

Implementation of Fuzzy C-Means in Investor Group in the Stock Market Post-Covid-19 Pandemic

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Abstract: - This study aims to implement fuzzy c-means for groups of investors in the stock market post-covid-19 pandemic. The data used in this study is primary data generated by a Likert scale. Measurement of variables in primary data using the average score of each item. The sample selection of 100 investors is because it follows the central limit theory which says that the sampling distribution curve (for a sample size of 30 or more) will center on the population parameter values and will have all the properties of a normal distribution. This study uses an analytical method, namely fuzzy c-means. The results obtained in this study are the grouping of data into various types depending on the data for each parameter owned by the type of stock. The number of iterations is also very dependent on the value of the cluster center determined in the first iteration. Originality in this study is the object of research, namely post-pandemic stock market investors using a fairly reliable data grouping algorithm, namely Fuzzy C-Means, the algorithm groups data based on the characteristics of the data they have.

Key-Words: - Fuzzy C-Means, Investors, Pandemic, Stock Market.

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1 Introduction

According to, Solimun [1], the measurement of population characteristics to be investigated must be known comprehensively and very rarely research only uses one variable. Therefore, multivariate analysis is needed in measuring the characteristics in this study. One of the commonly used multivariate analysis methods is cluster analysis. Cluster analysis has the aim of grouping objects based on their similar characteristics. Grouping with cluster analysis is divided into two methods, namely Hierarchy and Non Hierarchy Cluster Analysis methods. In the Non Hierarchy method, one simple method that is often used is the K-Means cluster method. The K-Means cluster method is a hard clustering method that is often used, where the grouping of each object is assigned to only one cluster. However, at one time the hard clustering method could not be carried out because an object was located between two or more clusters. So that a grouping method appears by considering the degree of membership and includes a fuzzy set as a weighting basis called fuzzy clustering. One of the fuzzy clustering methods that is often used is the Fuzzy C-means method

In the Fuzzy C-means method, an object tends to become a member of a cluster based on the

highest membership degree value. The Fuzzy C-Means method is often used in grouping because it gives good results in determining the membership of an object that has the potential to become a member of two or more clusters. So with this fuzzy cluster method, you get a deep understanding of several investors who are grouped based on the characteristics of the factors that affect stock investment after the COVID-19 pandemic.

In the economic development of a country, it takes a lot of money or funds. These funds can be obtained from loans or own capital, which in its use the funds can be allocated as an investment, where investment here can be interpreted as investment for one or more assets owned and usually for a long period of time in the hope of getting profits in the future. come. With regard to investment in the capital market, the Indonesian government considers that the capital market is a means that can support the acceleration of Indonesia's economic development. This is possible because the capital market raises the movement of long-term funds from the public (investors) which are then channeled to productive sectors with the hope that these sectors can develop and generate new jobs for the community. The role of the capital market for individuals, companies, and the economy, a

country must have a good (healthy) capital market. The capital market will run well if the information needed by the parties involved can be obtained quickly, precisely, accurately, continuously, and efficiently. A capital market that can function properly (healthy) will be able to improve economic performance through increasing national income, creating job opportunities, and distributing development results that are felt by the community.

One aspect that will be assessed by investors is financial performance. In principle, the better the company's performance in generating profits, the higher the demand for these shares, which in turn will increase the company's share price. The stock market price is a measure of the company's performance index, 3 which is how far the management has managed to manage the company on behalf of the shareholders. Thus the stock price in the capital market is an indicator of company value, namely how to increase shareholder wealth which is the company's general goal.

Stock prices always change every day even every second the stock price can change. Therefore, investors must be able to pay attention to the factors that affect stock prices. The price of a share can be determined according to the law of supply and demand. The more people who buy a stock, the stock price tends to move up. Vice versa, the more people who sell the shares of a company, the stock price tends to move down. One form of investment in the capital market is stocks. Prior to investing in stocks, individuals or organizations must ensure that the investments made are appropriate. This means that he must assess various alternatives that will bring positive returns in the future, both in the form of dividends, namely withdrawals or income based on the profits obtained by the company whose shares we own, as well as in the form of capital gains, namely the excess of the selling price of the purchase price, Saleh [2].

