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CLUSTERING OF DRUG, COSMETIC, TRADITIONAL MEDICINE, AND FOOD CRIME VULNERABILITY IN EAST JAVA USING THE K-MEDOIDS ALGORITHM

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ABSTRACT

Drug and Food crime vulnerability mapping is the process of identifying potential crimes based on investigation, news, and study analysis, including the results of supervision, intelligence, cyber, and information analysis. The purpose of this study is to classify the vulnerability of drug, cosmetic, traditional medicine, and food crime in East Java using the K-Medoids algorithm, as well as to see the development of the vulnerability of drug, cosmetic, traditional medicine, and food crime in East Java Province for 5 years from 2019 to 2023. The method used is the K-Medoids algorithm with the determination of the number of clusters using the Average Silhouette Width (ASW) method. The highest ASW value between 0.28447-0.61210 was obtained in clusters with 5 groups, namely very high, high, medium, low, and very low clusters. The results of the study show that from 2019 to 2023, as many as 12 regencies/cities have an increasingly vulnerable status, while 26 other regencies/cities have an increasingly safe status. The 12 regencies/cities that are increasingly vulnerable are Bangkalan Regency, Gresik Regency, Lamongan Regency, Nganjuk Regency, Pamekasan Regency, Pasuruan Regency, Ponorogo Regency, Sidoarjo Regency, Tuban Regency, Malang City, Probolinggo City, and Surabaya City. It is necessary to empower the community and intensify communication, provide education and disseminate information massively regarding the use of legal and safe Drugs and Food products, especially in areas with very high vulnerability.

Kata Kunci:
BPOM,
clustering,
k-medoids,
silhouette
kerawanan,

ABSTRAK

Pemetaan kerawanan kejahatan Obat dan Makanan adalah proses identifikasi potensi kejahatan berdasarkan penyidikan, pemberitaan, dan kajian, termasuk hasil pengawasan, intelijen, cyber, serta analisis informasi. Tujuan penelitian ini adalah untuk mengelompokkan kerawanan kejahatan obat, kosmetik, obat tradisional, dan pangan di Jawa Timur menggunakan algoritma K-Medoids, serta melihat perkembangan kerawanan kejahatan obat, kosmetik, obat tradisional, dan pangan di Provinsi Jawa Timur selama 5 tahun dari tahun 2019 sampai 2023. Metode yang digunakan adalah algoritma K-Medoids dengan penentuan jumlah cluster menggunakan metode Average Silhouette Width (ASW). Nilai ASW tertinggi antara 0.28447-0.61210 diperoleh pada cluster dengan 5 kelompok yaitu cluster sangat tinggi, tinggi, sedang, rendah, dan sangat rendah. Hasil penelitian menunjukkan bahwa dari tahun 2019 hingga 2023, sebanyak 12 kab/kota memiliki status semakin rawan, sedangkan 26 kab/kota lainnya memiliki status semakin aman. 12 kab/kota yang semakin rawan adalah Kabupaten Bangkalan, Kabupaten Gresik, Kabupaten Lamongan, Kabupaten Nganjuk, Kabupaten Pamekasan, Kabupaten Pasuruan, Kabupaten Ponorogo, Kabupaten Sidoarjo, Kabupaten Tuban, Kota Malang, Kota Probolinggo, dan Kota Surabaya. Diperlukan pemberdayaan masyarakat dan intensifikasi komunikasi, pemberian edukasi dan penyebaran informasi secara masif mengenai penggunaan produk Obat dan Makanan yang legal dan aman utamanya pada daerah dengan kerawanan sangat tinggi.

INTRODUCTION

Crimes in the field of Drugs and Food are acts that violate provisions related to production and distribution, and can be subject to criminal sanctions in accordance with applicable laws and regulations. Mapping of crime vulnerabilities is carried out to prevent such crimes from occurring. Mapping of drug and food crime vulnerabilities is the process of

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identifying potential crimes based on analysis of information, news, and studies, including the results of surveillance, intelligence, cyber, and investigations. This mapping includes aspects of products, distribution patterns, sources, modus operandi, and inter-regional relationships. Sources of data on drug and food crime vulnerabilities include investigation results, results of crime intelligence operations, surveillance results, cyber patrol results, requests for sample testing, requests for expert information, information from related cross-sectors, public complaint reports, results of monitoring issues in online media/mass media, and/or results of monitoring regional issues (1). Mapping of drug and food crime vulnerability aims to see the picture of crimes that have occurred and predict the potential for crimes that will occur to be used as material in formulating effective prevention strategies in reducing or preventing drug and food crimes. The map of drug and food crime vulnerability in Indonesia is in https://penindakan.pom.go.id , only describes the number of dominant cases in each province, there is no crime-prone map in each district/city. This map is needed for the Technical Implementation Unit or *Unit Pelaksana Teknis* (UPT) of the Food and Drug Supervisory Agency or *Badan Pengawas Obat dan Makanan* (BPOM) in the Province to tackle Drug and Food crimes more effectively and on target.

