

# Selection of agricultural industry stocks by application of K-means algorithm with Elbow method

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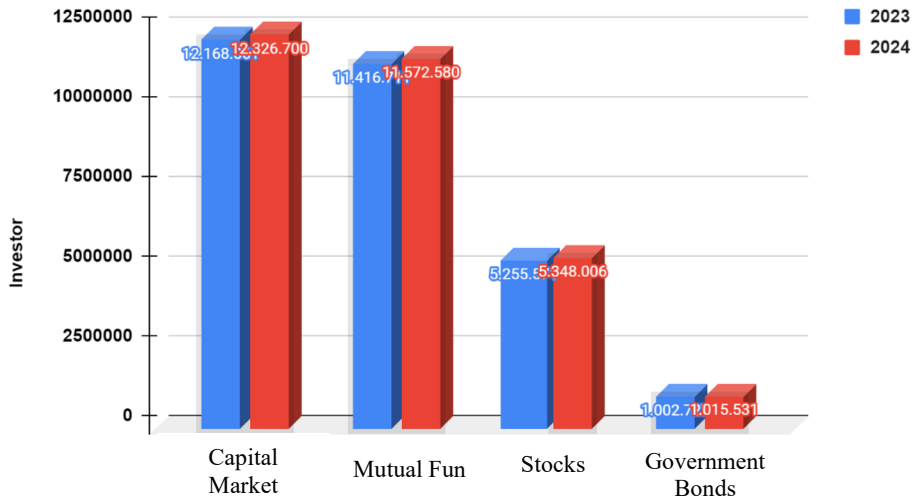
**Abstract.** Portfolio concentration is investing in assets with specific characteristics within the same sector. Agricultural product industry stocks can be used as an option to form portfolio concentration because they have good growth and performance. This study aims to cluster agricultural product industry stocks listed on the Indonesia Stock Exchange from 2020-2023 using the K-Means clustering algorithm with the Elbow method using the Python 3.10 analysis tool to determine clusters that contain a collection of stocks with the best financial performance. The research resulted in an optimal number of clusters of 3, namely cluster 0, 1, and 2. The cluster that contains a collection of stocks with the best financial performance is cluster 2, which is filled by BISI, LSIP, and DPUM. Cluster 1 has several stocks with relatively good financial performance as it is adjacent to cluster 2, namely AALI, STAA, and CPIN.

## 1 Introduction

Various groups in Indonesia are interested in investing, including the general public, entrepreneurs, and beginners who want to carry out investment activities. Investment can be defined as an action in managing capital owned by investors to achieve future profits by placing funds or capital. Investment can also be seen as a current attachment to capital, funds or other resources with the expectation of achieving profits in the future. Investments can be categorized into two types : real assets and financial assets. Investments with real asset types include land, equipment, facilities, knowledge, and buildings. Types of financial assets include stocks, bonds, or mutual funds. The capital market allows people to invest money in financial assets [1]. Investment plays a part in the country's economic development because it is one component of total spending in terms of state revenue analysis. Indonesia has an investing system, which includes the stock exchange. The stock exchange plays a role in determining financial investments for the country's economy.

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**Fig. 1.** Investment growth chart

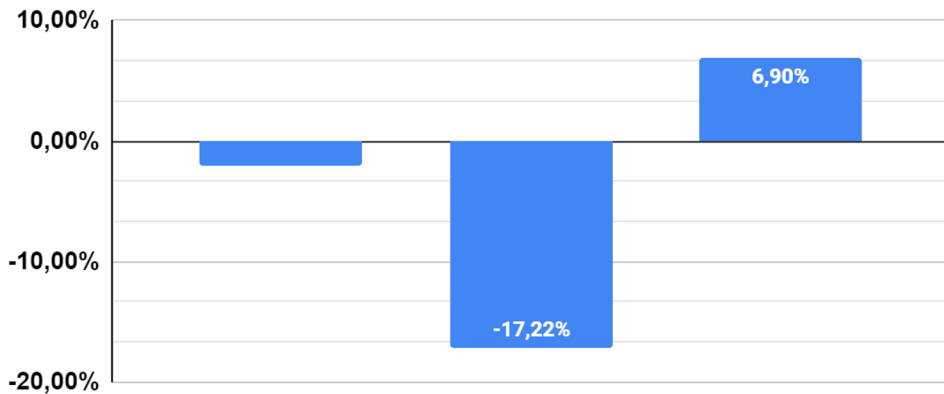
Source : Kustodian Sentral Efek Indonesia [2]

The picture above shows Indonesia's number of capital market investors, which continues to grow positively. Kustodian Sentral Efek Indonesia [2] reported the growth of investors in Indonesia. From 2021 to 2024, the number of investors in Indonesia increased from various investment instruments. The number of capital market investors in December 2023 was 12,168,061 peoples, an increase of 1.30% in January 2024 of 12,326,700 peoples. The number of mutual fund investors in December 2023 was 11,416,711, an increase of 1.37% in January 2024 of 11,572,580 peoples. The number of stock investors and other securities increased by 1.76%, from 5,255,571 people in December 2023 to 5,348,006 in January 2024. SBN investors also increased by 1.28%. The number in December 2023 was 1,002,727 peoples, while in January 2024, it was 1,015,531. This figure shows that more and more Indonesians are interested in investing.

