IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 24, Issue 1, Ser. I (Jan. –Feb. 2022), PP 43-49
www.iosrjournals.org

Application of Particle Swarm Optimization (PSO) to Improve K-means Accuracy in Clustering Eligible Province to Receive Fish Seed Assistance in Java

Nur Syahrani Majdina[1], M Arief Soeleman[2], Catur Supriyanto[3]
[1]*(Student of Masters of Informatics Engineering, Dian Nuswantoro University, Semarang, Indonesia)*
[2,3]*(Lecturer in Informatics Engineering, Dian Nuswantoro University, Semarang, Indonesia)*

Abstract:
Background*: The k-means algorithm is to divides the data into clusters based on the closest distance by using the Euclidean distance formula. K-means is often used because the resulting approach is easy to implement, but has the disadvantage that the central point depends on the choice of K, resulting in a decrease in the speed and quality of a cluster.*
Methodology*: The research method uses the Cross-Industry Standard Process for Data Mining (CRISP-DM) cycle using 6 phases. The purpose of this research is to automate the selection of numbering on K-means so as to further increase the speed and quality of a cluster.*
Discussion*: The algorithm used is the K-means algorithm and Particle Swarm Optimization (PSO) which is validated using the K-nn algorithm because if it is calculated using the confusion matrix it has an accuracy of 97.78% and has a Davies-Bouldin Index (DBI)) value of 0.369877333 which is included in the high category when applied to data on the volume of fishery products on the island of Java.*
Conclusion: *The final result of this study is that it has succeeded in automating the selection of numbering on K-means so that the speed and quality of a cluster is to determine which provinces are entitled to receive assistance in the form of fish seeds to increase the volume of fishery products on the island of Java because of the results of the calculation of K-means clustering and Particle Swarm Optimization (PSO) which was tested using the K-nn classification which was calculated using the confusion matrix and the Davies-Bouldin Index (DBI) the accuracy value increased, there were 261 fishery production volume data that we're entitled to receive assistance in the form of fish seeds on the island of Java.*

Key Word*: Clustering; Fishery Production Volume; K-means Algorithm; PSO Algorithm.*

Date of Submission: 04-01-2022 Date of Acceptance: 15-01-2022

I. Introduction

The clustering algorithm is to divides the data into clusters based on the shortest distance between the data and the central point in each cluster [1]. One of the clustering algorithms is K-means. K-means is to divide the data into clusters based on the closest distance using the Euclidean distance formula. K-means is often used because the computational approach is easy to implement [2]. This research will apply K-means.

The application of K-means has been widely carried out in the multimedia field, for example for handwriting recognition, face recognition, and image segmentation [8]. K-means is also applied in the field of image segmentation, for example for the development of software applications for the reconstruction of 3D models of the heart and liver [9]. In addition, K-means is also applied in the field of dimension reduction by integrating SVM for diabetes diagnosis [10], where K-means is used to look for patterns.

In the K-means algorithm, the resulting center point depends on the choice of K, resulting in a decrease in the speed and quality of a cluster [2]. In this study, the research problem will be raised on choice K.

The researcher tries to solve the problem of choice K using several methods, namely Cross-Validation [3], The Cluster Center and The Nearest Neighbor Cluster (VCN) [4], Gap Statistics [5], and Cluster Number Assisted K-means. (CNAK). [6]. This method can solve the problem with choice K, but is not suitable for handling very large data sets, because it requires large storage space.

This study uses Particle Swarm Optimization (PSO), K-means, and Distance methods to overcome the problem of choosing a center point and streamline time when calculating the distance in each iteration, using a dataset from data.go.id, namely data on the volume of fishery production in Indonesia. Indonesia. Java Island.

The K-means algorithm is quite easy to implement [2] but has the disadvantage that the resulting center point depends on the choice of K, resulting in a decrease in the speed and quality of a cluster.

The Particle Swarm Optimization (PSO) algorithm is an optimization method that has been proven effective in solving the K problem [7]. In this study, Particle Swarm Optimization (PSO), K-means, and Distance will be applied to overcome the problem of K choice and save time in calculating the distance in each iteration by using a dataset from data.go.id, namely data on the volume of fishery production in Java Island.