This study will apply fuzzy c-means to groups of investors in the stock market post-covid-19 pandemic. By conducting research, researchers hope to know the group of investors in the stock market from each type of stock so that they can find out which types of stocks are sustainable after the COVID-19 pandemic. The data used in this study is primary data generated by a Likert scale. Originality in this study is the object of research, namely investors in the stock market after the COVID-19 pandemic. Based on this description, research on the application of fuzzy c-means to groups of investors in the stock market after the COVID-19 pandemic is important.

2 Literature Review

2.1 Cluster Analysis

A newly developed technique to solve data analysis problems is the cluster analysis technique. This technique will look for categories or patterns of sample data (data sets) based on the process of forming homogeneous data groups called clusters. Cluster analysis is a class of techniques used to classify objects or cases (respondents) into relatively homogeneous groups, called clusters. Objects/cases in each group tend to be similar to each other and different (not the same) from objects from other clusters. Cluster analysis is also called classification analysis or numerical taxonomy, Supranto [3].

Cluster analysis is an analytical method in statistics that is used to build groups or clusters of multivariate data objects, Hardle and Simar [4]. The main purpose of cluster analysis is to group objects based on the similarity of characteristics between these objects. According to Mattjik and Sumertajaya, [5], cluster analysis is a method in multiple variable analysis that aims to classify units of observation into groups based on variables. The characteristics of a good cluster are that it has high homogeneity (similarity) between its members in one cluster (within-cluster) and has high heterogeneity (difference) between one cluster and another (between cluster).

According to Supranto, [3] cluster analysis is referred to as classification analysis or numerical taxonomy, with a clustering procedure in which each object only belongs to one cluster, there is no overlapping or interaction. In general, cluster analysis is divided into two methods, namely the hierarchical method and the non-hierarchical method. The difference between the two methods is in determining the number of groups or clusters. If the non-hierarchical method in determining the number of clusters is determined in advance according to the wishes of the researcher, then the hierarchical method goes through a gradual grouping process such as forming a kind of tree with levels.

2.2 Fuzzy Logic

From one dataset, many prediction models can be obtained either using different techniques or using similar algorithms. Each model then produces predictions that can differ from one another. The ensemble learning approach combines these various predictions into one final prediction. Ensemble techniques that rely on variations from the random forest and boosting approaches can

provide predictions with excellent accuracy. Random forest works by making ensemble composing models in such a way that various possibilities can be optimally accommodated while boosting works iteratively so that unpredictable cases are no longer a problem.

The ensemble method can reduce classification errors effectively, and is believed to have good performance compared to using a single classifier. The ensemble method is an algorithm in Machine Learning where this algorithm combines several models to achieve a higher generalization performance than a single model can do (Peter, 2014). The main idea of the ensemble method is to combine several sets of models that solve the same problem to get more accurate model (Aziz, 2020).

2.3 Fuzzy C-Means

Fuzzy clustering is a grouping technique in determining clusters based on distance using a fuzzy membership function. This method is a development of partitional with fuzzy weighting that performs grouping even though the data groups are not clearly distributed. According to, Kusumadewi and Purnomo [7]. Fuzzy clustering is a technique for determining the optimal cluster in a vector based on the Euclidian normal form for vector distances. According to, Kusumadewi [8] Fuzzy C-Means is a method of grouping data where each data is in a group determined by the membership value. According to Karim, Reda, and Georges [9] Fuzzy C-Means is a grouping method that allows one part of the data to have two or more groups.

The Fuzzy C-Means algorithm was first proposed by Dunn in 1973 and then updated by Bezdek in 1981. This algorithm is one of the most popular soft clustering techniques using a data point approach where the center point of the cluster will always be updated according to the membership value of the cluster. existing data and besides that the fuzzy c-means algorithm is also an algorithm that works using a fuzzy model so that it allows all data from all group members to be formed with different membership degrees between 0 and 1, Bora and Gupta [10]; Sanmorino [11]. The Fuzzy C-Means method basically has the aim of minimizing the function and getting the center of the cluster which will later be used to find out the data that enters a cluster.

