0	109015.24	34.54	201.84	997.29
Processing industry	2054	8628.72	51865.2	0	1145490.45	156.58	810.95	3670
Procurement of Electricity and Gas	2054	118.04	626.99	0	10304	2.39	7.42	22.15
Water Supply, Waste Management, Waste and Recycling	2054	27.57	104.95	0	2648.3	2.42	7.93	19.72
Construction	2054	5750.78	49906.29	0.19	1198867.36	461.47	1094.53	2251.41
Wholesale and Retail Trade; Car and Motorcycle Repair	2054	4563.31	15314.33	0.02	246221.13	496.28	1355.22	3270.69
Transportation and Warehousing	2054	1470.29	5060.7	0.08	81597.6	125.75	339.05	932.06
Provision of accommodation and food and drink	2054	997.96	4619.61	0.07	95519.34	34.53	155.07	508.65
Information and Communication	2054	1180.67	4869.93	0.06	75526.59	71.07	256.86	724.87
Financial Services and Insurance	2054	1203.7	7555.92	0	159991.98	69.91	221.14	601.48
Real Estate	2054	998.76	4332.89	0.19	64942.36	103.41	245.74	529.74
Company Services	2054	538.86	4378.21	0	75557.67	2.94	14.84	76.8
Government Administration, Defense and Mandatory Social Security	2054	2758.95	25861.71	0.82	590978.24	384.96	615.95	971.98
Education Services	2054	1223.58	5045.09	0.37	95359.94	142.39	368.23	843.32
Health Services and Social Activities	2054	540.14	3678.08	0.19	79290.9	65.62	136.62	261.01
Other services	2054	572.72	2549.62	0.06	38877.68	31.77	116.57	332.09

**DATA PREPROCESSING**

Before implementing the K-Means algorithm, data needs to be preprocessed to ensure quality and consistency. Preprocessing steps include data cleaning to address missing or invalid values, data normalization to avoid bias caused by different scales, and merging GRDP and CP data into one dataset that can be analyzed.

To get optimal cluster results, each year, data from districts/cities that are outliers are tested by calculating the interquartile range:

$$IQR = Q3 - Q1 \tag{1}$$

Q3 is the median of 75% of the data, Q1 is the median of 25% of the data, and outlier data is determined to be data with a value more than  $Q3 + (3 \times IQR)$ .

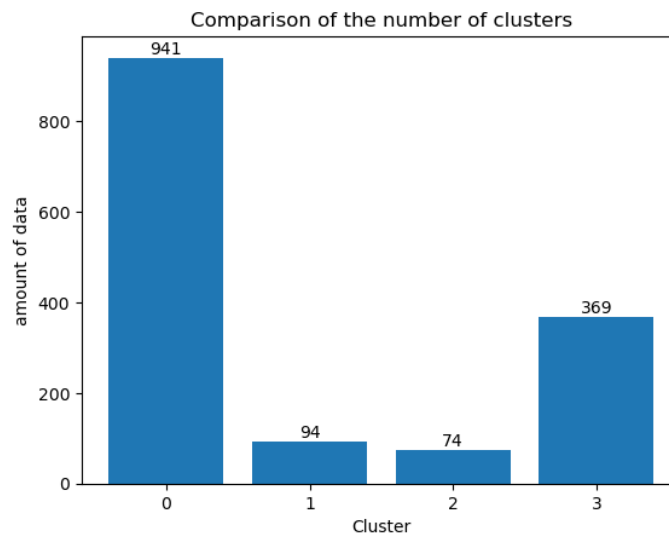
Based on the test results, it was found that 576 data were detected as outliers, so these data would not be used, leaving 1478 data remaining for creating the clustering model.

**IMPLEMENTATION OF THE K-MEANS ALGORITHM**

The next step is implementing the K-Means algorithm to group GRDP CP data in business fields in cities/districts throughout Indonesia. The application of the algorithm will consider the number of clusters (K) to the research objectives. Initial cluster center initialization, data grouping, cluster center update, and iteration will be implemented using a programming language or data analysis software.

The clustering model was created using the K-Means algorithm, and it was determined that the resulting clusters would be 4 clusters.

The following is the amount of data from the resulting cluster:



**Figure 2.** comparison of the number of cluster

From the Comparison of the Number of cluster images, it is known that cluster 0 is the cluster that has the most significant amount of data, namely 941 data, followed by cluster 3 with 369 data and clusters 1 and 2 with 94 and 74 data.