II. Related Work

Based on [1] the goal is to obtain information to determine policies and assist the community in utilizing information on the potential and drawbacks of the fisheries sector in each district or city to develop business. This study using fuzzy k-means using a dataset of fishery production volume in East Java. The result of the research is that there are 3 clusters, cluster 1 is 9 districts/cities in East Java which is included in the lowest cluster of all clusters. Cluster 2 is 3 districts or cities in East Java that are included in the best cluster. Cluster 3, which is 26 districts or cities in East Java, is ranked second compared to other clusters.

Based on [4] the purpose of this study is to improve the quality to predict the number of K-means clusters if the selection of the resulting center point depends on the choice of K, numbering is done using cross-validation using an iris dataset which is split into 10 parts. The results of the research are quite consistent and can increase the speed and quality to predict the number of K-means clusters but are not suitable to be applied to big data.

Based on [5] the goal is to improve the quality to predict the number of K-means clusters if the selection of the resulting center point depends on the choice of K, numbering is done using the gap statistic, using k-means clustering via the gap statistics, and using the UCI dataset, namely iris, breast cancer, wine, vowel, and glass. The result is that it can improve the quality for predicting the number of K-means clusters but is not suitable to be applied to big data.

Based on [7] the purpose of this study is to improve the quality to predict the number of K-means clusters if the selection of the resulting center point depends on the choice of K. In this study using the Cluster Number Assisted K-means (CNAK) algorithm using the UCI dataset, namely iris, breast cancer, wine, vowel, and glass. The result is that it can improve the quality to predict the number of K-means clusters but it is less effective because it takes a long time.

Based on [2] the purpose of this study is to improve the quality for predicting the central point of K-means if the selection of the resulting center point depends on the choice of K, on nonlinear partition clustering. This study using FAPSO (fuzzy adaptive particle swarm optimization), ACO, and K-means using a benchmark dataset. The result is that the FAPSO (fuzzy adaptive particle swarm optimization) algorithm, ACO, and K-means have better performance than PSO, ACO, simulated annealing (SA), PSO and SA, ACO and SA, PSO and ACO, genetic algorithm (GA), tabu search (TS), honey bee mating optimization (HBMO) and k-means.

III. Methodology

3.1 Research method

The research method is the Cross-Industry Standard Process for Data Mining (CRISP-DM) cycle using 6 phases, namely:

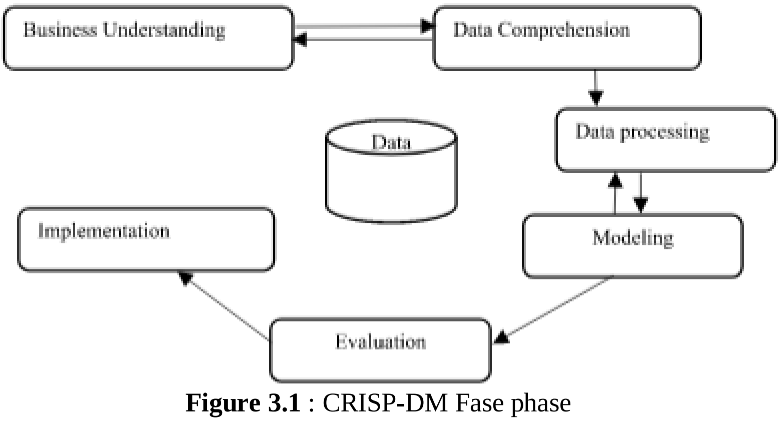


Figure 3.1 : CRISP-DM Fase phase

3.1.1 Business Understanding Phase

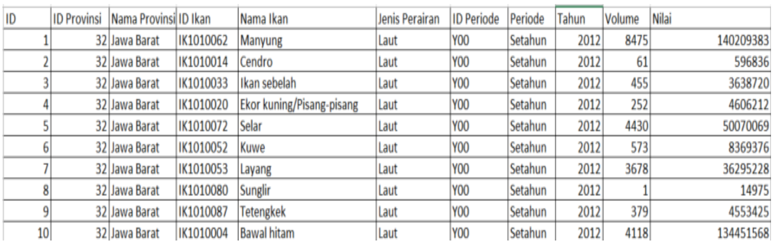
This study aims to apply the Particle Swarm Optimization (PSO), K-means and Distance methods. Where Particle Swarm Optimization (PSO) is used to automate the selection of numbering on K-means so as to further improve the quality of a cluster. K-means clustering is used to assist in grouping the data and Distances are used to streamline time when calculating the distance in each iteration, so as to increase the speed and quality of a cluster. If it is done manually, it takes a long time and is not necessarily accurate.