East Java is a province with a fairly large population and has 38 districts/cities, making it a region with a very wide distribution potential for food and medicine products. The number of vulnerable cases in East Java (175 cases) is in second place after DKI Jakarta (294 cases). East Java is also a region that is a source of illegal drug and food imports in the West Nusa Tenggara, East Nusa Tenggara and other regions in the eastern region (1).

Medicines, cosmetics, traditional medicines, and food circulating in the community and produced domestically or abroad must have a distribution permit from BPOM. The existence of a distribution permit proves that the product is safe for consumption and has met the established safety, benefit/efficacy, and quality standards (2). However, many violations have been found regarding the distribution of drugs and food, such as the fake vaccine case which has been going on since 2003 and was successfully uncovered in 2016.(3). The Annual Report of the Food and Drug Monitoring Agency or *Balai Besar Pengawas Obat dan Makanan* (BBPOM) in Surabaya revealed thatIn 2022, in East Java, 13,002 pieces of drugs without a distribution permit or *Tanpa Ijin Edar* (TIE) were found with an economic value of 13.25 million rupiah.(4). Meanwhile, in 2023, 2,143 TIE male stamina drugs worth 14.9 million rupiah were also found (1).

The desire of Indonesian women to always appear beautiful, attractive, with white and smooth skin free from acne is exploited by cosmetic business people in Indonesia and abroad in order to gain large profits (5). BPOM has found 158 items or 152,744 cosmetic products (TIE) originating from China with an economic value of around 2.2 billion rupiah in 2024. The confiscated products include powder, lipstick, cushion, eye shadow, foundation, eyeliner, mascara, and concealer with certain brands and batches. The illegal cosmetic products were identified as containing the prohibited dyes Red K-3 and Red K-10, which are carcinogenic. Exposure to these substances can increase the risk of skin cancer, liver cancer, and liver dysfunction(6).

Apart from medicines and cosmetics, many traditional medicines are misused. Not all traditional medicines in circulation are truly made from natural ingredients. Often traditional medicines are given a mixture of Chemical Drugs or *Bahan Kimia Obat* (BKO) to hasten their effects so that they are considered efficacious and sell well on the market. Herbal medicine is mixed with sildenafil or tadalafil which are generally for aphrodisiacs. While herbal medicine for rheumatism is usually mixed with paracetamol, mefenamic acid, and antalgin (7). Illegal traditional medicine products in East Java Province are generally found in distribution facilities (drug stores, herbal medicine shops, pharmacies, etc.) that use fake registration numbers and are not easily traced with distribution mainly in the areas of Surabaya, Tuban, Sidoarjo, and Bojonegoro. TIE traditional medicine totaling 250,744 pcs with an economic value of 4.1 billion rupiah was found in 2022 in East Java Province. The types of TIE traditional medicine found in Mojokerto City were mostly gout herbal medicine, men's herbal medicine, and aches and pains herbal medicine with various brands, such as Sumber Sehat, Montalin, Urat Madu, Sinar Serambi, Tawon Klanceng, and others (4). TIE traditional medicine was also found in Nganjuk

Regency in the form of men's stamina herbal medicine, aches and pains herbal medicine, and gout herbal medicine, as many as 53 items 47,712 pcs worth 645 million rupiah in 2023 (1). The use of chemical drugs in traditional medicine products without proper medical indications and without the appropriate dosage prescribed by a doctor, if consumed repeatedly, has the potential to cause adverse side effects such as liver damage, stomach bleeding, increased blood sugar levels, osteoporosis, and stunted child growth (8).

Crimes in food products include TIE food, counterfeiting of labels, trade in substandard food, damaged products and expired food products. BBPOM officers in Surabaya along with the Supervision Coordinator or *Koordinator Pengawasan* (Korwas), Civil Servant Investigators or *Penyidik Pegawai Negeri Sipil* (PPNS), East Java Regional Police, East Java Provincial Health Office, and East Java Provincial Trade and Industry Office, have conducted inspections of 2 food producers, 5 food distributors and 5 food stores in 2022. The results found that 53 items of food did not meet the label requirements 805,117 pcs, 13 items of expired food 4,790 pcs, 22 items of damaged packaging food 39 pcs with an economic value of 4.3 billion rupiah. Expired food and food with damaged packaging found include canned milk, canned fruit, and cooking spices. Food with the label Does Not Meet the Requirements or *Tidak Memenuhi Ketentuan* (TMK) includes powdered drinks, sports food and imported food in the form of marshmallows, candy, chocolate, bubble gum, imported food in the form of candy, chocolate, and marshmallows (4).

Sanctions against perpetrators of drug and food crimes often do not have a deterrent effect because they only receive administrative punishment without strict criminal sanctions, even though the regulations allow for a fine of 1.5 billion rupiah and 15 years in prison (9). Weak law enforcement, social norms, and religious understanding also weaken the deterrent effect on violations of Drug and Food laws in Indonesia (10).

The BPOM Technical Implementation Unit in East Java certainly needs to strive for the safety of Drug and Food products, especially in East Java Province. With limited resources, a strategy is needed for effective supervision by prioritizing districts/cities with high crime vulnerabilities. This study also aims to see the development of drug, cosmetic, traditional medicine, and food crime vulnerabilities for 5 years from 2019 to 2023 in East Java Province. The clustering method was chosen because it is a technique for grouping similar data into several groups which aims to facilitate data analysis and visualization. Clustering is included in unsupervised learning because it groups data that does not yet have a label/class and then groups it into two or more groups by considering similarities (11).

