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Analysis of Indonesia's Export Unit Value Index in 2023 Using Descriptive Analysis and K-Means Clustering Method Based on Data from the International Trade Centre (ITC) and the 2023 Annual Export Report by BPS (Statistics Indonesia)

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Abstract

This research aims to analyze the unit value index of Indonesian exports in 2023 based on monthly data according to the 3-digit SITC code. The export unit value index is an indicator that measures changes in export commodity prices compared to the base year 2018. Using descriptive analysis and K-Means clustering methods, this research explores the patterns and characteristics of Indonesia's export unit value index and groups commodities based on the similarity of their index values. The research results show that there are fluctuations in the export unit value index for various commodities throughout 2023, with several commodities experiencing significant price increases or decreases. Through clustering analysis, export commodities can be grouped into several clusters based on similar index values, providing an overview of commodities that have similar price trends. These findings can provide valuable information for policy makers and business actors in developing appropriate export strategies.

Keywords: Export Unit Value Index, SITC, K-Means Clustering, Export Commodities

INTRODUCTION

Export plays a crucial role in Indonesia's economy. As a country rich in natural resources, Indonesia has vast potential to boost its export contribution to national economic growth. One of the key indicators to measure export performance is the Export Unit Value Index, which reflects the average price change of exported commodities compared to a base year—2018 in this case. This index not only

illustrates global commodity price dynamics but also indicates the competitiveness of Indonesia's export products.

However, throughout 2023, Indonesia faced various challenges in its export sector. According to data from Statistics Indonesia (BPS), the total export value from January to December 2023 reached USD 258.82 billion—an 11.33% decline from the previous year's USD 291.90 billion. This decrease resulted from weakened global demand due to international economic uncertainty and falling prices of key export commodities such as coal and palm oil.

On the other hand, several export sectors performed relatively well or even grew, such as textiles, processed foods, and basic metals. These trends suggest a shift in Indonesia's export structure that requires further exploration. Therefore, analyzing price fluctuations through the Export Unit Value Index becomes increasingly important.

This study aims to analyze Indonesia's 2023 Export Unit Value Index using monthly data classified by the 3-digit Standard International Trade Classification (SITC). The research employs descriptive analysis and K-Means clustering. Through this approach, we aim to identify patterns in commodity price movements and group export products based on similar pricing trends. The results are expected to provide strategic insights for export policy development and enhance the global competitiveness of Indonesian products (Gustientiedina, 2019).

THEORETICAL FRAMEWORK

a. Data Mining

Data has become one of the most critical components in the digital era. All data-related activities are recorded and stored in data storage systems or databases, allowing users to process the data and extract useful information (Setiawansyah, 2020). A key challenge in data processing lies in discovering valuable insights from vast databases (Ahmad Ari Aldino, 2021).

Data mining serves as a powerful tool that enables users to quickly access and analyze large volumes of data. More specifically, data mining refers to tools and applications that apply statistical analysis to datasets. It involves a collection of techniques designed to discover previously unknown patterns within accumulated data (Fitri Marisa, 2021).

Hermawati (2013:3) defines data mining as "a process that employs one or more machine learning techniques to analyze and automatically extract knowledge." Data mining focuses on uncovering desired trends or patterns within large databases to support future decision-making.

b. K-Means Algorithm

The K-Means algorithm represents one of the most commonly used clustering techniques. K-Means clustering is a non-hierarchical method that partitions data into one or more clusters or groups (Abdurrahman, 2016).

This algorithm attempts to organize objects into clusters based on their characteristics, ensuring that objects with similar features fall into the same group, while those with differing characteristics are grouped separately (Khomarudin, 2016).

K-Means clustering analyzes a set of N observations and assigns each observation to a cluster with the nearest mean value. This process is similar to the Expectation algorithm and helps structure data into meaningful groups (Syahra, 2018).