3.1.2 Data Comprehension Phase

The data used in this study are datasets from data.go.id, namely data on the volume of fishery production in Indonesia, which amounted to 76792 data, but to narrow the topic of discussion, based on the problem limitations, only fishery production volumes were used on the island of Java in 2012 so that only 315 were used. data.

3.1.3 Data Processing Phase

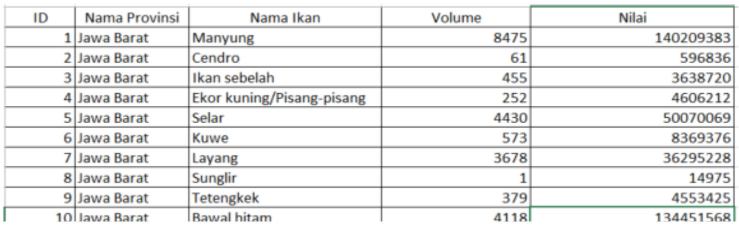
In this study, only 2 stages of data mining were used in the data processing phase, namely data cleaning and data selection. Data cleaning is used to remove empty data. The results of the data after cleaning:



ID	ID Provinsi	Nama Provinsi	ID Ikan	Nama Ikan	Jenis Perairan	ID Periode	Periode	Tahun	Volume	Nilai
1	32	Jawa Barat	IK1010062	Manyung	Laut	Y00	Setahun	2012	8475	140209383
2	32	Jawa Barat	IK1010014	Cendro	Laut	Y00	Setahun	2012	61	596836
3	32	Jawa Barat	IK1010033	Ikan sebelah	Laut	Y00	Setahun	2012	455	3638720
4	32	Jawa Barat	IK1010020	Ekor kuning/Pisang-pisang	Laut	Y00	Setahun	2012	252	4606212
5	32	Jawa Barat	IK1010072	Selar	Laut	Y00	Setahun	2012	4430	50070069
6	32	Jawa Barat	IK1010052	Kuwe	Laut	Y00	Setahun	2012	573	8369376
7	32	Jawa Barat	IK1010053	Layang	Laut	Y00	Setahun	2012	3678	36295228
8	32	Jawa Barat	IK1010080	Sunglir	Laut	Y00	Setahun	2012	1	14975
9	32	Jawa Barat	IK1010087	Tetengkek	Laut	Y00	Setahun	2012	379	4553425
10	32	Jawa Barat	IK1010004	Bawal hitam	Laut	Y00	Setahun	2012	4118	134451568

Figure 3.2 : Data after cleaning

After cleaning the data, the next process is data selection. This study using Particle Swarm Optimization (PSO). The following is the data after the selection process is carried out:



ID	Nama Provinsi	Nama Ikan	Volume	Nilai
1	Jawa Barat	Manyung	8475	140209383
2	Jawa Barat	Cendro	61	596836
3	Jawa Barat	Ikan sebelah	455	3638720
4	Jawa Barat	Ekor kuning/Pisang-pisang	252	4606212
5	Jawa Barat	Selar	4430	50070069
6	Jawa Barat	Kuwe	573	8369376
7	Jawa Barat	Layang	3678	36295228
8	Jawa Barat	Sunglir	1	14975
9	Jawa Barat	Tetengkek	379	4553425
10	Jawa Barat	Bawal hitam	4118	134451568

Figure 3.3 : Data after selection

3.1.4 Modeling Phase

The modeling phase is carried out by choosing a suitable modeling technique to be applied or implemented in the dataset from data.go.id, namely data on the volume of fishery

products on the island of Java, and adjusting the existing model rules which aim to optimize the results of this research. In this study, the most suitable algorithm used on the data is to automate the selection of the numbering on the K-means so as to further improve the quality of a cluster by using Particle Swarm Optimization (PSO), clustering using the K-means algorithm, and making time-efficient when calculating the distance to the data. each iteration using Distance.

3.1.5 Evaluation Phase

The evaluation phase process in this study uses the davies-Bouldin index (DBI), to calculate cluster performance in the K-means algorithm and the confusion matrix to calculate the accuracy of the K-means algorithm and Particle Swarm Optimization (PSO).