K-Medoids or PAM (Partitioning Around Medoid) is a non-hierarchical clustering method that uses one of the objects in the data set as a cluster center (medoid). This algorithm divides data of n objects into k clusters, with the number k determined at the beginning. Compared to other clustering methods, K-Medoids has the advantage of stability against outliers, making it more reliable when handling data with extreme values that deviate from the general distribution (12). In addition, K-Medoids is also more accurate, and has a faster execution time compared to the K-Means algorithm (13). The K-Medoids algorithm is easy to implement and understand (14). In addition, this algorithm can be used with various distance measurements so it is suitable for all types of data (15). However, the quality of K-Medoids clusters is highly influenced by the initial selection of medoids and is less than optimal for large data due to repeated iterations and having to calculate the distances between all pairs of points (14). Before conducting the analysis, the number of clusters must be determined first (16).

The steps for using the K-Medoids algorithm are as follows: determine the number of clusters (k), randomly select the initial medoids as many as the number of clusters from the data, calculate the distance from each object to the initial medoid using the Euclidean distance formula as follows.

$$d_{(a,b)} = \sqrt{\sum_{i=1}^{n} (a_i - b_i)^2}$$

Information:

d(a,b) = distance between objects a and b

n = dimension of the data

ai = coordinates of object a in data dimension n

bi = coordinates of object b in data dimension n

The next step is to calculate the total closest distance (from all clusters formed) on the initial medoid, repeat the medoid selection step, calculate the total deviation (S) with the formula S = b - a where a is the sum of the closest distances between objects to the initial medoid and b is the sum of the closest distances between objects to the new medoid. If S<0, replace the object with data to form a new set of k as medoids; repeat steps 3 to 5, until there are no more changes in medoid members. Iteration is stopped if S>0 (11).

The purpose of this study is to classify the vulnerability of drug, cosmetic, traditional medicine and food crimes in East Java using the K-Medoids algorithm and to see the development of the vulnerability of crimes involving drugs, cosmetics, traditional medicines and food for 5 years from 2019 to 2023 in East Java Province.

MEHODS

This study is a quantitative study using K-Medoids clustering in RStudio. The research location is 38 districts/cities in East Java Province based on reports from 2019 to 2023. The study was conducted in January 2025. The population and sample in this study follow the data sources taken from the Annual Report of BBPOM in Surabaya, *Balai POM* in Kediri, and Balai POM in Jember from 2019 to 2023.

The variables used are drug cases, cosmetic cases, traditional medicine cases, and food cases. Drug cases are the number of findings of violations of drug distribution regulations such as counterfeit drugs, TIE drugs, and drug abuse. Cosmetic cases are findings of violations of cosmetic distribution regulations such as counterfeit cosmetics, cosmetics containing hazardous materials, and TIE cosmetics. Traditional medicine cases are findings of violations of traditional medicine distribution regulations such as TIE traditional medicines, counterfeit and traditional medicines containing BKO. Food cases are findings of violations of processed food distribution regulations such as TIE food, food containing hazardous materials, and counterfeit food.

Case data were processed using RStudio software. Data multicollinearity testing was performed at the initial stage, by calculating the tolerance or Variance Inflation Factor (VIF) value. Multicollinearity between variables occurs if the VIF value exceeds 10(11). After that, data normalization was carried out by changing the values with a range of 0-1. K-Medoids cluster analysis was carried out separately on 5 data objects in 2019 to 2023 with the number of clusters 3, 4 and 5.

The Average Silhouette Width (ASW) method is used to determine the optimal number of clusters. ASW is used to determine the optimal number of clusters by evaluating the level of similarity of an object to its own cluster compared to other clusters (17). ASW combines two important clustering criteria: how close the points in a cluster are to each other (compactness) and how different a cluster is from other clusters (separation).(18). The formula for performing ASW is as follows. If X = {x1, . . . , xn} is a set of data from n objects in space X, d is the inconsistency or distance over X. For example, for points x1, x2, x3 it is possible that d(x1, x2) and d(x2, x3) are very small, but d(x1, x3) is very large. The grouping C = {C1, . . . , Ck} which is a partition, does not overlap and is complete. A partition can be expressed by the labels l(1), . . . , l(n)∈Nk = {1, . . . , k} where l(i) = r⇔xi∈Cr, i∈Nn, and the cluster size is given by nr = ∑ni=1 1(l(i) = r), r∈Nk (17).