Investment can be done by saving capital in several financial assets, such as stocks. The type of investment most favoured by investors is stocks because stocks have a high rate of return when compared to other types of investments and can earn profits from dividends and profits for shareholders. With Indonesia's increasingly competitive capital market, investors and prospective investors face the challenge of analyzing the types of stocks worth investing in. An in-depth analysis is needed to determine good and bad stocks to generate maximum investor profit potential. Portfolio concentration can be applied when implementing investment strategies. A concentration portfolio is a strategy that involves purchasing certain types of stocks in one industry with comparable typical price movements. This strategy is suitable for investors with a high-risk profile. Risk-averse investors prefer diversification to reduce risk, while risk-tolerant investors choose a concentration to gain higher returns. The concentration technique proposed by Buffet is based on a robust fundamental analysis and utilizes personal feelings when choosing which stocks to buy.

Since January 25, 2021, the Indonesia Stock Exchange has implemented a new classification for listed firms' sectors and industries, known as the Indonesia Stock Exchange Industrial Classification, or IDX-IC. These sectors include energy, raw materials, industry, primary and non-primary consumer products, health, finance, property and real estate, technology, infrastructure, and transportation and logistics. Each sector can be classified based on sub-sectors, industries, and sub-industries. The agricultural product industry is included in the primary consumer goods sector, which is now experiencing significant growth

and increase. When Indonesia experienced a declining economic condition during the pandemic, the agricultural product industry experienced an increase in Gross Domestic Product (GDP). In 2020, the agricultural industry had a gross domestic product value of 1.37 billion rupiah. It increased in 2021 and 2022 by 1.40 billion rupiah and 1.43 billion rupiah, respectively [3]. The Central Statistics Agency (BPS) reported that the GDP of the agricultural sector grew by 1.30 per cent in the fourth quarter of 2023 [4]. Gross domestic product comes from consumer goods not counted as capital goods. Both economic growth and the size of corporate income are correlated with increased consumption of goods. Gross domestic product growth is a favourable indication for investment because it increases consumer purchasing power, which increases demand for goods and benefits companies [5]. In terms of exports, the agricultural industry also increases every year. In 2020, agricultural industry exports were worth 29,170,043 USD. In 2021 and 2022, export values grew by 41,271,128 USD and 42,530,242 USD, respectively [6].



**Fig. 2.** Comparison of Export Growth of Various Industries Between Quarters 2023 with Q1 2024  
Source: Badan Pusat Statistik [3]

In the conditions of a weakening rupiah and a strengthening US dollar, the plantation and food crop industry is considered a sector that benefits because it focuses on exports. The figure above, according to the Badan Pusat Statistik [3], non-oil and gas exports from the processing industry fell 1.97% between January and April 2024 compared to the same period in 2023, as well as exports of mining and other products, which fell 17.22%. Meanwhile, exports of other agricultural, forestry, and fishery products increased by 6.90%. This figure shows that the agricultural product industry excels in terms of income. Exports can increase a company's productivity; the more export operations a company carries out, the higher its income [7]. The company's profitability will attract investors to invest in it.

Although the agricultural product industry has good performance and growth, not all companies in the agricultural sector can be selected for investment decisions. A stock assessment must be conducted to determine which stocks are the best. Fundamental analysis is one of the analyses that can assess the performance of an issuer's shares. A method for evaluating equities based on the performance and future prospects of the company is called fundamental analysis, that is used by investors to assess the security of a stock value. One of the methods used in fundamental analysis is to use various financial ratio indicators.

Three financial ratios are used in this study: the profitability, solvency, and liquidity ratios. Since these three ratios provide a preliminary assessment of the state of the business, they are always the primary focus, particularly for investors. Businesses can utilize the profitability ratio to ascertain their capacity to turn a profit, the liquidity ratio to gauge their capacity to meet short-term obligations, and the solvency ratio to gauge their capacity to

satisfy all obligations. The current ratio is used to calculate the liquidity ratio, the debt-to-equity ratio is used to calculate the solvency ratio, and return on assets is used to calculate the profitability ratio.

The goal of stock grouping is to identify high-yielding equities or possible stocks. It is safe to purchase stocks when you are aware of their quality and performance. If stock categorization and analysis are not done thoroughly, estimated losses will be larger. To optimize gains and reduce losses, investors need to choose and evaluate stocks [8]. Stocks in the agriculture industry were grouped according to financial ratios using the K-Means algorithm and the Elbow method with the Python analysis tool 3.10. According to Tendean and Purba [9], K-Means is a non-hierarchical clustering method that divides data into many groups, placing dissimilar objects in different clusters and similar objects in one cluster. The ideal number of clusters produced during clustering is established by the elbow approach [10].