3.1.6 Implementation Phase

The stages in an analysis process are the first step, which is to determine what software will be used to measure the performance of the K-means and Particle Swarm Optimization (PSO) algorithms, perform data cleaning, select data using Particle Swarm Optimization (PSO), and perform testing of previously obtained data.

3.2 Experiment

The proposed method is the use of k-means to determine which provinces are entitled to receive assistance in the form of fish seeds to increase the volume of fishery products on the island of Java. To increase the speed and quality of clustering volume of fishery production in Java, the Particle Swarm Optimization (PSO) algorithm is used to automate the selection of numbering on K-means so as to further improve the quality of a cluster, and Distance is used to streamline time when calculating the distance in each iteration, So that it can increase the speed and quality of a cluster.

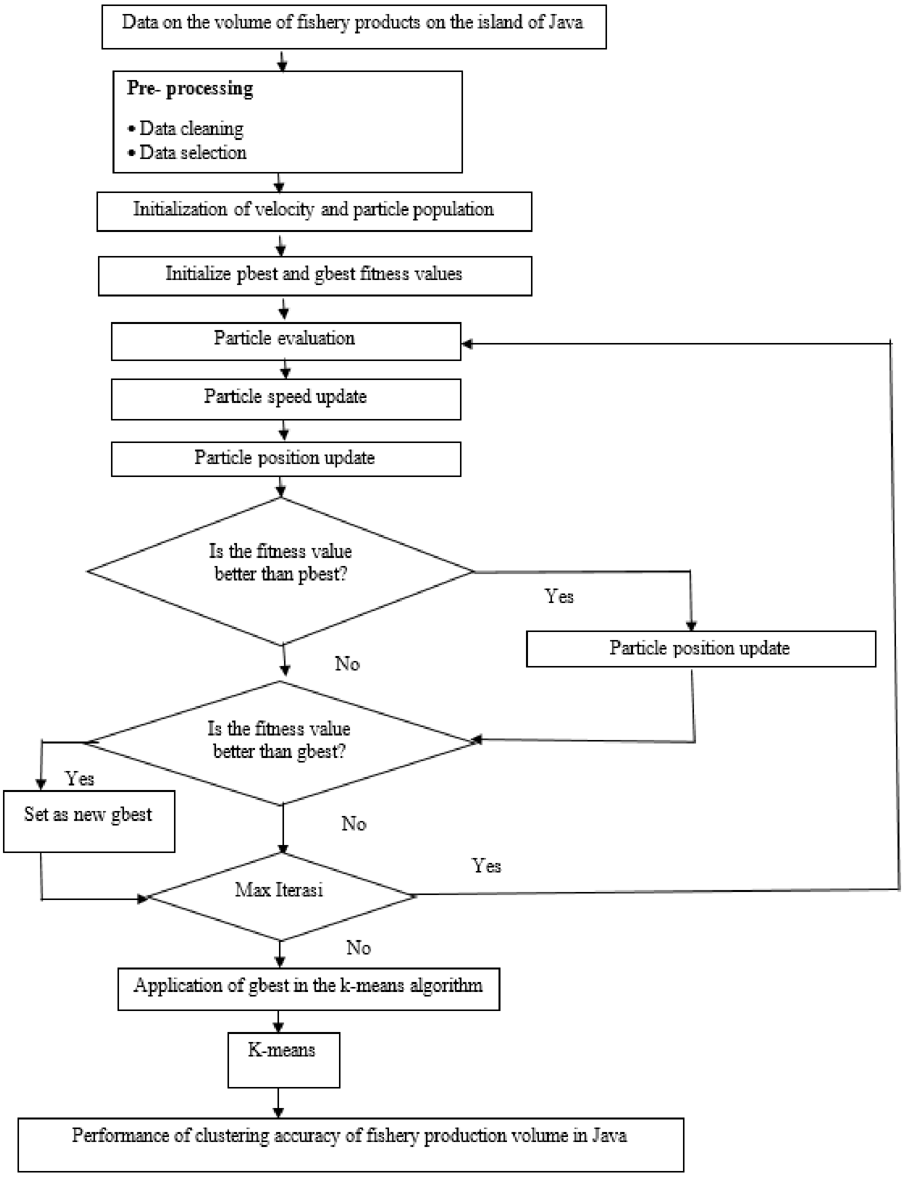

Data on the volume of fishery products on the island of Java
Pre- processing
• Data cleaning
• Data selection
Initialization of velocity and particle population
Initialize pbest and gbest fitness values
Particle evaluation
Particle speed update
Particle position update
Is the fitness value better than pbest?
Yes
Particle position update
No
Is the fitness value better than gbest?
Yes
Set as new gbest
No
Max Iterasi
Yes
No
Application of gbest in the k-means algorithm
K-means
Performance of clustering accuracy of fishery production volume in Java