ASW for xi∈X is,

$$s_i(\mathrm{C}, d) = \frac{b(i) - a(i)}{\max\{a(i), b(i)\}}$$

Where,

$$a(i) = \frac{1}{n_{l(i)} - 1} \sum_{\substack{l(i)=l(j) \\ i \neq j}} d(x_i, x_j)$$

And

$$b(i) = \min_{r \neq l(i)} \frac{1}{n_r} \sum_{l(j)=r} d(x_i, x_j)$$

if nr > 1 for l(i) = r. While si(C, d) = 0. The ASW for cluster C is,

$$\bar{S}(\mathrm{C}, d) = \frac{1}{n} \sum_{i=1}^{n} s_i\,(\mathrm{C}, d)$$

a(i) is the average distance from xi to the points in the cluster in which it is placed, and b(i) is the average distance from xi to the points in the nearest cluster in which it is not placed. A large value of si(C, d) means that b(i) is much larger than a(i), and thus xi is much closer to observations in its own cluster than to any other

nearby cluster. Since clustering aims to have good internal homogeneity and separability between clusters, higher values of s_i and S reflect better clustering quality, and the optimal clustering (i.e. with optimal k if various values of k are compared) in the ASW sense is the one that maximizes S.

The cluster with the highest ASW value is used for further case mapping. The clustering results are entered into the East Java map shapefile so that a visualization is obtained in the form of a case/crime prone map in East Java that displays different colors for each cluster.

RESULT

The number of crimes began to increase significantly in 2022 and 2023 as seen in Figure 1. Multicollinearity tests on all variables were carried out first to fulfill the requirements for clustering analysis.

Table 1. Multicollinearity Test Results

Year	VIF Value			
	Drug case	Cosmetics case	Traditional medicine case	Food case
2019	2.649627	2.220889	1.251068	1.265303
2020	1.669287	2.757035	1.659049	1.652065
2021	1.094514	2.282301	1.945863	1.376416
2022	2.153230	1.502204	2.187332	2.836146
2023	1.239673	1.195076	1.311221	1.231480

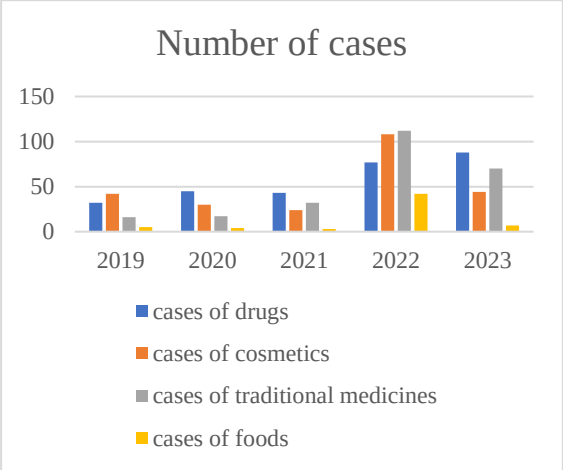

Figure 1. Number of Cases of Drugs, Cosmetics, Traditional Medicines, and Food in 2019-2023 in East Java Province

The results of the analysis show no multicollinearity because all VIF values are below 10 (table 1). After K-Medoids clustering was performed on each year's data, the ASW method was used to determine the most optimal number of clusters according to table 2. The most optimal number of clusters between 3 to 5 clusters from 2019 to 2023 is 5 clusters because it has the highest ASW value among all clusters analyzed with a range of ASW values0.28447 to 0.61210 (table 2). According to the results, further analysis was carried out with 5 clusters. The cluster categories in order are very low, low, medium, high, and very high.

Table 2. ASW value calculation results

Year	ASW Value		
	3 cluster	4 cluster	5 cluster
2019	0.50052	0.55835	0.61210
2020	0.44130	0.49624	0.58807
2021	0.36416	0.45937	0.55398
2022	0.26547	0.25645	0.28447
2023	0.41996	0.46259	0.49342

The visualization of the results of K-Medoids clustering for each year in the form of a map of East Java can be seen in Figure 2. Regencies/cities with very low to very high vulnerability are spread from the west to the east in 2019-2022. While in 2023, the green (very low) district/city areas dominate the east, while the west varies from blue (low), yellow (medium), orange (high) and red (very high). Changes in the number of cluster members each year can be seen in Table 3.

Table 3. Number of Members Cluster

Year	Cluster (District/City)				
	1	2	3	4	5
2019	21	8	4	4	1
2020	24	2	10	1	1
2021	20	10	4	3	1
2022	22	13	1	1	1
2023	22	5	9	1	1

Description: 1 (cluster very low), 2 (cluster low), 3 (cluster medium), 4 (cluster high), and 5 (cluster very high