The basic concept in Fuzzy C-Means is to determine the center of the cluster, which will mark the average location for each cluster. Each data point has a degree of membership for each cluster that is formed. In the initial conditions, the cluster

center is still not accurate, therefore, improvements are made to the cluster center and the degree of membership of each data point repeatedly until it is at the right point. This iteration is based on the minimization of the objective function that describes the distance from a given data point to the center of the cluster which is weighted by the degree of membership of the data point. From this iteration, it can be seen that the longer the cluster center will move to the right location, Kusumadewi [7]. In fuzzy theory, membership of a data is not expressly stated by giving a value of 1 if it is a member, and 0 if it is not a member, but is expressed by a degree of membership whose value range is between 0-1. The value is 0 if it is not a member at all and 1 if it is a full or partial member in a set. A data can be a member in several sets which is expressed by the value of the degree of membership of a set, Prasetyo and Sutisna [12].

Fuzzy C-Means relates to the concept of the similarity of functions of adjacent objects and finds the center point of the cluster as a prototype. For some data objects, there is no limitation on only one class, but the data can be grouped based on the degree of membership, which is between 0 and 1 which indicates partial membership of the data, Merliana [13]. Fuzzy C-Means cluster analysis is a cluster technique that is widely used in cluster applications. Fuzzy C-Means applies fuzzy grouping, each object can be a member of several clusters with different degrees of membership in each cluster. Fuzzy C-Means is an iterative algorithm that applies iteration to the data cluster process. The purpose of Fuzzy C-Means is to get the center of the cluster which will later be used to find out the data that enters a cluster. In fuzzy logic there is a fuzzy cluster which is one method to determine the optimal cluster in a vector space based on the Euclidean normal form for the distance between vectors.

2.4 Stock Market

Stock Market is an activity related to the public offering and trading of Securities, public companies relating to the securities they issue, as well as institutions and professions related to Securities. The stock market consists of the primary/primary market and the secondary market (Law no. 21 of 2011 concerning OJK). The primary market is the market for newly issued securities. The secondary market is the market for trading securities that have existed (old securities) on the stock exchange and as a means of buying and selling securities between investors.

Economic growth, which includes economic growth, purchasing power of the society, investment prospects in the area of operations. Social and political situations, which includes demography, social conditions, culture, politics, stability in terms of security of the area of operations, Fernandes and Solimun [14]. In the stock market, the most important thing investors should know is the stock price. Share price is the price of a share that occurs on the stock market at a certain time determined by market participants and determined by the demand and supply of the relevant shares in the capital market, Jogiyanto [15]. The share price determines shareholder wealth. Maximizing shareholder wealth translates into maximizing the company's share price. The stock price at any given time will depend on the cash flows expected to be received in the future by the "average" investor if the investor buys the stock, Houston [16].

The nation's competitiveness means the role of existing human resources in Indonesia in contributing to world market through products and/or services produced by the ability of Indonesian human resources through mastery of technology, science and skills, Sumardi and Fernandes [17]. Stock prices in the market are always fluctuating, or always changing. Several studies link stock prices with company performance. If the company's performance is good, the stock price will also increase. The company's performance can be seen from its financial statements. Usually companies that have gone public have an obligation to publish their financial statements at least once every three months. When there is publication of financial statements, investors will see the performance of the financial statements of the company. If the company's profits increase, investors will be interested in buying the shares, the demand for these shares will also increase, so the stock price will rise. This applies vice versa, if the company suffers a loss then the stock price will tend to fall.

The article that regulates the stock market is stated in Law no. 8 of 1995 article 1 point 13, "the stock market is a public offering activity carried out in securities trading, political companies, institutions and professions related to securities have been issued", Dyasartika [18]. Tandelilin [19], defines the stock market as a place used to trade securities between people who have a lot of funds or excess funds and people who lack funds or need funds which usually have an age of more than 1 year.