Figure 3.1 : Experiment Steps

IV. Discussion

Here are the results of manual calculations, for example, when looking for id 1 and the name of the province of West Java, it will display id 1, the name of the province of West Java, the name of catfish, volume 8475, selling value 140209383 and one table id 1, data 1 is volume 8475, data 2 namely the selling value of 140209383, included in cluster 2 which is included in the medium category.

a. K-means Clustering Testing

Taken from data on the volume of fishery production based on random data, which amounted to three data used to find clustering results using the K-means algorithm, namely volume and selling value, namely:

M1 = data on id 1 in West Java province, the name of catfish which has a volume of 8475 and a selling value of 140209383

M2 = data on id 2 in West Java province, the name of cendro fish which has a volume of 61 and a selling value of 596836

M3 = data on id 29 in the province of West Java, the name of red snapper which has a volume of 5940 and a selling value of 234812448

The centroid of each cluster randomly

Table 4.1 : centroid of each cluster

Cluster	X1	X2
c1	100	400000
c2	8000	100000000
c3	5940	234812448

Enter the object to the nearest centroid, using the euclidian distance formula, where c1 is the low cluster, c2 is the medium cluster and c2 is the high cluster. Results of the 1st iteration:

Table 4.2 : the results of the 1st iteration

Cluster	Item
c1	M2
c2	M1
c3	M3

The new center point is obtained:

Table 4.3 : new center points

Cluster	X1	X2
c1	61	596836
c2	8475	140209383
c3	5940	234812448

Performed calculations using the euclidian distance formula using the new center point. Then the final result of the grouping of the training data iteration-2 is obtained:

Table 4.4 : final results of the 2nd iteration of clustering

Cluster	Item
c1	M2
c2	M1
c3	M3

Since no data has changed, the calculation is stopped.
Based on comparing the results of the K-means clustering calculation which is calculated manually and the results of the rapidminer 8.1 tools, it is appropriate.

b. Analysis of Research Results
After getting the results of the K-means clustering calculation and Particle Swarm Optimization (PSO) to get the label, it will be validated using classification with the K-NN algorithm, then the analysis of the research results is carried out using a confusion matrix to find accuracy in the training data by using as many as test data. 315 data, namely:
Accuracy = ((TP + TN))/(Number of cases) x 100% = 308/315 x 100% = 97.78%
K-means algorithm and Particle Swarm Optimization (PSO) validated by classification using the Naïve Bayes algorithm:
Accuracy = ((TP + TN))/(Number of cases) x 100% = 304/315 x 100% = 96.50%
The K-means algorithm is validated by classification using the K-NN algorithm:
Accuracy = ((TP + TN))/(Number of cases) x 100% = 250/315 x 100% = 79.36%
The K-means algorithm is validated by classification using the Decision Tree algorithm:
Accuracy = ((TP + TN))/(Number of cases) x 100% = 240/315 x 100% = 76.19%
Based on the results of the above calculations, it can be concluded that clustering using the K-means algorithm and Particle Swarm Optimization (PSO) has high accuracy when applied to fishery production volume data.

c. K-means Evaluation

In this final project, the Davies-Bouldin Index (DBI) matrix is used. Taken from fishery production volume data based on three random data, which are used to find clustering results using the K-means and Particle Swarm Optimization (PSO) algorithm, namely the volume and selling value as follows:

M1 = data on id 1 in West Java province, the name of catfish which has a volume of 8475 and a selling value of 140209383

M2 = data on id 2 in West Java province, the name of cendro fish which has a volume of 61 and a selling value of 596836

M3 = data on id 29 in the province of West Java, the name of red snapper which has a volume of 5940 and a selling value of 234812448

The training data used will be divided into 3 clusters (c1, c2, and c3)