Following clustering, the investigation continues by examining the association between financial success and listing date. The listed corporations are public, which means that the general public can own their shares. According to this explanation, researchers are interested in using the K-Means algorithm and the Elbow method to categorize shares of agricultural product industry issuers.

## **2 Literature Review**

### **2.1 Investment**

Investment activities play a leading role in Indonesia's economic development. Through investment, the government and private investors can finance various development projects and increase economic productivity, improving people's welfare. The role of investment includes driving economic growth, improving infrastructure, encouraging innovation and technology, and increasing financial access.

Investment in Indonesia is influenced by several factors, such as political and security conditions, government policies, national and global economic conditions, infrastructure availability, and human resources. Investment is an effort to invest funds in more than one asset in the long term with the hope of generating profits in the future. Investment objectives can be divided based on time targets into three categories: short-term, medium-term, and long-term. Some forms of investment generally chosen by the public include savings, deposits, bonds, stocks, mutual funds, gold, and property.

### **2.2 Share**

Stocks are proof of ownership in a company or business entity. By purchasing shares, a person invests capital in the company, where the funds will be managed by management to support the company's operations. Some of the reasons investors choose to invest in stocks, are as follows.

- a. The capital required is relatively small; with funds of Rp 5 million, investors can invest in stocks.
- b. Stock investment can be done anywhere.
- c. Investment time is flexible because trading on the Indonesia Stock Exchange (IDX) has no time limits.
- d. Risk can be minimized according to the amount of capital invested.
- e. The profit potential is unlimited.

Currently, the stock market in Indonesia has several characteristics that distinguish it from stock markets in other countries, such as Relatively small market size, low liquidity levels, high volatility levels, and investor composition dominated by local investors. Factors affecting demand, supply, and stock prices in Indonesia include company performance, economic and market conditions, interest rates, and political factors.

### **2.3 Portfolio concentration**

Portfolio concentration means that stocks come from only one sector; in other words, all eggs are put in one basket until it is full. Portfolio concentration is riskier than diversification because all assets are dedicated to one sector, which means that if that sector declines, the portfolio's total value will decrease [11]. Concentration in a particular business is suitable for investors who understand the ins and outs of an industry and anticipate its future growth.

Concentration and diversification are competing investment strategies that often directly contrast. The selection of stocks for a portfolio is the main difference between the concentration method and the diversification method. Buying many stocks to secure an investment rather than based on examining the company's fundamentals is a diversification strategy. In contrast, Buffet's concentration strategy focuses on an excellent long-term fundamental analysis and uses his emotions and moods to determine which stocks to buy.

### **2.4 Fundamental analysis**

Fundamental analysis is an approach that involves assessing the condition of a company, the economy, and the related industry. The goal is to understand the company's performance during its operational activities, primarily through published income statements. The better the company's performance, the more likely it is to make a profit over that time span.

Compared to technical analysis, fundamental analysis is more widely used by investors because it is considered to have easier-to-understand calculations and more accurate information about the company's condition. This analysis provides a more comprehensive understanding of an investment's health and long-term prospects.

Fundamental analysis believes that everything that affects market movements, including fundamental factors, politics, natural disasters, and psychological factors of market players, is reflected in price movements. Thus, this analysis aims to understand and anticipate the impact of these various factors on market movements.

### **2.5 Financial Ratios**

Financial analysis is required to evaluate a company's financial health and performance. Financial statement analysis tools enable business owners and managers to learn about numerous areas of the company's finances and development. Financial ratios are one of the most commonly utilized analytical techniques. Financial ratios compare statistics in financial accounts by dividing one number by another. Comparisons can be conducted between one component and another in a single financial statement or between components across multiple financial statements. Financial ratios are a collection of figures from the income statement and balance sheet that removes the influence of firm size, resulting in relative measurements rather than absolute values.

The most often employed financial ratios are as follows:

- a. Liquidity ratios assess a company's capacity to satisfy short-term obligations. Examples include the current ratio and rapid ratio.

- b. Activity Ratios: These ratios reflect the company's operational activity. These ratios include total assets turnover, inventory turnover, average collection period, days in turnover, and accounts receivable turnover.
- c. Solvency Ratios: These ratios assess a company's capacity to cover long-term liabilities or liquidation costs. Solvency ratios include the total debt ratio, debt-to-equity ratio, cash flow interest coverage, cash flow to net income, and cash return on sales.
- d. Profitability ratios assess a company's ability to create profits. Examples include gross profit margin, net profit margin, return on assets, return on equity, and operating ratio.
- e. Market Value Ratio: This ratio measures a company's performance in the capital markets. Examples include dividend yield, earnings per share, dividend payout ratio, price-earnings ratio, and price-to-book value.