The average value of each cluster produced is as follows:

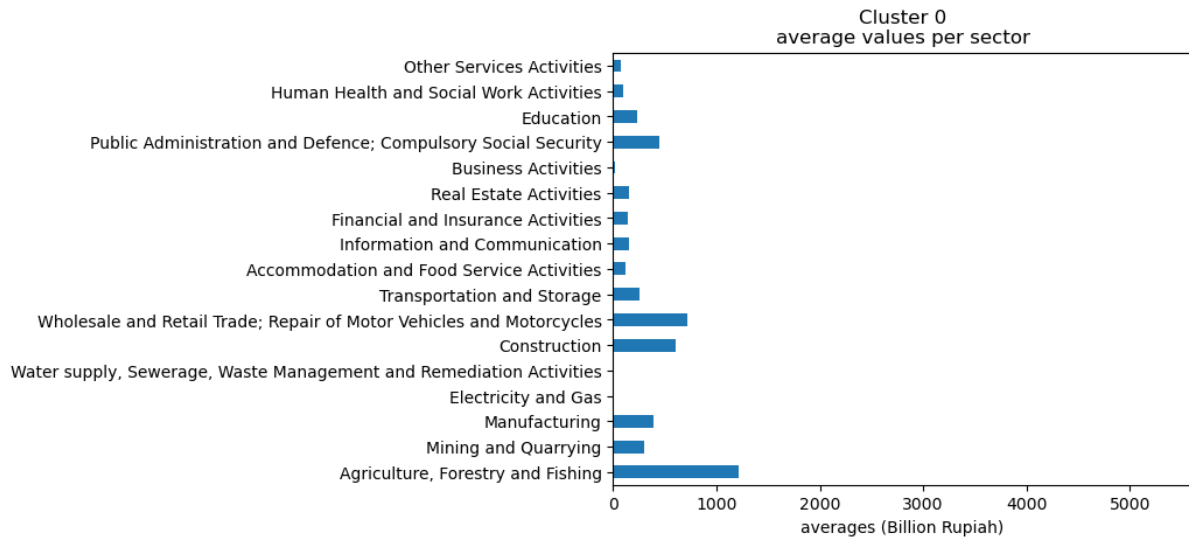
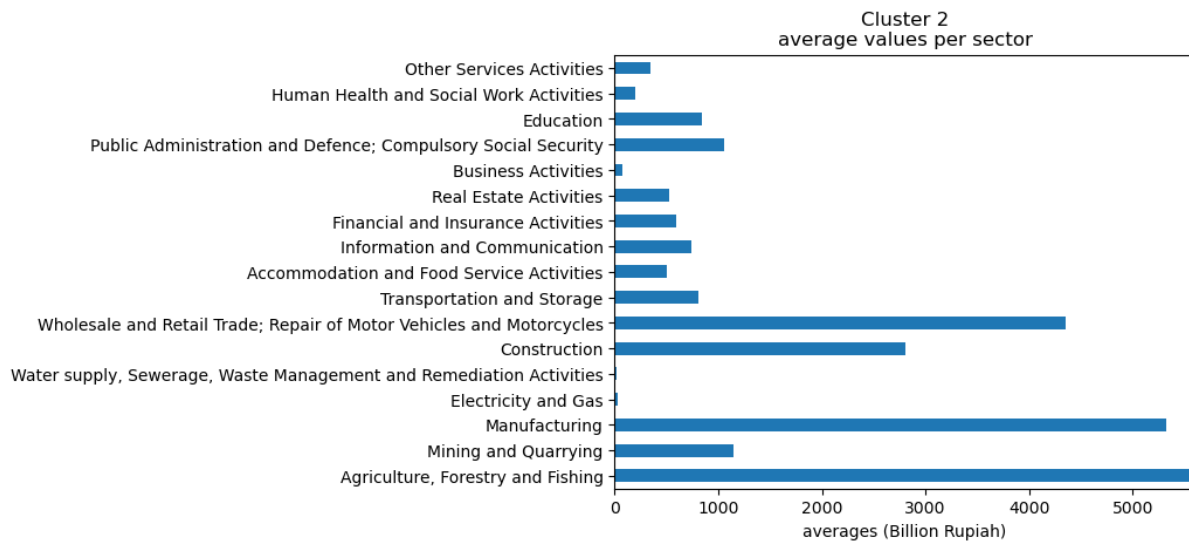
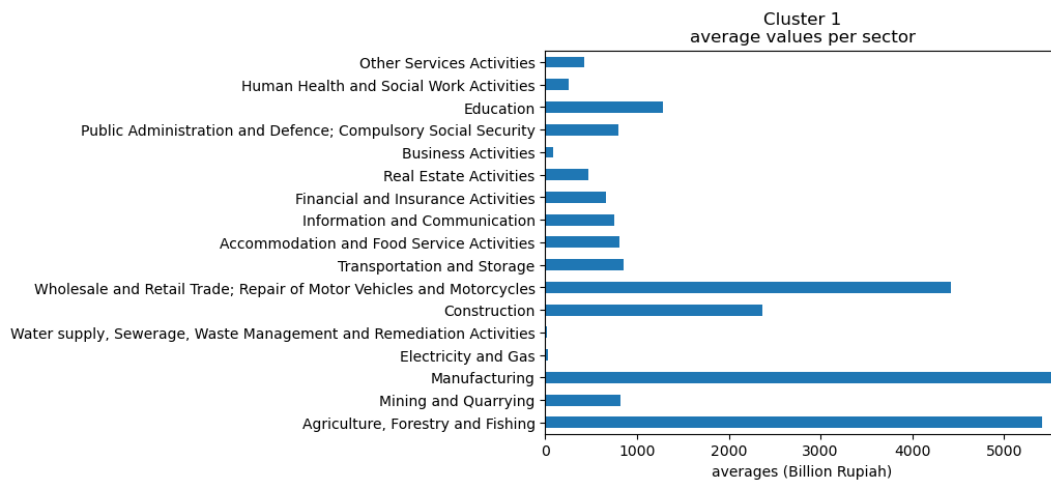


