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K-MEANS ANALYSIS OF FOOD SECURITY CLUSTER IN EAST JAVA

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ABSTRACT

Resilience food is fundamental aspect for well-being public. Study This aim study distribution spatial resilience food in the Province East Java uses k-means clustering and analysis method autocorrelation spatial. Data used is wide harvest and production rice in the Province East Java from 2020 to 2023. Method study covers k-means clustering analysis and Moran's I calculation for autocorrelation spatial. The results of the k-means clustering analysis on 2023 data produce three region based clusters level resilience food: low (23 regions), moderate (9 regions), and high (6 regions). Analysis autocorrelation spatial disclose exists autocorrelation significant positive, indicating pattern grouping resilience food with concentration high in districts and cities certain. Findings This indicated exists dependency spatial between internal regions matter resilience food. Study results This expected can give outlook valuable for planning policy resilience more food effective and targeted in East Java.

Keywords: resilience food, k-means clustering, autocorrelation spatial, East Java.

1. INTRODUCTION

Indonesia, first known as a country with sector agriculture largest in Asia and the majority its inhabitants work in the field agriculture, now face challenge big in guard resilience food. Along walking time, lots of it land agriculture has changed become settlements, roads and facilities other. If it's trending This Keep going continuity, environment and society will experience impact negative, incl disruption to resilience food. According to Republic of Indonesia Law No. 18 of 2012 concerning food in Indonesia, defining resilience food is the conditions under which a country is capable provide sufficient food in matter quantity, quality and sustainability. Therefore that's food own very important role in life something nation. If endurance food disturbed, various problem economic, social and political will arise. Iqbal and Sumaryanto (2007) stated that switch function land agriculture be non-agricultural is one of threat biggest for resilience food national. In the period 1981-1999, the rate switch function land agriculture reached 187,720 hectares per year, and in the 1999-2002 period, the figure This increase to 239,547 hectares per year, as found by Dewi et al. (2017).

In Indonesia, rice is source important food for Indonesian society. Paddy No only become material food principal part big Indonesian society, but also become source income and field work for millions farmers in rural areas. According to the Central Statistics Agency, in 2023 the harvest area Indonesian rice reaches around 1.698 million hectares, experience increase as many as 4.87 thousand hectare or 0.29 percent compared to wide harvest rice in 2022 which is 1.693 million hectares. With production paddy amounting to 9.71 million tons of GKG, experienced increase as much as 184.15 thousand tons or 1.93 percent compared to production rice in 2022 which will amount to 9.53 million tons of GKG. This figure making Indonesia a producing country paddy biggest third in the world after China and India.

Even though Indonesia is one producer paddy world's largest, production paddy national Not yet capable sufficient need food domestic. Therefore that, every provinces in Indonesia are expected can independent in guard resilience food in their respective regions. As example, Province East Java is one of them center production paddy major in Indonesia, demanded For can fulfil need food its inhabitants in a way independent without dependent on supply from Other region.

Resilience food is one of issue important in development sustainable. Resilience food defined as a situation where everyone, every moment, have access in a way physical, social and economic to sufficient, safe and nutritious food For fulfil need food and preferences food they For healthy and productive lives (FAO, 2006). Province Java East, as one province with population largest in Indonesia, has challenge separately in guard resilience food the region .