Liquidity, solvency, and profitability ratios are important to investors because they provide an early indication of a company's financial health. Liquidity ratios measure a company's capacity to meet short-term obligations. Solvency ratios reflect a company's ability to satisfy its long-term obligations and debts. Profitability ratios evaluate a company's ability to generate profit from its operations.

## 2.6 Clustering

Clustering is a data analysis approach, also referred to as a data mining method, that seeks to group data with similar properties together. Data with varying features, on the other hand, are classified into distinct categories. Each grouping strategy is based on how we compare items. Objects are compared according to their position, attributes, or behaviour.

In business intelligence, clustering can be used to group users into several categories as needed. For example, customers can be classified based on a high degree of characteristic similarity. Clustering can be interpreted as data segmentation, where clustering groups several datasets into some groups based on strong similarities. Clustering is often used in various fields, such as marketing, where customers are grouped based on purchasing behaviour, or in biology, where genes are grouped based on expression patterns. In text analysis, clustering can group documents based on the same topic.

In cluster analysis, there are two clustering methods: hierarchical and non-hierarchical. By creating clusters depicted as dendrograms, the hierarchical clustering approach is applied. The data will be combined with other data to create a hierarchy. Meanwhile, a non-hierarchical clustering focuses on combining and separating data. Data is grouped based on the same characteristics.

## 2.7 K-Means

Among the non-hierarchical algorithms is K-Means. K-Means, which can only be applied to numerical attributes, is used to divide data into many distance-based portions. This technique, which divides data into k distinct sections, falls under the category of partitioning clustering.

The following are the processes involved in clustering using the K-Means method [12].

- a. Find the number of clusters that need to form, denoted by k.
- b. Establish each cluster's original center point.
- c. Use the Euclidean distance formula to determine how far each input data point is from each centroid until the data point is as near to the centroid as possible.

Euclidean Distance Equation:

$$D(y,x) = \sqrt{(X1- Y1)^2 + (X2- Y2)^2 + \dots + (Xn- Yn)^2}$$

Information:

D = Distance

x = Data

y = Centroid

- d. Group information according to how close it is to the centroid.
- e. Using the present cluster members, recalculate the cluster centers. The average value of all the object data in a given cluster is called the cluster center.
- f. Use the updated cluster centers to recalculate every object. If the cluster centers remain constant, the clustering procedure is finished. Otherwise, return to step 3 and repeat until the cluster centers remain unchanged.

*K-Means* has several methods, such as the Elbow and Silhouette methods. The method in *K-Means*, according to Dewi and Pramita [13], the Elbow method, and the Silhouette method have unique qualities that require exact accuracy when combined with the clustering process methodology.

## **2.8 Elbow Method**

The Elbow method determines the best number of clusters by comparing the percentage of each cluster that forms an elbow at a certain point. This method is usually presented in graphical form to clearly show the elbow points formed so that the optimal *k* (cluster) value can be selected. The main objective of the Elbow method is to select a small *k* value while maintaining a low within value.

The Elbow method works by comparing the percentage of the Sum of Square Error (SSE) calculation for each number of clusters and finding the point where the graph shows the largest change, or Elbow, in the graph line. SSE is calculated by measuring the distance between a data point and the cluster's centroid and by adding the squared results of this distance for all points in that cluster. As a result, when we add more clusters, the SSE will decrease because each cluster becomes smaller, and the data points are closer to their centroids. However, adding more clusters at a certain point will not significantly reduce SSE, and this is the elbow point sought in this method [14].

The *K-Means* algorithm with the Elbow Method is used in this study, which distinguishes it from earlier investigations. The equities evaluated are from the agriculture product business, with a yearly data period spanning 2020 to 2023. The financial ratios used are the liquidity ratio using the current ratio calculation, the solvency ratio using the debt-to-equity ratio calculation, and the profitability ratio using the return on assets calculation—as well as an analysis of the relationship between financial performance and the company's listing date.

## **3 Method**

### **3.1 Framework**

A portfolio concentration is a technique that involves purchasing certain types of stocks in an industry that has similar characteristics. Portfolio concentration is suitable for investors with a high-risk profile to obtain high profits. Shares of agricultural product industry issuers can be an option in portfolio concentration because they have good growth and performance. Shares of agricultural product business issuers are essentially examined using financial ratio calculations, specifically the liquidity ratio using the current ratio, the solvency ratio using the debt-to-equity ratio, and the profitability ratio using return on assets. The Python 3.10 analysis tool groups shares of agricultural product industry issuers using the *K-Means* algorithm and the Elbow approach. The study identifies clusters with the best financial performance, which may be used by investors to make investment decisions.

### 3.2 Data types and sources

Secondary data is used to be processed in research analysis. Secondary data comes from [finance.yahoo.com](https://finance.yahoo.com), which collects annual financial data from 2020 to 2023. The data is used to calculate the financial ratio of each stock.