Shares are a sign of participation or ownership of individual investors or institutional investors or traders on investments or a number of funds invested in a company, Musdalifah, Mintarti and Maryam [20]. The stock market is a place where government and industry can raise long-term capital and investors can buy and sell securities, Saraswati [21]. In addition, there is a positive relationship between an efficient stock market and economic growth in both the short and long term. This is in line with the statement that the stock market will not be able to run away from the economic conditions of a country, Filbert and Prasetya [22].

2.5 Covid-19

In December 2019, the corona virus or known as Covid-19 appeared in Wuhan, China. This virus spreads very quickly and infects not only Chinese citizens but spreads to all corners of the world including Indonesia. In Indonesia, the first case of death due to COVID-19 occurred in March 2020, after which new victims emerged, both positive for COVID-19, as well as PDP (Patients Under Supervision) and ODP (People Under Supervision). Until now, the number of positive patients continues to increase (Covid-19, 2020). Covid-19 has an incubation period of 2-14 days in the human body with complaints resembling the flu, ranging from fever, cough, runny nose, chest pain, shortness of breath, to pneumonia, acute respiratory distress syndrome, skepticism, and even death. The pandemic has caused the International Monetary Agency (IMF) to predict a global economic slowdown will occur.

During the Covid-19 pandemic, which spread all over the world. At first this did not affect the stock market, but with more confirmed victims the stock market reacted negatively, Khan, Ali, Shi, Siddique, Nabi, Hu & Han [23]. This also caused prices in the stock market to decline, especially after WHO declared that Covid-19 was a pandemic and caused negative abnormal returns, Alali [24].

3 Results and Discussion

3.1 Research Method

The statistical application should not be complicated and difficult, it but must rather be simple and easy, so that it is user-friendly, Solimun and Fernandes [25]. The data used in this study is primary data. The variables used in this study are as follows: Rupiah Exchange Rate Fluctuations, Government Policy and Market Manipulation

Factors. The time of data collection was on January 2, 2022. The data was obtained by simulation by generating data using a Likert scale. Measurement of variables in primary data using the average score of each item. The sampling technique used is purposive sampling. The object of observation is investors in the stock market as many as 100 respondents. The sample selection of 100 investors is because it follows the central limit theory which says that the sampling distribution curve (for a sample size of 30 or more) will center on the population parameter values and will have all the properties of a normal distribution. This study uses the fuzzy c-means method. The research path diagram of the fuzzy c-means method is shown in Figure 1.

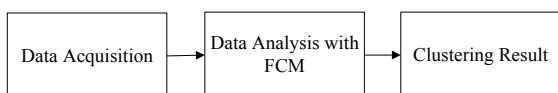


Fig. 1: Research Path Diagram Fuzzy C-Means.

3.2 Data Acquisition

Grouping will be carried out on the data that has been generated as many as 10000 investors into 3 groups where the definition of each group is determined by the researcher. Grouping is done based on parameters according to the case to be analyzed. For example, to group investors by type of stock against Fluctuations in the Rupiah Exchange Rate and the value of parameters such as the number of investors from before the pandemic and the number of investors who dare to invest post-pandemic will be calculated. More details can be seen in Table 1.

Table 1. Number of investors after the pandemic on Rupiah Exchange Rate Fluctuations in Indonesia.

No.	Stock Type	Number of investors from before the pandemic	Number of investors after the pandemic
1	Blue Chip Stocks	4521	429
2	Income Stocks	6173	456
3	Growth Stocks	9200	6676
4	Speculative Stocks	3280	1031
5	Counter Cyclical	1497	885

Meanwhile, the grouping of investors based on the type of stock against Government Policy will be calculated based on the parameters of the number of investors from before the pandemic and the number of investors who dare to invest after the pandemic. More details can be seen in Table 2.

Table 2. Number of investors after the pandemic on Government Policy in Indonesia.