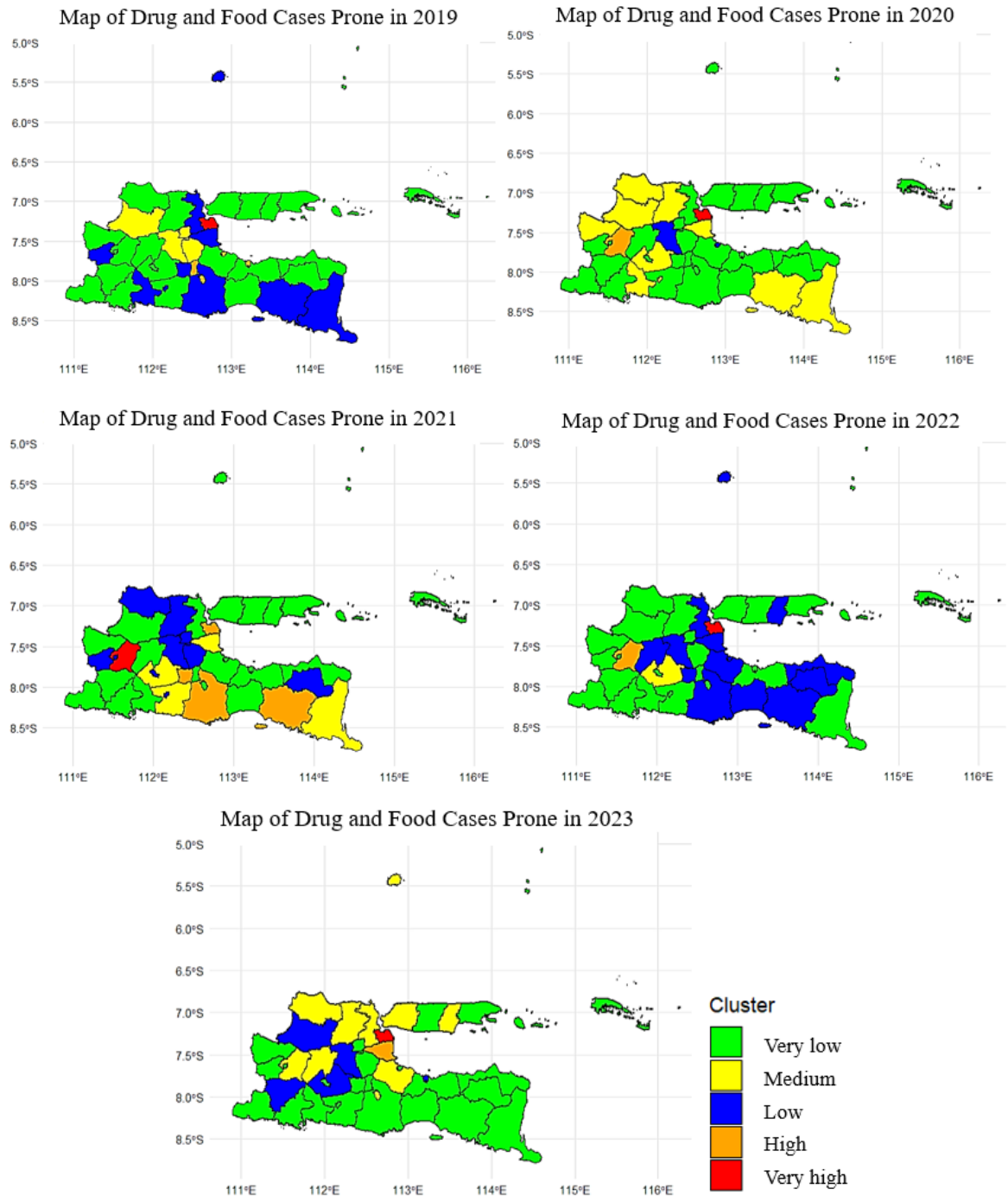

Figure 2. Drug and Food Crime Clusters 2019-2023

The number of members in cluster 1 changes every year from 20 to 24 members. Cluster 2 also experiences changes in members every year from 2 to 13 members with the most members in 2021 and 2022. Cluster 3 has far more members than members in the other 3 years in 2020 and 2023. The number of members decreases in cluster 4 with 1 to 4 members. While cluster 5 only contains 1 member from 2019 to 2023.

The status of crime vulnerability development in each district/city from 2019-2023 explains the changes in cluster grouping. If the cluster changes from "very low" in 2019 then changes to "very high" in 2023, then its status is increasingly vulnerable. Conversely, if the cluster changes from "very high" in 2019 then changes to "very low" in 2023, then its status is increasingly safe (table 4).

Table 4. Crime Vulnerability Status In 5 years

District/city	Status
Bangkalan Regency	**increasingly vulnerable**
Bojonegoro Regency	more secure
Gresik Regency	**increasingly vulnerable**
Jombang Regency	more secure
Lamongan Regency	**increasingly vulnerable**
Madiun Regency	more secure
Magetan Regency	more secure
Malang Regency	more secure
Mojokerto Regency	more secure
Nganjuk Regency	**increasingly vulnerable**
Ngawi Regency	more secure
Pacitan Regency	more secure
Pamekasan Regency	**increasingly vulnerable**
Pasuruan Regency	**increasingly vulnerable**
Ponorogo Regency	**increasingly vulnerable**
Probolinggo Regency	more secure
Sampang Regency	more secure
Sidoarjo Regency	**increasingly vulnerable**
Sumenep Regency	more secure
Tuban Regency	**increasingly vulnerable**
Stone City	more secure
Madiun City	more secure
Malang City	**increasingly vulnerable**
City of Mojokerto	more secure
City of Pasuruan	more secure
City of Probolinggo	**increasingly vulnerable**
Surabaya City	**increasingly vulnerable**
Blitar Regency	more secure
Blitar City	more secure
Kediri Regency	more secure
City of Kediri	more secure
Trenggalek Regency	more secure
Tulungagung Regency	more secure
Jember Regency	more secure
Banyuwangi Regency	more secure
Bondowoso Regency	more secure
Lumajang Regency	more secure
Situbondo Regency	more secure

The status of the development of crime vulnerability in each district/city from 2019-2023 is shown in table 4. A total of 12 districts/cities have an increasingly vulnerable status, while 26 other districts/cities have an increasingly safe status. The 12 districts/cities that are increasingly vulnerable are Bangkalan Regency,Gresik Regency, Lamongan Regency, Sidoarjo Regency, Nganjuk Regency, Pasuruan Regency, Tuban Regency, Pamekasan Regency, Ponorogo Regency, Malang City, Probolinggo City, and Surabaya City.