### 3.3 Population and sample

Stocks in the agricultural sector make up the research population. Purposive sampling was used to choose the research sample, and the following criteria had to be met :

- The Indonesia Stock Exchange (IDX) is where it is listed.
  - Part of the agricultural product industry's main consumer goods sector.
  - Complete the company's annual financial reports (from 2020 to 2023).
- Based on these criteria, 30 stocks meet and are selected in this study as follows.

**Table 1.** List of selected stocks and their financial ratios

Company	Code	CR	DER	ROA
Prediksi Gunatama Tbk.	PGUN	1,9274	0.6758	0.0225
Charoen Pokphand Indonesia Tbk.	CPIN	1,9841	0.2874	0.0912
Central Proteina Prima Tbk.	CPRO	0.8441	1,7824	0.1291
Dua Putra Utama Makmur Tbk.	DPUM	4,8185	1,2189	0.1162
Sawit Sumbermas Sarana Tbk.	SSMS	1,5643	3.5295	0.0988
Mahkota Group Tbk.	MGRO	0.9124	2,0785	0.0144
Japfa Comfeed Indonesia Tbk.	JPFA	1.8444	0.8298	0.0442
Sreeya Sewu Indonesia Tbk.	SIPD	1.0122	1.1275	0.0192
Astra Agro Lestari Tbk.	AALI	2,5814	0.2299	0.0476
Andira Agro Tbk.	ANDY	1,0967	0.7706	0.0500
Austindo Nusantara Jaya Tbk.	ANJT	1.6076	0.3951	0.0253
Bisi International Tbk.	BISI	7,2742	0.0721	0.1305
Jhonlin Agro Raya Tbk.	JARR	1.6474	7,0456	0.0047
Sampoerna Agro Tbk.	SGRO	1,1926	0.8706	0.0530
Bumi Teknokultura Unggul Tbk.	BTEK	0.8823	1,5713	0.0328
Salim Ivomas Pratama Tbk.	SIMP	1,2629	6,3832	0.0438
Eagle High Plantations Tbk.	BWPT	0.6989	2,5400	0.0261
FAP Agri Tbk.	FAPA	0.9286	1,1295	0.0169
Gozco Plantations Tbk.	GZCO	0.8761	0.4925	0.0033
Palma Serasih Tbk.	PSGO	1.7855	1.6269	0.0357
PP London Sumatra Indonesia Tbk.	LSIP	4,7743	0.3354	0.0539
SMART Tbk.	SMAR	1,3579	1.0935	0.0396
Citra Borneo Utama Tbk.	CBUT	1,2644	2,7978	0.0358
Teladan Prima Agro Tbk.	TLDN	1,9084	1,1657	0.0840



**Table 1.** List of selected stocks and their financial ratios (*continue*)

Company	Code	CR	DER	ROA
FKS Multi Agro Tbk.	FISH	1,3105	1,0046	0.0524
Nusantara Sawit Sejahtera Tbk.	NSSS	0.8703	1,8958	0.0082
Triputra Agro Persada Tbk.	TAPG	1,4108	0.9151	0.1050
Sumber Tani Agung Resources Tbk.	STAA	1,7580	0.7180	0.1163
Dharma Satya Nusantara Tbk.	DSNG	0.9660	2,3879	0.0431
Menthobi Karyatama Raya Tbk.	MKTR	1.2324	1.6375	0.0403

Source : Yahoo Finance, processed data (2024)

### 3.4 Data processing and analysis methods

The study began by calculating the current ratio (CR), debt-to-equity ratio (DER), and return on assets (ROA) of each selected stock using Google Spreadsheet. The calculation results were then continued to the clustering stage with the K-Means algorithm with the Elbow method using the Python 3.10 analysis tool on Google Colab.

The Elbow method uses the total value equation WSS (Within Cluster Sum of Squares), commonly called SSE (Sum Square Error), with the formula [13]:

$$SSE = \sum_{k=1}^k \sum_{xi \in Sk} ||xi - Ck||_2^2$$

Description :

$xi$ : attribute value of the  $i$ -th data

$Ck$ : attribute value of the  $k$ th cluster center

After determining the number of clusters, a cluster will be selected with a collection of shares of agricultural product industry issuers with the best financial performance as seen from the liquidity ratio (current ratio), solvency ratio (debt to equity ratio), and profitability ratio (return on assets) with the following criteria.

- CR is high. A high current ratio indicates the company is increasingly liquid, meaning it can pay its short-term obligations.
- DER is low. A low debt-to-equity ratio indicates less use of debt in corporate funding, thus reducing dependence on external parties.
- ROA is high. A high return on assets indicates the company's financial performance is improving; that is, the company can generate greater profits with the same amount of assets.