Figure 1. Production Rice in 4 Provinces Island Java 2020-2023
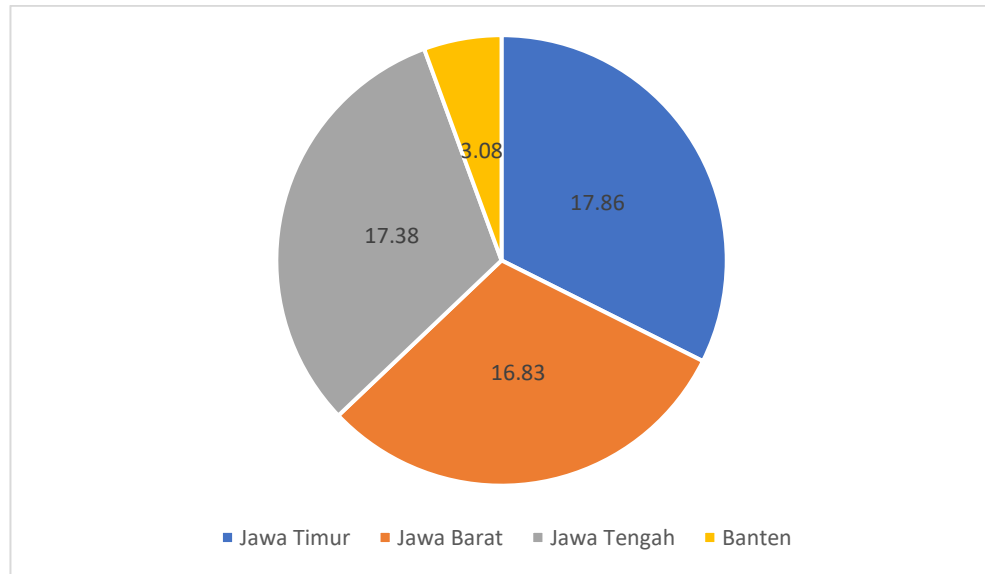
Analysis cluster *(cluster analysis)* is one possible methods used For grouping regions in East Java based on characteristics resilience the food. The K-Means Cluster method is one a popular and effective clustering technique in grouping multivariate data (Likas et al., 2003). With identify regional groups that have characteristics resilience similar food, govt can formulate more policies and programs appropriate target For increase resilience food in these areas.

Refer to the explanation previous, research This aim For analyze data as well interpret results application method deep K-Means Cluster analysis grouping Districts and cities in the Province East Java based characteristics resilience the food. In other words, goals main study is use K-Means Cluster analysis for categorizes regions in East Java into in groups certain in accordance with similarity indicator resilience the food you have.

2. RESEARCH METHODS

In study In this case, secondary data is used originate from the Central Statistics Agency East Java. Selected variables includes Harvest Area Rice (hectares) and Production Rice (quintals / hectares) City/ Regency in the Province East Java in 2023. Research This using Geoda software For do Multivariate cluster analysis, which is capable grouping objects with the same characteristics. Cluster analysis does not own variable free and variable it depends, however group formed own heterogeneity high external and internal homogeneity. Final solution from Cluster analysis depends on the variables used as base For evaluate similarity.

Cluster analysis or analysis group is one of technique Multivariate included in category method interdependent. Method This focused on studying structure connection between variable, between case/respondent, and between object. Objective main from analysis cluster is For grouping object or case to in groups that have similarity or relative nature homogeneous. Objects that have similarity or similarity will grouped to in One the same cluster, meanwhile objects that are not similar will grouped to in different clusters.

In analysis cluster, exists two size frequent similarities used, ie distance *Euclidean* and distance *Mahalanobis*. *Euclidean* Distance applied when variables observation each other free or No correlated One each other (no happen multicollinearity). However, if happen multicollinearity among variables that, problem This can overcome with do data transformation using method *Principal Component Analysis* (PCA).

According to Johnson and Wichern (1982), distance *Euclidean* between two object observation calculated with method take root square from amount square difference values differentiating variables second object the. In other words, distance *Euclidean* is something size similarity that counts distance between two object in room multidimensional with consider all existing variables. The more small distance *Euclidean* between two object, increasingly similar second object the.

$$U\kappa = \frac{1}{N_\kappa} \sum_{q=1}^{N_\kappa} xq$$

Where : $U\kappa$: centroid point of the -Kth cluster

N_κ : the amount of data in the K - th cluster

Xq : the qth data in the Kth cluster

According to Johnson and Wichern (1982), algorithm in K-Means Cluster allocating method A object to in the cluster that has the closest centroid (average value). This process divided become three stage :

1. Determine desired number of clusters.
2. Allocate every object to in the nearest cluster based on distance *Euclidean* from object to *cluster centroids*.
3. Count reset *centroid* from the acquiring cluster object new and lost object.