DISCUSSION

Clustering data analysis begins with a multicollinearity test between variables. Multicollinearity conditions are violations of assumptions in cluster analysis. If multicollinearity is found, it must be followed up by deleting or combining correlated variables marked with a VIF value above 10 (11). The results of the VIF analysis on the number of cases of drugs, cosmetics, traditional medicines and food from 2019 to 2023 used did not show multicollinearity between variables, so that cluster analysis could be continued.

The ASW method is one of the internal validation indexes that measures the quality of cluster separation by considering similarities within clusters and differences between clusters. The most optimal number of crime vulnerability clusters for drugs, cosmetics, traditional medicines and food is 5 according to the results of the ASW analysis. This finding is in line with previous research on the analysis of crime vulnerability levels in 16 sub-districts in Semarang City using the Kernel Density cluster method, which produced five vulnerability level clusters, namely very low, low, medium, high, and very high (19). Research on clustering of crime-prone areas in Indonesia using Fuzzy C-Means clusters obtained different results, namely the formation of 3 clusters, namely low, medium, and high crime-prone areas from 2018 to 2021 based on the results of the silhouette coefficient test of 0.8322 (20). Meanwhile, in the research on the grouping of crime-prone areas in South Sulawesi Province using the K-Means cluster, 4 clusters were obtained, namely fairly safe from crime, crime-prone, safe from crime, and fairly crime-prone (21). The difference in the optimal number of clusters

depends on the data distribution and the clustering algorithm used.

Based on data on the number of cases of drugs, cosmetics, traditional medicines and food from 2019 to 2023, there was an increase in 2022 and 2023. The highest increase in drug cases occurred in 2023 with a total of 88 cases. Meanwhile, the highest increase in cosmetic cases (108 cases), traditional medicines (112 cases) and food (42 cases) occurred in 2022. A decrease in the number of cases in the three commodities occurred in 2023.

The number of members of each cluster in 2019 to 2023 changes every year. This shows the distribution of drug, cosmetic, traditional medicine and food cases that change every year. However, there is a city of Surabaya that is always included in the very high cluster (cluster 5) because the number of cases is very high in 4 commodities compared to other regions. This is influenced by the high participation of the police in handling drug cases and cyber patrols have also been actively carried out in the city of Surabaya (1). Surabaya was included in the very high cluster in 2019 and 2020, then in 2021 Surabaya shifted into the high cluster, then in 2022 and 2023 it re-entered the very high cluster. Cluster 5 in 2021 included Madiun Regency because the number of drug cases was very high, even exceeding the total cases in Surabaya. Several regencies/cities that have been members of the high or very high cluster are Madiun Regency, Malang Regency, Sidoarjo Regency, Jember Regency, Batu City, Malang City, Pasuruan City, and Probolinggo City. These 8 regions have a high number of drug, cosmetic, traditional medicine, and food cases in certain years. Table 3 shows a decrease in the number of members in cluster 4 in 2022 and 2023, reflecting a decrease in the level of vulnerability to drug, cosmetic, traditional medicine, and food crimes in the East Java Province. This is also supported by the findings of the actions taken by the BBPOM in Surabaya. The value of the confiscated TIE drugs, TIE traditional medicines and TIE cosmetics in 2022 was 11 billion rupiah (4). There was a decrease in the value of the seizure to 4.2 billion rupiah consisting of TIE food, TIE traditional medicine and TIE cosmetics in 2023 (1). BPOM RI through its official website has announced the results of supervision for cosmetic commodities, there has also been a decrease in the findings of cosmetics containing hazardous materials from 18 products in 2020-2021 to 16 products in 2021-2022 (22).

Based on the analysis of the results of the development of the vulnerability of drug, cosmetic, traditional medicine and food crimes, it was stated that as many as 31.6% of districts/cities in East Java Province experienced an increase in vulnerability status from 2019 to 2023. This increase in vulnerability includes very low vulnerability status to low (16.7%), low or very low to medium (66.7%), low to high (8.3%), and high to very high (8.3%). However, the increase in vulnerability status is still under control because it is dominant in the medium cluster. This must certainly be a concern for the UPT (Technical Implementation Unit or *Unit Pelaksana Teknis*) of BPOM in East Java to increase supervision of drugs, cosmetics, traditional medicines and food in the 12 districts/cities so that there is no increase in vulnerability to high or very high.

It is known that of the 12 districts/cities whose crime-prone status has increased, the district areas are more than the city areas, namely 9 district areas and 3 city areas. This is in line with the 2024 clustering study on theft crimes in West Java Province (23), where out of 27 districts/cities, there are 8 districts that have a high theft crime rate, 9 districts and 1 city with a moderate theft crime rate, and 8 cities and 1 district with a low theft crime rate.