Next, an analysis was conducted to see the relationship between financial performance and the listing date. The analysis results show the company's early or recent listing date and its relationship with the sound or poor financial performance of the company.

## 4 Results and discussion

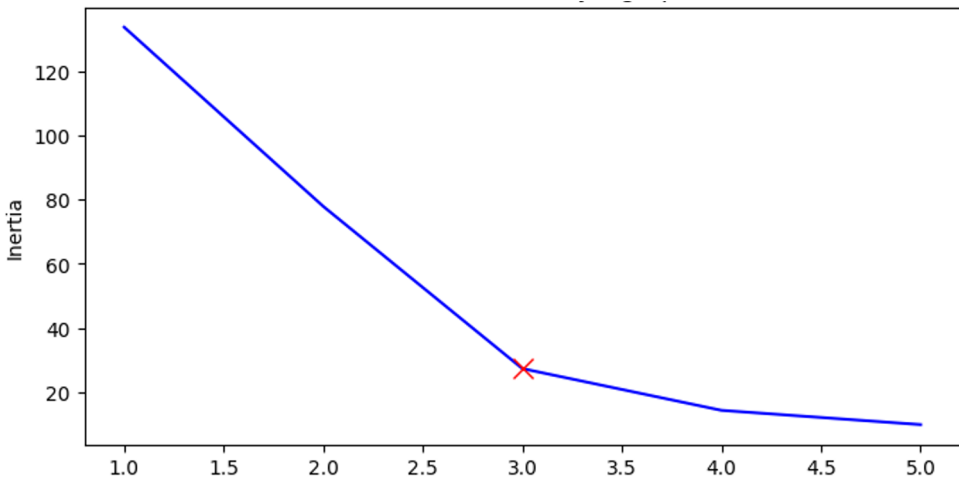
There are 52 stocks included in the agricultural product industry category listed on the Indonesia Stock Exchange (IDX). The stocks selected in this study were 30 stocks. The selected stocks have complete financial reports from 2020 to the first quarter of 2024. The financial reports of the other 22 stocks were incomplete, so they were not selected as research samples.

## 4.1 Calculation of CR, DER, and ROA

The stocks of selected agricultural product industry issuers will be calculated using each stock's CR, DER, and ROA. Table 1 is the calculations for the CR, DER, and ROA. The stocks with the highest CR, DER, and ROA are BISI at 7.2742, JARR at 7.0456, and BISI at 0.1305. Meanwhile, the stocks with the smallest CR, DER, and ROA are BWPT at 0.6989, BISI at 0.0721, and DPUM at -0.1162.

## 4.2 K-Means algorithm with elbow method

K-Means is an algorithm for dividing data into several pieces. This method separates data based on characters or values. The Elbow approach is a way for calculating the appropriate number of clusters by assessing the percentage of each group that forms an elbow at a given location [57]. The Elbow formed is called an elbow point, which shows a specific decreasing inertia value.



**Fig. 3.** Elbow Method for Optimal k

Source: Processed data (2024)

Calculation using the method *Elbow* shows that the optimal number of k (clusters) is 3. Based on the image above shows a decrease in the inertia value and an elbow shape. The Elbow or elbow point is at a cluster value of 3. The stocks formed in 3 clusters are as follows.

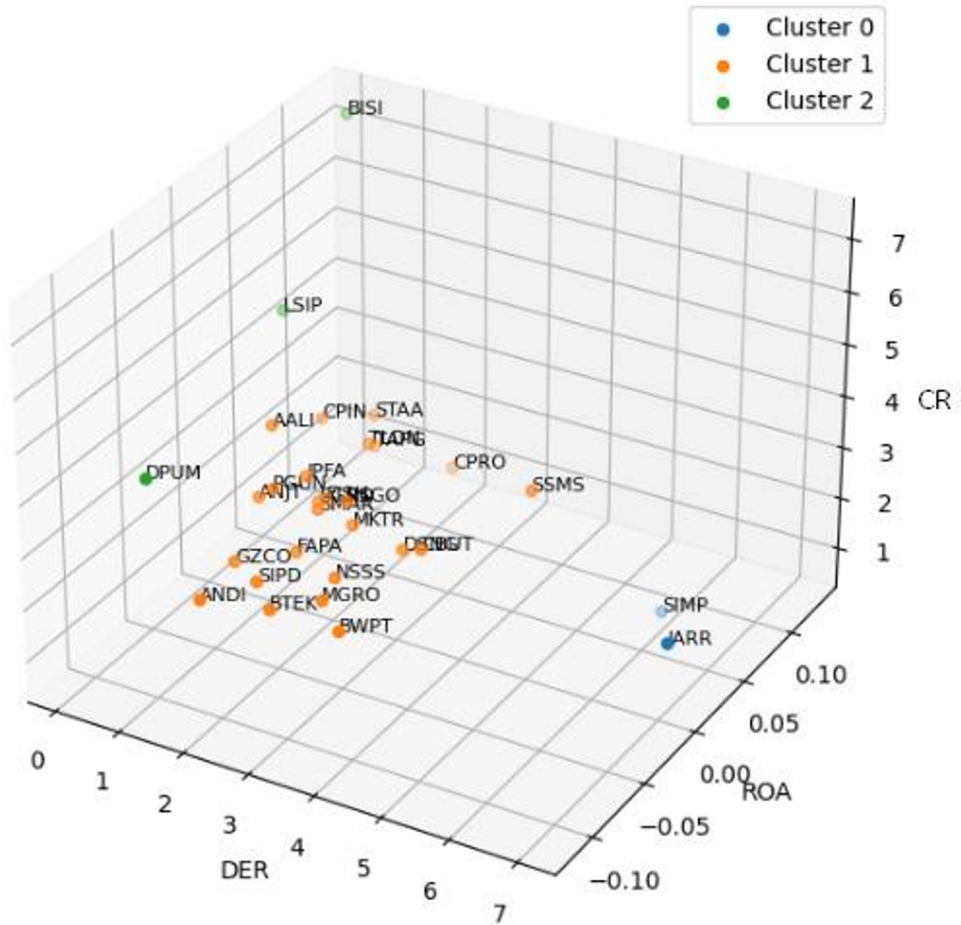
**Table1 2.** Stock grouping based on clusters and their listing dates