METHODOLOGY

This study applies a quantitative approach using descriptive analysis and the K-Means Clustering algorithm to examine the patterns and characteristics of Indonesia's Export Unit Value Index in 2023. The research relies on secondary data obtained from official publications by the International Trade Centre (ITC) and Statistics Indonesia (BPS), formatted according to the 3-digit Standard International Trade Classification (SITC).

ANALYSIS METHOD

This study uses monthly Export Unit Value Index data for Indonesia throughout 2023. Each data row represents one SITC code, and each column corresponds to a month from January to December. The analysis method consists of two main parts:

a. Descriptive Analysis

This method describes the research process from problem identification to solution discovery (Satria, 2023). The descriptive analysis aims to identify the basic patterns of Indonesia's export unit value index in 2023. This includes calculating the mean, minimum, and maximum values, normalizing the data using the Min-Max method to unify scales, and visualizing the data with histograms.

1. Descriptive Statistical Calculation
   Mean of the Export Unit Value Index

   We calculate the mean by summing all export unit value index values and dividing the result by the total number of data points.

   Formula:

Mean = Σ(Index Value) / Total Data Points

Maximum and Minimum Values of the Export Unit Value Index
We identify the maximum and minimum values by selecting the highest and lowest values in the entire dataset.

Min-Max Normalization
We transform all values in the dataset into the [0,1] range using the formula:

X_norm = (X – X_min) / (X_max – X_min)

Where:

- X_norm is the normalized value
- X is the original value
- X_min is the dataset's minimum value
- X_max is the dataset's maximum value

Based on the dataset:

- X_min = 21.63 (lowest value found in SITC code 897, June)
- X_max = 337.35 (highest value found in SITC code 531, March)
- We apply the normalization formula to each value:
- X_norm = (X – 21.63) / (337.35 – 21.63)

Example of normalized data:

022,0	193,0	185,0	199,0	144,0	155,0	229,0	0.214	0.236
034,0	241,0	272,0	259,0	277,0	264,0	269,0	268,0	0.293

022.0 → 0.214

193.0 → 0.236

034.0 → 0.293

The normalized values now range between 0 and 1.

- A value of 0 represents the minimum (21.63)
- A value of 1 represents the maximum (337.35)
- Other values fall between 0 and 1 based on their position relative to the min and max

Normalization ensures a uniform value scale, making it easier to compare and analyze the data further.

2. Data Visualization

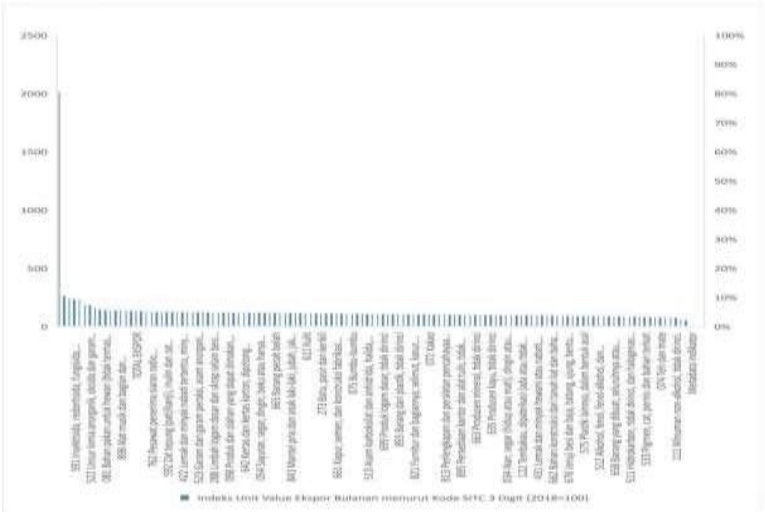

Figure 1. Histogram of Export Unit Value Index Distribution
Source :

We use histograms to visualize the frequency distribution of export unit value index values as bars. Figure 1 shows the histogram used in this study.

a. K-Means Clustering
The K-Means clustering method was applied to group export commodities based on the similarity of their export unit value index. The K-Means algorithm partitions the data into k clusters by assigning each data point (commodity) to the nearest cluster centroid. The optimal number of clusters was determined using the Elbow Method and Silhouette Analysis, as illustrated in Figure 2.