The increasing vulnerability of drug, cosmetic, traditional medicine, and food crimes in the district area can be caused by the influence of high information coming in, especially through the internet. Easy internet access can encourage consumers to make impulsive and excessive purchases (24). Lower purchasing power in the district makes people tend to choose products with cheaper prices without paying attention to the legality and safety of the product, thus encouraging crimes by business actors (25). The limited resources owned by BPOM also contribute to the less than optimal supervision of the distribution of drugs and food, as well as minimal education and socialization regarding the dangers of using unsafe products, especially in remote areas (3).

CONCLUSION AND SUGGESTIONS

Conclusion

The grouping of drug, cosmetic, traditional medicine, and food crime

vulnerabilities in East Java was analyzed using the K-Medoids cluster algorithm using secondary data on the number of cases. The highest ASW value between 0.28447-0.61210 was obtained in a cluster with 5 classes, namely very low, low, medium, high, and very high clusters. A total of 12 districts/cities have an increasingly vulnerable status, while 26 other districts/cities have an increasingly safe status from 2019 to 2023. The 12 districts/cities that are increasingly vulnerable are Bangkalan Regency,Gresik Regency, Lamongan Regency, Nganjuk Regency, Pamekasan Regency, Pasuruan Regency, Ponorogo Regency, Sidoarjo Regency, Tuban Regency, Malang City, Probolinggo City, and Surabaya City.

Suggestion

The data on the number of vulnerable cases used in the study were not only sourced from internal BPOM but also from external BPOM. Cooperation with stakeholders (police in districts/cities) also needs to be improved so that they can play an active role in handling and reporting crimes in their respective work areas. There needs to be an increase in the effectiveness of drug and food supervision by the UPT BPOM in East Java, so that with limited resources it can still reach all districts/cities to remote areas with the same intensity. In addition, community empowerment and intensification of communication, education and massive dissemination of information regarding the use of legal and safe Drug and Food products are also needed, especially in areas with very high and high crime vulnerability clusters, namely the cities of Surabaya, Madiun Regency, Malang Regency, Sidoarjo Regency, Jember Regency, Batu City, Malang City, Pasuruan City, and Probolinggo City..Increasing consumer knowledge about safe Drug and Food products enables them to protect themselves from the risks of using dangerous products, while also contributing to a reduction in the number of violations or crimes related to the distribution of these products.

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AUTHOR CONTRIBUTIONS

RP collection, data processing and drafting of manuscript, MM concept idea and method, DI validation and correction of manuscript, RI correction of final manuscript, EA literature review search.

REFERENCES

1. Balai Besar POM. Laporan Tahunan 2023 Balai Besar POM di Surabaya [Internet]. 2024. Available from: https://www.pom.go.id/storage/sakip/Laporan%20Tahunan%20Balai%20Besar%20POM%20di%20Surabaya%20Tahun%202023.pdf
2. Maisusri S, Indra M, Erdiansyah. Penegakan Hukum Terhadap Tindak Pidana Peredaran Obat Impor yang Tidak Memiliki Izin Edar oleh Penyidik Pegawai Negeri Sipil Balai Besar Pengawas Obat dan Makanan di Pekanbaru. J Online Mhs Fak Huk Univ Riau [Internet]. 2016;3(2):1–15. Available from: https://doi.org/10.46807/aspirasi.v8i1.1252
3. Yuningsih R. Penguatan Kendali Pemerintah Terhadap Peredaran Obat Dan Makanan. Aspir J Masal Sos [Internet]. 2017;8(1). Available from: https://jurnal.dpr.go.id/index.php/aspirasi/article/view/1252
4. Balai Besar POM. Laporan Tahunan 2022 Balai Besar POM [Internet]. 2022. Available from: https://pppomn.pom.go.id/storage/informasipublik/LAPTAH%20PPPOMN%202024_compressed.pdf
5. Restiawaty R, Alrip I. Penegakan Hukum Terhadap Peredaran Kosmetik Ilegal: Perspektif Teori Kontrol Sosial Travis Hirschi. J Legistlatif [Internet]. 2024;8(1). Available from: https://journal.unhas.ac.id/index.php/jhl/article/view/41596
6. Biro Kerjasama Dan Humas BPOM. BPOM Tindak Tegas Penjual Kosmetik Impor Ilegal Senilai 2,2 Miliar Rupiah di Jakarta [Internet]. 2024. Available from:

https://www.pom.go.id/berita/bpom-tindak-tegas-penjual-kosmetik-impor-ilegal-senilai-2-2-miliar-rupiah-di-jakarta