Figure 3. average values sector 0



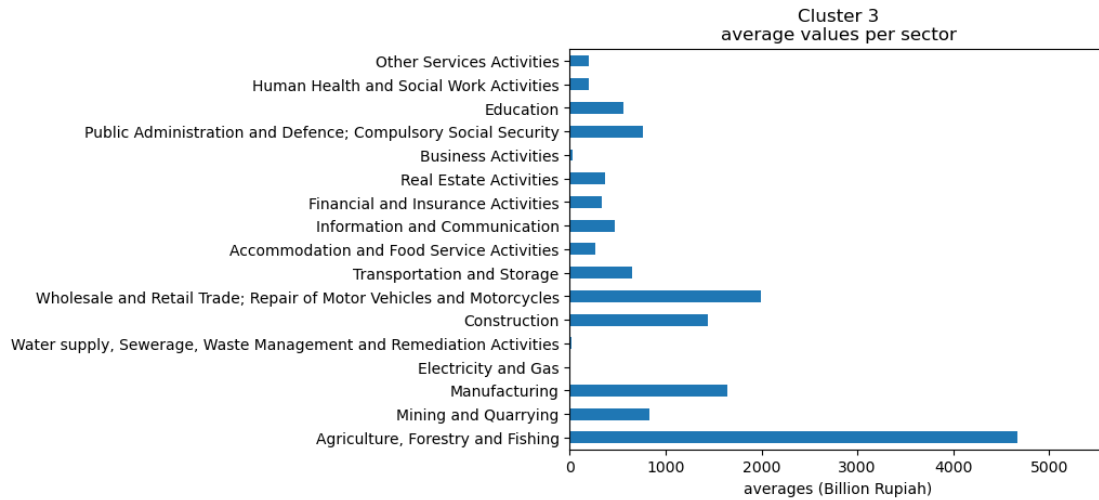
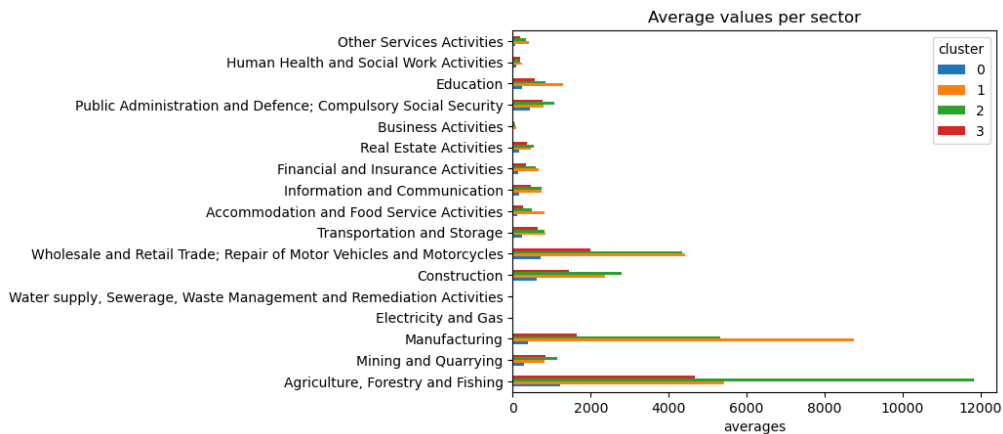
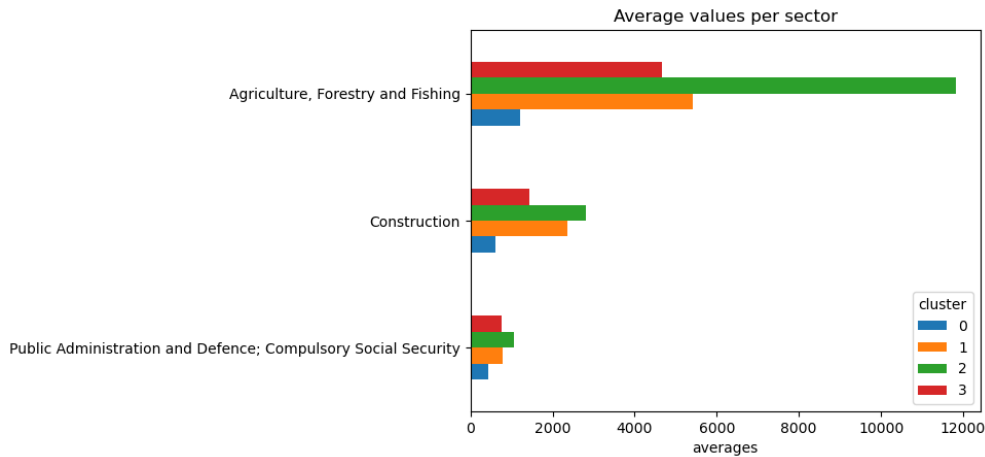


Figure 4. average values sectore 1, 2, 3

**INTERPRETATION OF GROUPING RESULTS**

After the K-Means algorithm produces economic sector clusters, the final step is interpreting the grouping results. This involves analyzing the characteristics of each set, such as economic growth, CP distribution, and the profile of dominant business fields. The results of this analysis will provide insight into economic growth patterns in different cities/districts.