Steps 2 and 3 are repeated until No There is Again transfer object between clusters. At the end iterations, clusters are formed own minimum internal variation (within clusters) and variation maximum external (between clusters)

3. RESULTS AND DISCUSSION

Objective main from this paper is For analyze data as well interpret results application method deep K-Means Cluster analysis grouping Districts and cities in the Province East Java based characteristics resilience the food. There are two desired achievement from this article. First, reveal is there is dependency spatial or linkages interregional in matter food per district / city in East Java. And the to Second, give contribution important related grouping or cluster areas in East Java. Second expected achievements the will discussed more carry on in this article.

Dependency Spatial between internal regions matter food

Based on Resilience Service study Food East Java (2023) and research Sulistyawati et al. (2022) in Journal Economy Agriculture, dependency spatial between internal regions matter food in East Java in 2023 involves analysis deep related distribution production food main like rice, vegetables, fruit, and sources of animal protein in each region, mapping pattern consumption food public along with factors that influence it, evaluation comprehensive to chain supply and infrastructure distribution food covers network transportation, facilities storage, and wholesale markets, studies impact various policy government regional and central related resilience food like subsidies, imports, and exports, as well identification opportunity cooperation interregional in matter production, distribution, consumption food, and formation cluster or area economy special To use optimizing system regional food and guarantee resilience food in a way comprehensively in East Java.

Resilience food in East Java itself in decade final Still not enough evenly and have trend For group in a way geographic. Activity economy tend gather in certain areas. Moran's model makes it possible For observe exists linkages spatial or dependency interregional. For prove that resilience food No spread in a way random and independent to factor geographical, used Moran's Global Metrics I. Index This analyze autocorrelation spatial or linkages spatial interregional related with its spread. High Moran's I score indicated exists interaction strong spatial, which causes dependency spatial or grouping in certain areas.

Figure 2. Global Morans *I plot* for production rice in East Java, 2020-2023
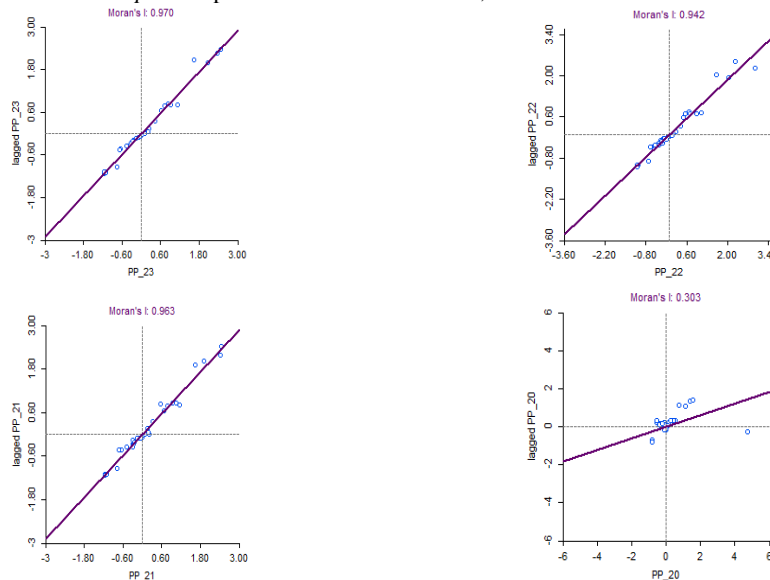
source:processed by the author using Geoda software

Positive Moran's I value show correlation positive spatial, which shows that Upaten districts/cities in East Java that have amount production high rice or low own similarity with neighboring regions. In contrast, the Moran's I value is negative and significant indicated correlation negative spatial, which shows that Regency/city with amount production high rice or low No The same with province his neighbor. Moran's I statistic is 0.970 for in 2023, shows exists connection spatial strong positive (autocorrelation) and pattern demonstrated phenomenon is group. For prove significance, pseudo p-value in randomization used For report p-value, namely $\rho = 0.001$ (proves that matter the Certain significant). Moran's I value is also indicative that production paddy assume in pattern group.