7. Cahyono I, Marsitiningsih M, Widodo S. Peran Badan Pengawas Obat dan Makanan terhadap Peredaran Obat Tradisional yang Mengandung Bahan Kimia Obat Berbahaya dalam Perlindungan Konsumen. Kosmik Huk [Internet]. 2019;19(2):110–7. Available from: https://doi.org/10.30595/kosmikhukum.v19i2.8216
8. Priyana P. Sosialisasi Bahaya Obat Kimia pada Obat Jamu Tradisional dipandang dari Aspek Hukum Kesehatan. I-com Indones Community J [Internet]. 2023;3(1). Available from: https://doi.org/10.33379/icom.v3i1.2239
9. Ameliani P, Iskandar H, Wardana DJ. Perlindungan Hukum Bagi Konsumen Terhadap Produk Kosmetik yang Tidak Terdaftar BPOM. Al-Manhaj J Huk dan Pranata Sos Islam [Internet]. 2022;4(2). Available from: https://doi.org/10.37680/almanhaj.v4i2.2062
10. Khodijah K. Agama Dan Budaya Malu Sebagai Kontrol Sosial Terhadap Perilaku Koruptif. Sos Budaya [Internet]. 2018;15(2):1–15. Available from: http://dx.doi.org/10.24014/sb.v15i2.7606
11. Muhima RR, Kurniawan M, Wardhana SR, Yudhayana A, Sunardi S, Rahmawati WM, et al. Kupas Tuntas Algoritma Clustering: Konsep Perhitungan Manual dan Program [Internet]. Risanto E, editor. Penerbit Andi; 2021. Available from: https://repository.telkomuniversity.ac.id/pustaka/190007/kupas-tuntas-problem-it.html
12. Wang X, Xu Y. An improved index for clustering validation based on Silhouette index and Calinski-Harabasz index. IOP Conf Ser Mater Sci Eng [Internet]. 2019; Available from: https://doi.org/10.1088/1757-899X/569/5/052024
13. Nurhayati N, Sinatrya NS, Wardhani LK, Busman B. Analysis of K-Means and K-Medoids's Performance Using Big Data Technology. 6th Int Conf Cyber IT Serv Manag [Internet]. 2018; Available from: https://doi.org/10.1109/CITSM.2018.8674251
14. Zhang L, Gao X, Dong Z, Tan Y, Wu Z. Premarital Sexual Activities Among Students in a University in Beijing, China. Sex Transm Dis. 2002 May;1(29):212–5.
15. Domingo J, Leon T, Dura E. Scellpam: an R package/C++ library to perform parallel partitioning around medoids on scRNAseq data sets. BMC Bioinformatics. BMC Bioinformatics [Internet]. 2023; Available from: https://doi.org/10.1186/s12859-023-05471-1
16. Ushakov A V., Vasilyev I. A parallel heuristic for a k-medoids clustering problem with unfixed number of clusters. MIPRO (42nd Int Conv Inf Commun Technol Electron Microelectron [Internet]. 2019; Available from: https://doi.org/10.23919/MIPRO.2019.8756919
17. Batool F, Hennig C. Clustering with the Average Silhouette Width. Comput Stat Data Anal [Internet]. 2021;158. Available from: https://doi.org/10.1016/j.csda.2021.107190
18. Lengyel A, Botta-Dukát Z. Silhouette width using generalized mean—A flexible method for assessing clustering efficiency. Ecol Evol [Internet]. 2019;9(23):13231–43. Available from: https://doi.org/10.1002/ece3.5774
19. Nanda CA, Nugraha AL, Firdaus HS. Sugiastu Firdaus H. Analisis Tingkat Daerah Rawan Kriminalitas Menggunakan Metode Kernel Density di Wilayah Hukum Polrestabes Kota Semarang. J Geod Undip [Internet]. 2019;8(4). Available from: https://ejournal3.undip.ac.id/index.php/geodesi/article/view/25144
20. Inayah J, Maghfiroh DASN, Novitasari DCR. Clustering Daerah Rawan Kriminalitas Menggunakan Algoritma Fuzzy C-Means. Jurnal Ilmiah Informatika Komputer. J Ilm Inform Komput [Internet]. 2022;27(2).

Available from: http://dx.doi.org/10.35760/ik.2022.v27i2.6019

21. Irwan I, Sanusi W, Saman F. Pengelompokan Daerah Rawan Kriminalitas di Sulawesi Selatan Menggunakan Metode K-means Clustering. Journal of Mathematics, Computations, and Statistics. J Math Comput Stat [Internet]. 2022;5(1). Available from: https://doi.org/10.35580/jmathcos.v5i1.32719
22. Suyudi I, Afif MN, Kevin Y, Gabrielle MV. Analisis Pengawasan Post-Market Badan Pengawas Obat dan Makanan pada Peredaran Kosmetik Berbahaya. Deviance J Kriminologi [Internet]. 2022;6(2). Available from: https://doi.org/10.36080/djk.2103
23. Suryadi UT. Sistem Clustering Tindak Kejahatan Pencurian di Wilayah Jawa Barat Menggunakan Algoritma K-Means. J Teknol Inf Dan Komun Subang [Internet]. 2019;12(1). Available from: https://doi.org/10.47561/a.v12i1.147
24. Shi HY, Jing FJ, Yan Y, Nguyen B. No The Concept of Consumer Vulnerability: Scale Development and Validation. Int J Consum [Internet]. 2017;41(6). Available from: https://doi.org/10.1111/ijcs.12390
25. Kumari S, Atem TD, Chaudhary V, Sahu SK, Pal B. Prevalence and risk factors of cosmetic-induced adverse events: A systematic review and meta-analysis. J Appl Pharm Sci [Internet]. 2024;14(11). Available from: https://doi.org/10.7324/JAPS.2024.193512