No.	Stock Type	Number of investors from before the pandemic	Number of investors after the pandemic
1	Blue Chip Stocks	2847	1057
2	Income Stocks	774	280
3	Growth Stocks	1339	1021
4	Speculative Stocks	5040	1277
5	Counter Cyclical	2983	2034

The grouping of investors based on the type of stock against the Market Manipulation Factor will be calculated based on the parameters of the number of investors from before the pandemic and the number of investors who dare to invest after the pandemic. More details can be seen in Table 3.

Table 3. Number of investors after the pandemic on Market Manipulation Factors in Indonesia

No.	Stock Type	Number of investors from before the pandemic	Number of investors after the pandemic
1	Blue Chip Stocks	3471	1272
2	Income Stocks	441	380
3	Growth Stocks	1739	1421
4	Speculative Stocks	3240	2147
5	Counter Cyclical	3923	1834

3.3 Data Analysis with Fuzzy C-Means

Fuzzy logic is an appropriate way to map an input space into an output space, for example:

- 1) The warehousing manager tells the production manager how much inventory is at the end of this week, then the production manager will determine the number of items that must be produced tomorrow.
- 2) Restaurant services provide services to guests, then guests will give appropriate tips on whether or not the services provided.
- 3) You tell me how cool you want the room to be, I will adjust the rotation of the fan in this room.

Fuzzy clustering is a technique to determine the optimal cluster in a vector space based on the Euclidian normal form for the distance between vectors. Fuzzy clustering is very useful for fuzzy modeling, especially in identifying fuzzy rules. The clustering method is a grouping of data and their parameters in groups according to the tendency of the nature of each data (similarity of properties).

The concept of Fuzzy C-Means first is to determine the center of the cluster, which will mark the average location for each cluster. In the initial

conditions, the center of this cluster is still not accurate. Each data point has a degree of membership for each cluster. By fixing the center of the cluster and the degree of membership of each data point repeatedly, it will be seen that the center of the cluster will move to the right location. This iteration is based on the minimization of the objective function that describes the distance from a given data point to the center of the cluster which is weighted by the degree of membership of the data point.

The FCM algorithm flowchart is as follows:

- 1) Entering the data to be grouped x , in the form of a matrix measuring $n \times m$ serves to determine the amount of data and the attributes of each data to be used:

n = number of data samples

m = attribute of each data

X_{ij} = sample data - i ($i = 1, 2, \dots, n$) attribute - j ($j = 1, \dots, m$)

- 2) Determine:
 - Number of clusters = c ;
 - Weight power = w ;
 - Maximum Iteration = $MaxIter$
 - Smallest expected error = ξ
 - Initial Objective Function = $P_0 = 0$
 - Initial iteration = $t = 1$
 - Based on to determine the initial value of the equation, before processing the data.

- 3) Generating random numbers u_{ik} , $i = 1, 2, \dots, n$; $k = 1, 2, \dots, c$; function as elements of the initial partition matrix U . Counting the number of each column (attribute):

$$Q_j = \sum_{k=1}^c \mu_{ik} \quad (1)$$

Calculate:

$$\mu_{ik} = \frac{\mu_{ik}}{Q_j} \quad (2)$$

- 4) Calculate the center of the k -th cluster: V_{kj} , with $k = 1, 2, \dots, c$; and $j = 1, 2, \dots, m$; The determination of the cluster center is used to mark the average location for each cluster with inaccurate initial conditions.

$$V_{kj} = \frac{\sum_{k=1}^n ((\mu_{ik})^{w*} X_{kj})}{\sum_{k=1}^n (\mu_{ik})^w} \quad (3)$$

- 5) Calculating the objective function in the iteration = t , P_t : the calculation of the objective function is used to describe the distance from a given data point to the center of the cluster which is weighted by the degree of membership of the data point.

$$P = \sum_{k=1}^n \sum_{i=1}^c \left(\left[\sum_{j=1}^m (X_{ij} - V_{kj})^2 \right] (\mu_{ik})^2 \right) \quad (4)$$

- 6) Calculate the partition matrix change

$$\mu_{ik} = \frac{\left[\sum_{j=1}^m (X_{ij} - V_{kj})^2 \right]^{\frac{-1}{w-1}}}{\sum_{k=1}^c \left[\sum_{j=1}^m (X_{ij} - V_{kj})^2 \right]^{\frac{-1}{w-1}}} \quad (5)$$