Table 4.5 : SSW

Data ke-i	Fitur		Klaster	Centroid		Jarak ke centroid	SSW
	Volume	Nilai jual		Volume	Nilai jual		
2	61	596836	1	100	400000	196836,0039	196836,0039
1	8475	140209383	2	8000	100000000	40209383	40209383
3	5940	234812448	3	5940	234812448	0	0

Table 4.6 : SSB

	SSB	Data ke-i		
		1	2	3
Data ke-i	1	0	99600000,31	234412448,1
	2	99600000,31	0	134812448
	3	234412448,1	134812448	0

Table 4.7 : DBI

	R	1	2	3	Rmax	DBI
Data ke-i	1	0	0,405685	0,000840	0,405685	0,3698 77333
	2	0,405685	0	0,298262	0,405685	
	3	0,000840	0,298262	0	0,298262	

Table 4.8 : DBI Comparison

Algoritma	DBI
K-means	0,531
K-means + PSO	0,369877333
K-means + SOM	0,864

Based on the results of the calculations above, it can be concluded that the cluster that uses the K-means algorithm and Particle Swarm Optimization (PSO) is included in the good cluster category because the SSW and DBI values are small, namely non-negative ≥ 0.

V. Conclusion

This research was successful because the results of the accuracy calculation using the confusion matrix were 97.78% which was included in the high category and the Davies-Bouldin Index (DBI) value was 0.369877333 which was included in the good cluster category.

References

[1]. Rakhlin, A., & Caponnetto, A. (n.d.). Stability of K -Means Clustering.

[2]. Tibshirani, R., Walther, G., & Hastie, T. (2001). Estimating the number of data clusters via the gap statistic. In Journal of the Royal Statistical Society: Series B (Vol. 63, Issue Part 2, pp. 411–423).

[3]. Wang, J. (2010). Consistent selection of the number of clusters via crossvalidation. Biometrika, 97(4), 893–904. https://doi.org/10.1093/biomet/asq061

[4]. Saha, J., & Mukherjee, J. (2021). CNAK: Cluster number assisted K-means. Pattern Recognition, 110, 107625. https://doi.org/10.1016/j.patcog.2020.107625

[5]. Informatics, S., Na, S., & Xumin, L. (2010). Research on k-means Clustering Algorithm. 63–[1] Wulandari, S. A., Prasetyanto, W. A., & Kurniatie, M. D. (2019). Classification of Normal, Oily and Dry Skin Types Using a 4-Connectivity and 8-Connectivity Region Properties Based on Average Characteristics of Bound. TRANSFORMTIKA, 78-87.

[6]. Kusrini, & Luthfi, E. T. (2009). Algoritma Data Mining. Yogyakarta: Penerbit ANDI Yogyaka

[7]. Prasetyo, E. (2012). Data Mining - Konsep dan Aplikasi Menggunakan MATLAB. Gresik: Penerbit ANDI Yogyakarta.

[8]. Metisen, B. M., & Sari, H. L. (2015). Analisis Clustering Menggunakan Metode K-means dalam Pengelompokkan Penjualan Produk pada Swalayan Fadhila. Jurnal Media Infotama, Volume 11, Nomor 2, 110-118.

[9]. Ong, J. O. (2013). Implementasi Algoritma K-means Clustering untuk Menentukan Strategi Marketing President University. Jurnal Ilmiah Teknik Industri, Volume 12, Nomor 1, 10-20.

[10]. Kristanto, N. H., L.A, A. C., & S., H. B. (2016). Implementasi K-means Clustering untuk Pengelompokkan Analisis Rasio Profitabilitas dalam Working Capital. JUISI, Volume 2, Nomor 1, 9-15.

[11]. Muningsih, E., & Kiswati, S. (2015). Penerapan Metode K-means untuk Clustering Produk Online Shop dalam Penentuan Stok Barang. Jurnal Bianglala Informatika, Volume 3, Nomor 1, 10-1767. https://doi.org/10.1109/IITSI.2010.74

Nur Syahrani Majdina, et. al. "Application of Particle Swarm Optimization (PSO) to Improve K-means Accuracy in Clustering Eligible Province to Receive Fish Seed Assistance in Java." *IOSR Journal of Computer Engineering (IOSR-JCE)*, 24(1), 2022, pp. 43-49.