From the comparison of the average values for each cluster, it was found that the districts/cities included in cluster 2 had relatively high GRDP CP in the Agriculture, Forestry, and Fisheries sectors; Government Administration,

Defense, and Mandatory Social Security; and the Construction sector compared with the average of other clusters in that sector.

Examples are as follows:

```
In [55]: df[['province name', 'city name', 'year'] + cluster_column_hi + ['cluster']].loc[df.cluster == '2'].head(5)
```

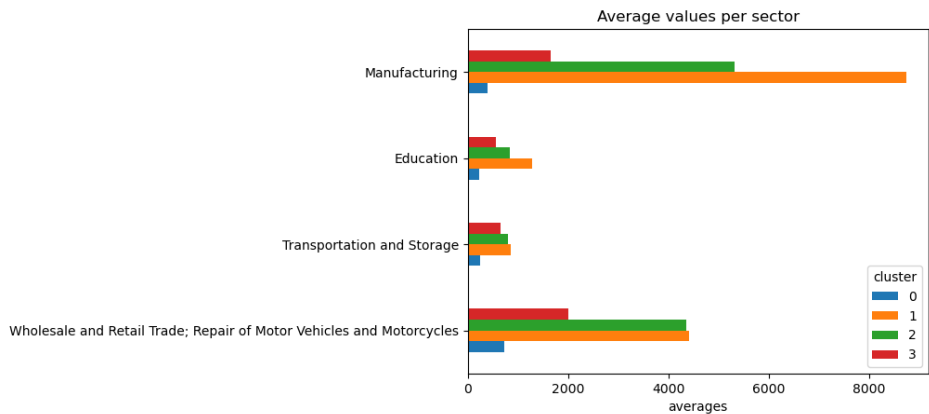
Out[55]:

	province name	city name	year	Public Administration and Defence; Compulsory Social Security	Construction	Agriculture, Forestry and Fishing	Public Administration and Defence; Compulsory Social Security	cluster
120	SUMATERA UTARA	KABUPATEN ASAHAN	2016	1019.08	2013.80	10872.47	1019.08	2
121	SUMATERA UTARA	KABUPATEN ASAHAN	2017	1114.05	2205.64	11729.09	1114.05	2
122	SUMATERA UTARA	KABUPATEN ASAHAN	2018	1196.46	2472.78	12499.95	1196.46	2
123	SUMATERA UTARA	KABUPATEN ASAHAN	2019	1295.23	2726.36	13282.53	1295.23	2
124	SUMATERA UTARA	KABUPATEN SIMALUNGUN	2016	1404.27	2967.81	15328.44	1404.27	2

```
In [56]: df[['province name', 'city name', 'year'] + cluster_column_hi + ['cluster']].loc[df.cluster == '3'].head(5)
```

Out[56]:

	province name	city name	year	Public Administration and Defence; Compulsory Social Security	Construction	Agriculture, Forestry and Fishing	Public Administration and Defence; Compulsory Social Security	cluster
16	ACEH	KABUPATEN ACEH TIMUR	2016	771.93	602.87	3899.88	771.93	3
17	ACEH	KABUPATEN ACEH TIMUR	2017	847.92	657.16	4116.49	847.92	3
18	ACEH	KABUPATEN ACEH TIMUR	2018	919.15	722.34	4313.84	919.15	3
19	ACEH	KABUPATEN ACEH TIMUR	2019	1001.78	794.72	4527.18	1001.78	3



For Cluster 1, it was found that in the Processing Industry sector, Education Services, and the Accommodation and Food and Drink Provision sector, this cluster has a GRDP CP that is relatively higher than the average of other clusters but tends to be similar to the standard of cluster 2 data in the Wholesale and Retail Trade sector; Car and Motorcycle Repair. Examples are as follows:

```
In [62]: df[['province name', 'city name', 'year'] + target_cluster + ['cluster']].loc[df.cluster == '1'].head(5)
```

Out[62]:

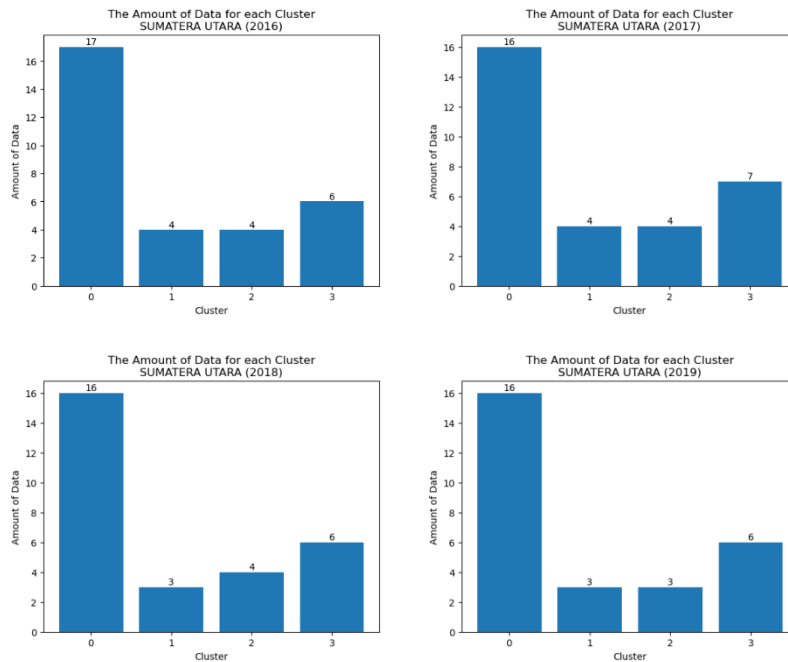
	province name	city name	year	Manufacturing	Education	Accommodation and Food Service Activities	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	cluster
116	SUMATERA UTARA	KABUPATEN LABUHAN BATU	2016	9128.17	475.44	405.11	4462.94	1
117	SUMATERA UTARA	KABUPATEN LABUHAN BATU	2017	10269.39	504.55	455.90	4828.05	1
118	SUMATERA UTARA	KABUPATEN LABUHAN BATU	2018	11131.39	550.45	482.54	5418.87	1
119	SUMATERA UTARA	KABUPATEN LABUHAN BATU	2019	11693.16	601.78	508.96	6054.30	1
164	SUMATERA UTARA	KABUPATEN BATU BARA	2016	13230.20	117.83	334.01	4516.46	1

```
In [63]: df[['province name', 'city name', 'year'] + target_cluster + ['cluster']].loc[df.cluster == '2'].head(5)
```