With: $i = 1, 3, \dots, n$; and $k = 1, 2, \dots, c$

- 7) Check stop condition
 - a. If $(|P_t - P_{t-1}| < \xi)$ atau $(t > MaxIter)$ then the iteration stops
 - b. Otherwise: $t = t + 1$, repeat step 4

3.4 Clustering Results

Clustering results in the form of grouping investors based on the similarity of the data they have, the types of shares will be grouped into 3 groups. Optimum clustering results will depend on the value of the initial partition matrix which has a range of 0-1.

4 Result and Discussion

The results and discussion in this study refer to the Fuzzy C-Means algorithm which has been described in the Research Methodology section. The grouping of investors here is based on the type of stock against Rupiah Exchange Rate Fluctuations, Government Policies and Market Manipulation Factors in Indonesia. Number of Investors After The Pandemic On Rupiah Exchange Rate Fluctuations in Indonesia:

- 1) The data to be entered is as shown in Table 1
- 2) Determine:
 - Number of clusters = 3;
 - Weight power = 2;
 - Maximum Iteration = $MaxIter = 100$
 - Smallest expected error = 0.1
 - Initial Objective Function = $P_0 = 0$;
 - Initial iteration = $t = 1$;
- 3) Generating random numbers to fill the elements in the partition matrix, the value range is 0-1. The number of random numbers is the number of data multiplied by the number of clusters, so the number is 20 values, it can be seen in Table 4.
- 4)

Table 4. Initial Partition Matrix

0.90	0.83	0.27
0.21	0.86	0.76
0.28	0.07	0.52
0.70	0.48	0.15
0.52	0.68	0.96

- 5) Calculating the cluster center with Equation (3), then the following results are obtained

Table 5. Center Cluster -i

14.993	28,936.519	4,167.959
19.562	43,088.531	7,439.156
17.829	41,863.591	10,837.832

- 6) Calculating the objective function can be calculated using Equation (3), the value obtained is 4,318,556,757.28
- 7) Calculating the change in the partition matrix using Equation (5), we get a value as shown in Table 6. The value in this partition matrix change will then be used as the center of the cluster in the next iteration

Table 6. Changes in the partition matrix

0.12	0.61	0.27
0.15	0.47	0.38
0.23	0.39	0.38
0.48	0.22	0.30
0.64	0.17	0.19

- 8) Check the stop condition, where the objective function value in the current iteration is reduced by the objective function value in the previous iteration. If the value is greater than 0.1 then the iteration will continue, otherwise the iteration will stop. From the results of the calculation of the objective function of the current iteration minus the previous iteration, it turns out that the value is still greater than 0.1 so that the iteration continues.

The grouping of investors based on the type of stock against fluctuations in the rupiah exchange rate stops until the 60th iteration with the difference in the value of the objective function obtained at 0.089. The cluster center in the last iteration can be seen in Table 7. While the results of grouping types of shares can be seen in Table 8, this grouping is based on the value of the change in the partition matrix or better known as the degree of membership in the last iteration. A type of stock will enter a cluster if the cluster has the highest degree of membership.

Table 7. Center of Last Iteration Cluster

9.792091037	16142.46007	5034.628031
22.04496233	50337.02905	4265.125708
31.9057002	91543.68445	16617.23902

Table 8. Investor cluster results by type of stock on fluctuations in the rupiah exchange rate

Stock Type	Degree of data membership in the th cluster-			Cluster		
	1	2	3	1	2	3
Blue Chip Stocks	0.0526	0.8416	0.1057		*	
Income Stocks	0.0000	0.0001	0.9998			*
Growth Stocks	0.5062	0.4494	0.0443	*		
Speculative Stocks	0.9850	0.0123	0.0026	*		
	0.4103	0.5490	0.0406		*	

For the case of grouping investors by type of stock against Government Policy and Market Manipulation Factors using the same calculation steps as in the case of grouping investors by type of stock against fluctuations in the rupiah exchange rate. The initial partition matrix for each case can be seen in Table 9 and Table 10. Determination of the initial partition matrix is done randomly, so the results will greatly affect the number of iterations. The case of grouping investors by type of stock against Government Policy ended in the 34th iteration with a difference in the value of the objective function of 0.0954, the results of the grouping can be seen in Table 11. Meanwhile, the case of grouping investors by type of stock on Market Manipulation Factors ended at number 33, with the difference the objective function value is 0.0374, the results of the grouping can be seen in Table 12.