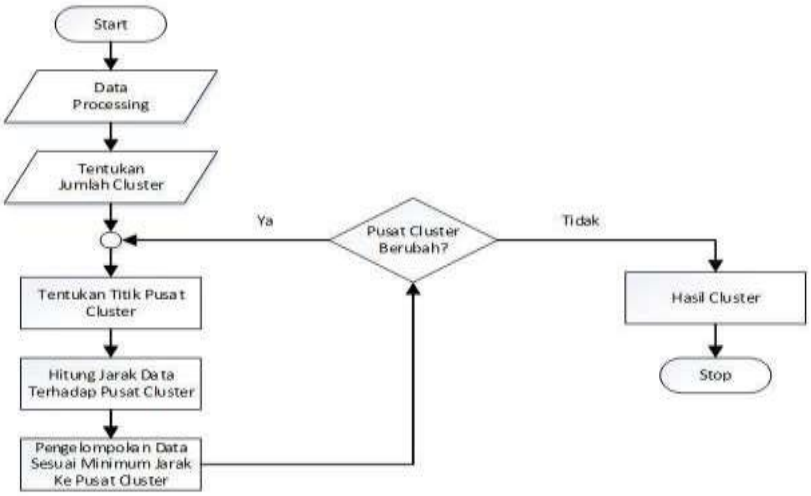

Figure 2. Implementation K-Means Clustering

Source :

Clustering Workflow:

1. Determining the Optimal Number of Clusters – Elbow Method
   The Elbow Method determines the optimal number of clusters by plotting the number of clusters (k) against the Sum of Squared Errors (SSE). The optimal value of k is identified at the "elbow" point, where increasing the number of clusters no longer significantly reduces SSE.
   Formula:
   $SSE = \Sigma(x - \mu)^2$
   Where x is a data point and μ is the centroid of the cluster.
2. Silhouette Analysis
   Silhouette Analysis evaluates the quality of clustering by computing the silhouette score for each data point. The optimal number of clusters corresponds to the highest average silhouette score.
   Formula:
   Silhouette Score = (b – a) / max(a, b)
   Where a is the average intra-cluster distance and b is the average nearest-cluster distance.
3. Initial Centroid Assignment
   The algorithm initializes k centroids randomly from existing data points.

4. Assigning Data Points to Clusters
   Each data point is assigned to the cluster with the closest centroid using Euclidean Distance.
   Formula:
   $d(x, \mu) = \sqrt{\Sigma(x_i - \mu_i)^2}$
5. Centroid Updating
   After all points are assigned, the centroids are recalculated as the mean of all points within the cluster.
   Formula:
   $\mu_j = (1 / |C_j|) \Sigma x_i$
   Where μ_j is the new centroid for cluster j and C_j is the set of points in that cluster.
6. Iteration and Convergence
   Steps 4 and 5 are repeated until centroids stabilize or the maximum number of iterations is reached.

b. Knowledge Discovery in Databases (KDD)
   Data mining is part of the broader KDD process, involving exploration, interpretation, and visualization of data models through integrated techniques. Figure 3 presents this workflow.

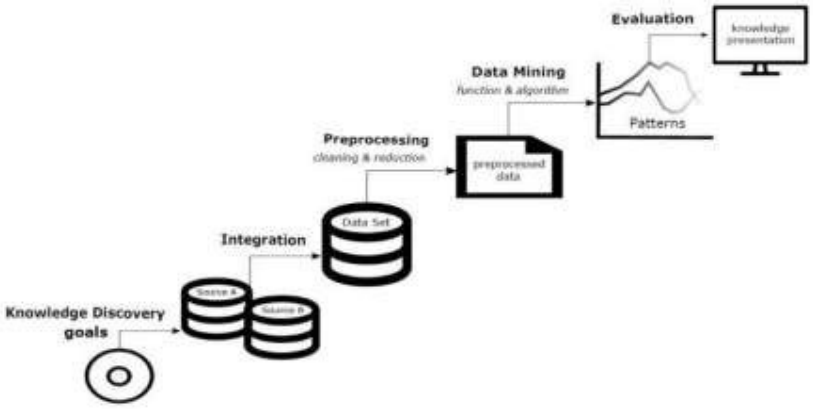

Figure 3. Knowledge Discovery in Databases (KDD)
Source :