Out[63]:

	province name	city name	year	Manufacturing	Education	Accommodation and Food Service Activities	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	cluster
120	SUMATERA UTARA	KABUPATEN ASAHAN	2016	6733.16	230.55	251.57	5449.96	2
121	SUMATERA UTARA	KABUPATEN ASAHAN	2017	7604.07	244.14	273.16	5973.24	2
122	SUMATERA UTARA	KABUPATEN ASAHAN	2018	8113.34	266.09	294.74	6710.70	2
123	SUMATERA UTARA	KABUPATEN ASAHAN	2019	8592.76	286.17	318.46	7565.37	2
124	SUMATERA UTARA	KABUPATEN SIMALUNGUN	2016	3601.65	316.10	286.29	4610.79	2

From the clustering results, it is also known which clusters are dominant in each province each year. For example, in North Sumatra Province, in 2016, it was found that 17 districts/cities were included in Cluster 0, 6 districts/cities were included in Cluster 3, and 4 districts/cities were included in Cluster 1 and cluster 2.



This methodological approach supports similar studies conducted by Setiawan et al. (2018) in grouping economic sectors at the provincial level using the K-Means algorithm. However, this research will expand the scope by considering CP factors and applying analysis at a more detailed level, namely in cities/districts.

**RESULTS AND DISCUSSION**

This study presents the results of grouping GRDP CP data for various business sectors in Indonesia. Four clusters were found, namely cluster 0, cluster 1, cluster 2, and cluster 3.

Sector 0 includes sectors.

Sector 1 includes sectors

Sector 2 includes sectors

Sector 3 includes sectors

A hypothetical example may show three groups: Group A, Group B, and Group C. Group A may include sectors with high growth rates, Group B may consist of stable but slow-growing sectors, and Group C may represent sectors experiencing an economic downturn.

This research reveals significant developments in the grouping of economic sectors in cities/regencies throughout Indonesia based on Gross Regional Domestic Product at Current Prices (GRDP CP) data using the K-Means algorithm. This analysis provides a deeper understanding of the economic characteristics of each region and its implications for more targeted economic development planning.

**RESULTS OF ECONOMIC SECTOR CLUSTER GROUPING**

From the analysis results using the K-Means algorithm, several economic sector clusters with similar characteristics can be identified.

For example, in city A, three main clusters were found. The first cluster includes manufacturing and industrial sectors, and the second cluster focuses on service sectors such as tourism and trade. In contrast, the third cluster consists of the agricultural and mining industries. These findings illustrate the economic diversity that exists in various regions.

### ***REGIONAL ECONOMIC GROWTH PATTERNS***

This grouping of economic sectors also allows the identification of different economic growth patterns in various regions. Some regions show more dynamic economic growth in the industrial and service industries, while others rely more on the agricultural and mining sectors. This variation illustrates the importance of developing economic sectors by the potential of each region.

### ***ECONOMIC POLICY IMPLICATIONS***

The results of this research have significant implications for policymaking. By understanding the characteristics of each cluster, local governments can formulate more effective economic strategies.

For example, investment in infrastructure and tourism promotion could be strengthened for regions with rapidly growing service clusters. On the other hand, areas with agricultural groups can focus on increasing productivity and market access. This implication is in line with research by Chen et al. (2020), which emphasizes the role of cluster analysis in supporting more targeted economic planning.