<b>Code</b>	<b>Cluster</b>	<b>Listing Date</b>
PGUN	1	December 18, 2020
CPIN	1	March 18, 1991
CPRO	1	June 21, 2006
DPUM	2	December 2, 2015
SSMS	1	December 12, 2013
MGRO	1	July 18, 2018
JPFA	1	January 15, 1989
SIPD	1	July 22, 1996
AALI	1	December 15, 1997
ANDY	1	May 1, 2018
ANJT	1	May 8, 2013
BISI	2	November 28, 2007
JARR	0	September 22, 2021
SGRO	1	September 12, 2007
BTEK	1	June 21, 2002
SIMP	0	June 9, 2011
BWPT	1	October 27, 2009
FAPA	1	January 9, 2020
GZCO	1	June 24, 2008
PSGO	1	November 27, 2018
LSIP	2	July 10, 1996
SMAR	1	October 23, 1992
CBUT	1	December 10, 2021
TLDN	1	April 12, 2022
FISH	1	October 24, 2000
NSSS	1	April 4, 2022
TAPG	1	April 12, 2021
STAA	1	December 14, 2021
DSNG	1	December 14, 2012
MKTR	1	November 23, 2021

Source : Processed data (2024)

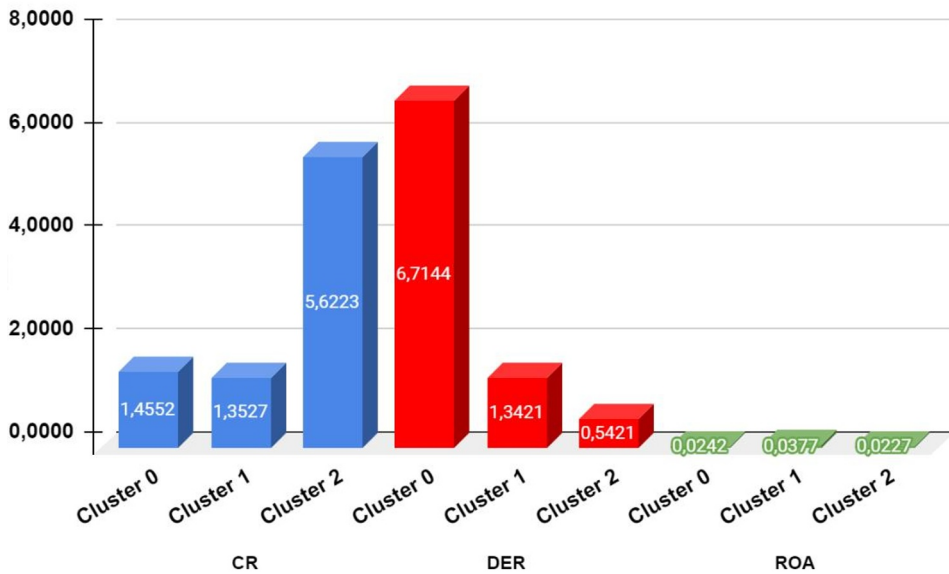
*Cluster* marked with numbers 0, 1 and 2. Cluster number 0 is filled by two stocks, JARR and SIMP. Cluster 1 is filled by 25 stocks, namely JPFA, CPIN, SIPD, AALI, ANJT, SGRO, BTEK, FAPA, GZCO, PSGO, SMAR, ANDI, TLDN, FISH, NSSS, TAPG, STAA, DSNG, PGUN, CPRO, MKTR, SSMS, MGRO, BWPT, and CBUT. Meanwhile, cluster 2 is filled by 3 stocks, namely BISI, LSIP, and DPUM.