1. Data Selection
   Only relevant data are selected for clustering. From the initial 30 attributes, 24 were retained by removing ‘Class’, ‘Name’, ‘Eks_2’, and ‘Eks_3’, which were deemed unnecessary for the clustering process.

2. Data Cleaning
   Although this stage typically removes duplicates, noise, and inconsistent entries, the dataset in this study required no cleaning.
3. Data Transformation
   Raw data were transformed into a format suitable for mining. In this case, the dataset was prepared in Excel (.xlsx) format for processing in RapidMiner software.
4. Data Mining
   This stage applies specific algorithms to uncover patterns. The K-Means algorithm was selected due to its suitability for identifying clusters within the normalized export data.
5. Interpretation/Evaluation
   The resulting clusters were interpreted to assess their relevance and coherence with prior knowledge and expected patterns. The findings were then evaluated in the context of existing economic and trade insights.

RESULTS AND DISCUSSION

The clustering process successfully classified Indonesia's export unit value indices into five major clusters, providing significant insight into their respective patterns and characteristics.

Cluster 1:
- Data Points: 25
- Average Index: 87.2
- Key Commodities: Milk and cream (022), crustaceans and mollusks (036), fresh fruits and nuts (057), preserved fruits (058), animal feed (081), cotton (263), crude vegetable materials (292), vegetable fats and oils (421), specialty yarns and textiles (657), women's and girls' coats (842), plastic products (893)
- Characteristics: This cluster includes commodities with relatively low unit value indices, mostly food products and raw materials from agriculture and textiles.

Cluster 2:
- Data Points: 32
- Average Index: 115.4
- Key Commodities: Cereal preparations (048), fresh vegetables (054), confectionery sugar (062), tea (074), spices (075), edible preparations (098), non-alcoholic beverages (111), waste paper pulp (251), stone and gravel (273), crude petroleum (333), alcohols and phenols (512), carboxylic acids (513), pigments and varnishes (533), insecticides and

fungicides (591), rubber tires (625), plywood (634), textile yarn (651–658), construction materials (661, 664), metal containers (692–699)
- Characteristics: These commodities have medium export unit values, spanning food, industrial inputs, chemicals, textiles, metals, and manufactured goods.

Cluster 3:
- Data Points: 14
- Average Index: 168.9
- Key Commodities: Natural rubber (231), copper ores (283), lignite and peat (322), vegetable oils (423), precious stones (667), and a range of iron and steel products (671–679)
- Characteristics: High unit value commodities, primarily raw materials and metals.

Cluster 4:
- Data Points: 11
- Average Index: 201.1
- Key Commodities: Precious metals such as silver and platinum (681), copper (682), nickel (683), aluminum (684), tin (685), zinc (686), and lead (687)
- Characteristics: Very high-value commodities related to refined metals.

CONCLUSION

The clustering analysis of Indonesia's export data reveals key takeaways for strategic trade development. Indonesia should expand its range of export products to reduce dependency on specific commodities and enhance global competitiveness. Efforts must also focus on improving the quality and market positioning of low-index products through innovation and targeted marketing. For high-value commodities, strategies should aim at improving production efficiency and supply chain management. Broadening the export destinations helps mitigate risks from overreliance on single markets. Additionally, enhancing innovation capacity through investment in research and development is crucial for long-term export sustainability and competitive advantage. By adopting these strategies, Indonesia can boost its export performance and solidify its economic position in global markets.

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