Table 9. Initial Partition Matrix of Government Policy

0.75	0.71	0.91
0.89	0.66	0.30
0.71	0.14	0.25
0.20	0.94	0.84
0.54	0.97	0.04

Table 10. Initial Partition Matrix of Market Manipulation Factors

0.52	0.02	0.65
0.92	0.35	0.16
0.95	0.98	0.02
0.05	0.21	0.07
0.10	0.51	0.56

Table 11. Investor cluster results by type of stock on Government Policy

Type Stock	Degree of data membership in the th cluster-			Cluster		
	1	2	3	1	2	3
Blue Chip Stocks	0.5315	0.1344	0.3339	*		
Income	0.0036	0.0019	0.9943			*

Stocks	0.7608	0.2197	0.0194	*		
Growth Stocks	0.0798	0.9116	0.0084		*	
Speculative Stocks	0.9586	0.0357	0.0055	*		

Table 12. Investor cluster results by type of stock on Market Manipulation Factors

Type Stocks	Degree of data membership in the th cluster-			Cluster		
	1	2	3	1	2	3
Blue Chip Stocks	0.5315	0.3339	0.1344	*		
Income Stocks	0.0036	0.9943	0.0019		*	
Stocks	0.7608	0.0194	0.2197	*		
Growth Stocks	0.0798	0.0084	0.9116			*
Speculative Stocks	0.9586	0.0055	0.0357	*		

5 Conclusion

Based on the results and discussion, it can be concluded that the Fuzzy C-Means method can be used to classify investors based on the type of stock on Rupiah Exchange Rate Fluctuations, Government Policies and Market Manipulation Factors in Indonesia. The Rupiah Exchange Rate Fluctuations data groups Stocks and Growth Stocks in the same group. The other group consists of Blue Chip Stocks and Speculative Stocks. The type of Income share becomes its own member in the next group.

Another case places these types of shares in different groups, it really depends on the value of the parameter that is the basis for the grouping. Because the grouping here is based on the similarity of the characteristics of the parameters possessed by these types of shares. The number of iterations is quite similar in numbers 30 to 35, only in the case of hypertension the number of iterations reaches 60. The number of iterations depends on the value of the initial cluster center. The use of methods to optimize the determination of cluster values at the beginning is very necessary so that the grouping results become more accurate).

References:

[1] Solimun. 2010. Metode Partial Least Square-PLS. CV Citra Malang, Malang.
 [2] Saleh, M. (2009). Penilaian saham PT. Unilever Indonesia Tbk. pasca akuisisi bisnis kecap Bango (Doctoral dissertation, Universitas Gadjah Mada).
 [3] Supranto, J. (2004). Analisis Multivariat Arti dan Interpretasi. Jakarta: Rineka Cipta.