Figure 3. *Trend Bubble chart Moran I* production rice in East Java , 2020-2023
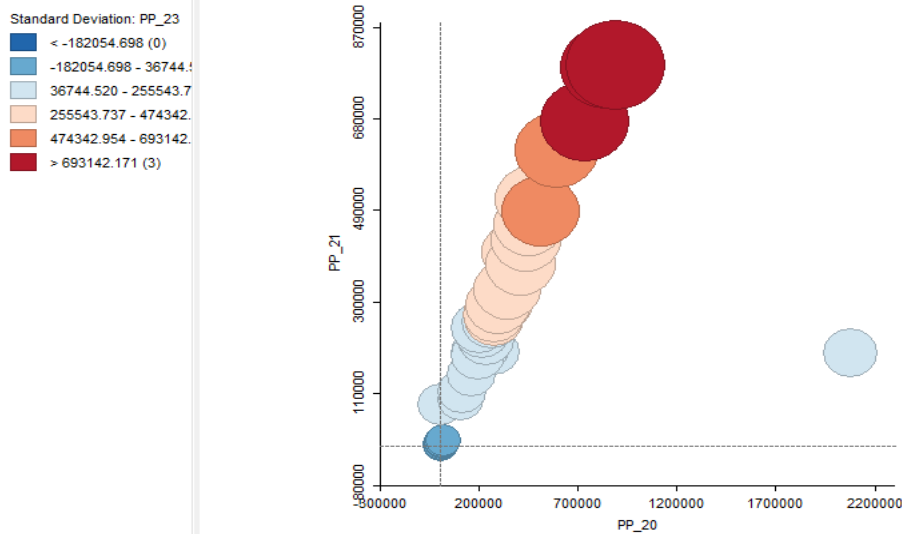
source: processed writer using Geoda software

With compare Moran's I value in something series, we can know trend dependency spatial occurrence between regions. is dependency spatial per district / city in East Java is increasing strengthen or weakened during period study. As example, Moran's I in 2020 was 0.303, in 2021 it was 0.963, reaching mark the maximum in 2022 is 0.942 and in 2023 it is 0.970 (calculation writer). attachment spatial production rice in East Java during period study have statistical data fluctuating. Figure 3 shows Moran's I global statistics for distribution spatial production paddy per district/city in East Java from 2020 to 2023 with use matrix weighter spatial. The value of the global Moran's I statistic shows up and down trend from 2020 to 2023 and autocorrelation spatial significant positive. Research result show that location of the district/city area in East Java with amount production high rice or low grouping, and patterns spatial own trend fluctuating autocorrelation spatial. That means resilience food (production paddy per Regency/City) still group However level dependency spatial between regions decreased. This matter caused by a series deregulation carried out by the government related development modern agriculture. With thus, distribution spatial resilience food especially production paddy the more evenly distributed in the East Java region.

K-means grouping of food clusters in East Java

first step before implement k-means cluster is standardize data, p This aim for all variable own the same purpose. Furthermore determine amount regional cluster, Within context grouping cluster resilience food in East Java, variables that can be considered including production food main like rice represented by production data paddy and broad rice fields, vegetables, fruit, and sources of animal protein, level consumption food community, access to infrastructure distribution food, as well policy government area related resilience food. With standardize data from variables including production data paddy and broad becoming rice fields indicator main production rice in East Java, analysis cluster can done For identify areas in East Java that have characteristics resilience similar food so that can grouped in One cluster.

Figure 4. Number members of each cluster

Cluster	123,000
	29,000
	36,000
Valid	38,000
Missing	$1,000

From the results analysis clusters performed, visible that number of regions or joined members in each cluster distributed as following : cluster First consists from 23 regions, clusters second consists from 9 regions, and clusters third consists from 6 regions.