### ***CONTRIBUTIONS TO FUTURE LITERATURE AND RESEARCH***

This research provides a new contribution to understanding economic characteristics at the local level in Indonesia. By focusing on the Gross Regional Domestic Product at Current Prices (GRDP CP) grouping of business fields in cities/districts, this research complements knowledge about regional economics. These results can be used as a basis for further study, including identifying factors that drive differences in economic clusters in various regions.

By applying the K-Means algorithm to Gross Regional Domestic Product at Current Prices (GRDP CP) data on business fields in cities/districts throughout Indonesia, this research provides a deeper understanding of the economic characteristics of each region. The results of grouping economic sectors reveal diverse growth patterns and policy implications that have the potential to support more focused and sustainable economic development.

### ***IMPLICATIONS***

The results of this research have important implications for economic development in cities/districts throughout Indonesia. Grouping economic sectors based on Gross Regional Domestic Product at Current Prices (GRDP CP) data using the K-Means algorithm provides insights that can help in formulating economic policies that are more targeted and sustainable.

### ***POLICY MAKING BASED ON CLUSTER CHARACTERISTICS***

The main implication of this research is more focused policymaking. By understanding the characteristics of each economic sector cluster, local governments can formulate economic development strategies that suit the potential and needs of the region. For example, investment in infrastructure and human resource training could be a priority for regions with strong service sector clusters. This approach is in line with the findings of Chen et al. (2020), which shows how cluster analysis of economic sectors can help develop more effective policies.

### ***DIVERSIFICATION AND INCREASING ECONOMIC COMPETITIVENESS***

Another implication is the potential for diversification of economic sectors. Local governments can encourage economic diversification to reduce dependence on specific sectors by knowing which sectors have the potential for further growth. In addition, understanding each cluster's characteristics can also help increase the region's economic competitiveness by focusing on developing existing comparative advantages.

### ***SUSTAINABLE DEVELOPMENT PLANNING***

The results of this research contribute to sustainable economic development planning. By optimizing the potential of existing economic sectors, regional governments can formulate steps to reduce economic disparities between

regions. This implication aligns with research by Setiawan et al. (2018), which shows how cluster analysis of economic sectors can support more inclusive financial planning.

### **CONTRIBUTION TO REGIONAL DEVELOPMENT**

The implications of this research provide a real contribution to regional development. By adopting the results of grouping economic sectors, local governments can design development programs that suit local economic characteristics. This approach allows for more efficient and effective use of existing resources.

In economic development in cities/districts throughout Indonesia, grouping economic sectors using the K-Means algorithm based on Gross Regional Domestic Product at Current Prices (GRDP CP) has significant implications. The results of this research can help local governments formulate more targeted policies, increase economic competitiveness, and accelerate sustainable development.

### **CONCLUSION**

To gain a deeper understanding of the economic characteristics of cities/districts throughout Indonesia, this research has applied the K-Means algorithm to Gross Regional Domestic Product at Current Prices (GRDP CP) data in various business fields. The economic sector grouping analysis results reveal diverse growth patterns in multiple regions and guide for making more targeted economic policies.

### **PRACTICAL IMPLICATIONS IN REGIONAL ECONOMIC DEVELOPMENT**

The results of this research have significant practical implications for regional economic development. By understanding the characteristics and growth patterns of the financial sector in each cluster, local governments can direct development efforts in a more practical direction. This has the potential to improve community welfare and stimulate sustainable economic growth.

### **CONTRIBUTIONS TO ECONOMIC RESEARCH AND PLANNING**

This research contributes to regional economic literature in Indonesia. Through a financial sector grouping approach using the K-Means algorithm, this research completes the understanding economic characteristics at the city/district level. These findings can also be used as a basis for further research on the factors influencing economic growth patterns in various regions.

### **RESEARCH LIMITATIONS AND SUGGESTIONS FOR FURTHER RESEARCH**

Although this research has provided valuable insights, there are still several things that could be improved. For example, the data used may need to be revised regarding completeness and accuracy. In addition, this analysis does not consider external factors that can influence economic growth in certain regions. Therefore, future research could expand the study by incorporating additional data and considering other relevant factors.

By applying the K-Means algorithm to Gross Regional Domestic Product at Current Prices (GRDP CP) data on business fields in cities/districts throughout Indonesia, this research provides new insights into economic characteristics at the local level. The results of this analysis can help make decisions in planning more effective and sustainable economic development in the region.

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