[4] Hardle, W., & Simar, L. (2003). Applied Multivariate Statistical Analysis, version 29th.
 [5] Mattjik, A. A., & Sumertajaya, I. M. (2002). Design of Experiments with SAS and Minitab applications.
 [6] Syafitri, A., Iwa, G. M., Gunawan, R., & Ardita, I. M. (2016, November). Fuzzy-PID simulation on current performance for Modern Elevator. In 2016 6th IEEE International Conference on Control System, Computing and Engineering (ICCSCE) (pp. 403-406). IEEE.
 [7] Kusumadewi, S., & Purnomo, H. (2010). Aplikasi logika fuzzy untuk sistem pendukung keputusan. Andi Offset, Yogyakarta.
 [8] Kusumadewi, S. (2007). Klasifikasi Kandungan Nutrisi Bahan Pangan Menggunakan Fuzzy C-Means. In Seminar Nasional Aplikasi Teknologi Informasi (SNATI).
 [9] Karim, T., Reda, B., & Georges, H. (2011). Multi-objective supervisory flow control based on fuzzy interval arithmetic: Application for scheduling of manufacturing systems. Simulation Modelling Practice and Theory, 19(5), 1371-1383.
 [10] Bora, D. J., Gupta, D., & Kumar, A. (2014). A comparative study between fuzzy clustering algorithm and hard clustering algorithm. arXiv preprint arXiv:1404.6059.
 [11] Sanmorino, A. (2012). Clustering batik images using fuzzy c-means algorithm based on log-average luminance. Computer Engineering and Applications Journal (ComEngApp), 1(1), 25-31.
 [12] Prasetyo, H., & Sutisna, U. (2014). Implementasi Algoritma Logika Fuzzy untuk Sistem Pengaturan Lampu Lalu Lintas Menggunakan Mikrokontroler. Techno (Jurnal Fakultas Teknik, Universitas Muhammadiyah Purwokerto), 15(2), 01-08.
 [13] Merliana, N. P. E. (2015). Perbandingan metode K-Means dengan fuzzy C-Means untuk analisa karakteristik mahasiswa berdasarkan kunjungan ke perpustakaan (Studi kasus Sekolah Tinggi Agama Hindu Negeri Tampung Penyang Palangka Raya) (Doctoral dissertation, UAJY).
 [14] Fernandes, A. A. R. and Solimun. (2017). Moderating effects orientation and innovation strategy on the effect of uncertainty on the performance of business

- environment. *International Journal of Law and Management*, 59(6), 1211-1219.
- [15] Jogiyanto, H. M. (2008). *Metodologi penelitian sistem informasi*. Yogyakarta: Andi Offset.
- [16] dan Houston, B. (2010). *Dasar-dasar Manajemen Keuangan*. Penerbit Salemba Empat, Jakarta.
- [17] Sumardi, S. and Fernandes, A.A.R. (2018). The mediating effect of service quality and organizational commitment on the effect of management process alignment on higher education performance in Makassar, Indonesia. *Journal of Organizational Change Management*, 31(2), 410-425.
- [18] Dyasartika, D. (2021). *Pengaruh Covid-19 Terhadap Perubahan Harga Dan Volume Perdagangan Saham (Studi Kasus Pada Perusahaan Farmasi Di Bei Periode September 2019 s/d SEPTEMBER 2020)* (Doctoral dissertation, Universitas Muhammadiyah Ponorogo).
- [19] Tandelilin, E. (2010). *Dasar-dasar Manajemen Investasi*. Diambil dari <http://repository.ut.ac.id/3823/1/EKMA5312-M1.pdf>.
- [20] Musdalifah Azis, S. E., Mintarti, S., & Maryam Nadir, S. E. (2015). *Manajemen Investasi Fundamental, Teknikal, Perilaku Investor dan Return Saham*. Deepublish.
- [21] Saraswati, H. (2020). Dampak Pandemi Covid-19 Terhadap Pasar Saham Di Indonesia. *JAD: Jurnal Riset Akuntansi dan Keuangan Dewantara*, 3(2), 153-163.
- [22] Filbert, R., & Prasetya, W. (2017). *Investasi Saham ala Fundamentalis Dunia*. Jakarta: PT Elex Media Komputindo.
- [23] Khan, S., Ali, A., Shi, H., Siddique, R., Nabi, G., Hu, J., ... & Han, G. (2020). COVID-19: Clinical aspects and therapeutics responses. *Saudi Pharmaceutical Journal*, 28(8), 1004-1008.
- [24] AlAli, M. S. (2020). The effect of who COVID-19 announcement on Asian Stock Markets returns: an event study analysis. *Journal of Economics and Business*, 3(3).
- [25] Solimun and Fernandes, A.A.R. (2017), Investigation the mediating variable: What is necessary? (case study in management research), *International Journal of Law and Management*, 59(6), 1059-1067.

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