### 4.3 Cluster assessment based on financial ratios



**Fig. 4.** Clustering visualization with Elbow Method

Source: Processed data (2024)



**Fig. 5.** Comparison of average financial ratio values between clusters

Source : Processed data (2024)

Based on the calculation table of CR, DER, and ROA, the comparison graph of the average financial ratio values between clusters, and clustering visualization using the Elbow method, it is known that cluster 0 has an average CR, DER, and ROA value of 1.2970, 6.7144, and 0.0242, respectively. The very high average DER value indicates that the company has a large debt compared to its equity.

*Cluster 1*, the average value of the CR, DER, and ROA are 1.3527, 1.3421, and 0.0377, respectively. The average value of ROA tends to be low, which indicates that companies in this cluster can generate profits. The average value of the CR, which tends to be low, indicates that companies in this cluster have difficulty in paying short-term obligations. Although this cluster has a low average CR, several companies have good CR, DER, and ROA. Other stocks include AALI, STAA, and CPIN are in the area bordering cluster 2, whose financial ratio values are not much different from the stocks in cluster 2. AALI has a CR of 2.5814, a DER of 0.2299, and a ROA of 0.0476. STAA has a CR of 1.7580, a DER of 0.7180, and a ROA of 0.1163. CPIN has a CR of 1.9841, a DER of 0.2874, and a ROA of 0.0912.

*Cluster 2* has an average value of the CR, DER, and ROA of 5.6223, 0.5421, and 0.0227, respectively. The average value of ROA tends to be small compared to other clusters because of DPUM shares have a ROA value of -0.1162, thus lowering the average value of ROA. Meanwhile, BISI and LSIP have a high return on assets values of 0.1305 and 0.0539, respectively. This cluster also has the highest average CR value, indicating that companies are smooth in paying short-term obligations. The lowest average DER value indicates that companies in this cluster have lower debts than their equity counterparts.

#### 4.4 Relationship between financial performance and listing date

Based on the table 2, it can be seen that the listing date has no relationship with financial performance. Cluster number 2 is filled with stocks with the best financial performance, namely issuers BISI, DPUM, and LSIP. The three issuers have different listing date periods. LSIP was listed on July 10, 1996, with the earliest listing date in cluster 2. However, in other

clusters, some companies have the earliest listing dates, such as SMAR in cluster 1, which was listed on October 23, 1992. The earlier the company's listing date, it only sometimes indicates good company performance and vice versa.

#### **4.5 Implications**

Investment activities, especially in stocks, require strategies to avoid risks and obtain high returns. Portfolio concentration is an investment effort in one type of sector or one industry only. Portfolio concentration is suitable for investors with a high-risk profile because the risks are also high in addition to its high profits. This strategy requires fundamental analysis so that investments continue to experience profits and avoid losses. This strategy is subjective, depending on investors' confidence in choosing stocks in a sector or industry.

Clustering a collection of stocks aims to group stocks according to their respective performances. This clustering makes it easier for investors to choose stocks with the best performance. In this study, stock clustering was carried out on a collection of agricultural industry issuer stocks using the K-Means algorithm with the Elbow method. Clustering is based on financial performance in the form of financial ratios, namely the liquidity ratio (CR), solvency ratio (DER), and profitability ratio (ROA). Three clusters were formed, with one cluster having a collection of stocks with the best financial performance, namely cluster 2, BISI, LSIP, and DPUM. However, DPUM shares have a negative ROA value that can be reconsidered for inclusion in the portfolio. Cluster 1 has stocks with good financial performance, such as AALI, CPRO, STAA, and CPIN.

### **5 Conclusion**

The following conclusions can be drawn based on the research results and discussion. The number of clusters formed from the stocks of selected agricultural product industry issuers using the K-Means algorithm with the Elbow method is 3 clusters, namely cluster 0, 1, and 2.

*The cluster*, which has a collection of stocks of agricultural product industry issuers with the best criteria for investment decisions seen from financial performance (financial ratios), is cluster 2 with a high CR value and ROA value and a low DER value compared to other clusters. Cluster 2 is filled by three stocks, namely BISI, LSIP, and DPUM. Cluster 0 is filled by stocks with a very high DER value, indicating that the company has a large debt compared to its equity. Cluster 0 is filled by two stocks, JARR and SIMP. Cluster 1 is filled by stocks with a high average ROA value, indicating that companies in this cluster have a good ability to generate profits. This cluster's average CR value tends to be low, indicating that companies have difficulty in paying short-term obligations. Other stocks include AALI, STAA, and CPIN are in the area bordering cluster 2, whose financial ratio values are not much different from the stocks in cluster 2.

The company's listing date is not related to the company's financial performance. The earlier the company's listing date, it only sometimes indicates its best financial performance and vice versa.

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