Figure 5. Members of each cluster per District / City in East Java

cluster	Member cluster
Cluster 1	Regency Nganjuk, Regency Ponorogo, Regency Tulungagung, Regency Trenggalek, Regency Madiun, Kediri Regency, Malang Regency, Regency Lumajang, Regency Bondowoso, Regency Situbondo, Regency Pasuruan, Mojokerto Regency, Regency Pacitan, Regency Probolinggo, Regency Bangkalan, Regency Sampang, Regency Pemekasan, Regency Sumenep, Kediri City, Pasuruan City, Mojokerto City, Madiun City and Surabaya City.
Cluster 2	Regency Magetan, Regency Sidoarjo, Regency Jombang, Regency Blitar, Gresik Regency, Batu City, Malang City, Probolinggo City and Blitar City.
Cluster 3	Regency Jember, Regency Banyuwangi, Regency Ngawi, Regency Bojonegoro, Regency Tuban and Regency Lamongan.

4. CONCLUSION

Food is need main and very important for public. Analysis results grouping use k-means clustering method for sector resilience food in East Java shows significant findings. From analysis that, you can concluded that in 2023 there will be three group or region based clusters level resilience the food. Group First is group with resilience weak food, consisting from 23 regions. Group second is group with resilience food medium, composed from 9 regions. Temporary group third is group with resilience strong food, consisting from 6 member regions. In study this, we add to the literature empirical about distribution spatial resilience food with in a way explicit consider dependency spatial between regions. We use Moran's I for characterize resilience food. Analysis results show exists connection spatial strong positive (autocorrelation) in the study area, which shows pattern grouping in resilience food, with concentration high in districts/cities in the province East Java. Research result show that location of the district / city area in East Java with amount production high rice or low grouping, and patterns spatial own trend fluctuating autocorrelation spatial. That means resilience food (production paddy per Regency/City) still group However level dependency spatial between regions decreased.

Findings This No only support theory regional economy, in particular theory geography economy, but also have role important in formulate recommendation policy related planning development national in Lots things, such as ; guard stability socio-economic, alleviation poverty, need basics, public health, resilience national, and sustainability environment. As implications policy, results study show that dependency spatial between regions is factor important and useful for growth regional economy. This imply that all area need Work The same For reach more integration Good.

For study next, will interesting For develop models that take into account a number of determining variable factor What only you can influential to resilience food in a region, in particular East Java. With Thus, the model can provide policy advice for government and planning purposeful public For ensure availability, accessibility, and stability food.

5. REFERENCE

Wijaya, T, Budiman. 2016. Multivariate Analysis for Management Research. Tree of Light: Jogjakarta.

Journal:

N. Ulinnuh , R. Veriani , " Cluster Analysis in Grouping Province in Indonesia Based Variable Disease Infectious Use Method Complete Linkage, Average Linkage and Ward", *National Journal of Informatics and Technology Network* , vol. 5, no. 1, pp: 101 - 108, 2020 .

P. Alkhairi , AP Windarto , " Application of K-Means Clusters in Potential Areas." Agriculture Rubber Productive in North Sumatra", *National Seminar on Technology Computers & Science* , pp 762 – 767, 2019 .

R. Chaireni , D. Agustanto , RA Wahyu, P. Nainggolan, " Resilience Food Sustainable ", *Journal Population and Environmental Development* , vol. 1, no. 2, pp. 70-79, 2020 .

R. Sibarani , Omby . " K-Means Clustering Algorithm for Marketing Strategy Reception Student New Satya Negara Indonesia University", *Journal Algorithms , Logic and Computation* , vol. 1, no.2, pp: 44 – 50, 2018 .

Rudita, Ewing Arini. "Application of K-means cluster in East Java Province Based on Food Security", *Journal of Science Nusantara* Vol.3, No.1, March 2023

T. Pribadi , R. Irsyada , H. Audytra , DA Fatah, " Implementation Algorithm KMeans For Clustering Potency Villages in Sectors Production Agriculture in Upaten Regency Bojonegoro ", *Journal Simantec* , vol. 9, no.1, pp: 20 – 28, 2020.

Central Statistics Agency Province East Java , " Statistical data Harvest Area and Rice Production per Regency/City in East Java."

Indonesian Central Statistics Agency, "Statistical data on rice production on the island of Java".

Republic of Indonesia Law Number 16 of 2012 concerning Food