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CLUSTERING OF FISHERY MANAGEMENT AREAS BASED ON THE LEVEL OF UTILIZATION IN INDONESIA

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Abstract: Indonesian territorial waters have abundant and diverse fishery resources. Based on the Minister of Marine Affairs and Fisheries Regulation, Indonesian Fisheries Management Areas (FMA) are divided into 11 regions to achieve optimal and sustainable use in fisheries management that ensures the sustainability of fish resources and the environment throughout Indonesia. This study is aimed at evaluating the similarities in the characteristics of eleven FMA of the Republic of Indonesia in 2017 based on the level of utilization of fishery resources by forming clusters of fisheries resource utilization levels in the Indonesian State Fisheries Management Area and applying descriptive analysis. The method used is the agglomerative hierarchical cluster method with calculations based on the distance between clusters. In general, it can be concluded that among the two clusters formed using the average linkage method, the highest level of fisheries resource utilization is in the second cluster, namely at FMA 571, FMA 572, and FMA 573 with an average utilization rate of 0.925.

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1. INTRODUCTION

Indonesia is the largest archipelago country in the world with a very strategic geographical position. Ministry of Marine Affairs and Fisheries of Indonesia said that the number of islands in Indonesia, officially recorded, reaches 17,162 islands, spread from Sabang to Merauke with extraordinary natural wealth. Indonesia also has a coastal state whose components of the national territory consist of land, oceans (waters) and air space. Two-thirds of the total area of Indonesia is a sea of 3.544 million km^2. Not only that, Indonesia's coastline with a length of 104,000 km is the second-longest in the world after Canada [1].

The marine and fisheries sector can be a path for Indonesians to prosperity with the availability of great potential (odyssey to prosperity). This is because the fisheries sector is one of the main sectors that will deliver Indonesia as a country with a developed economy by 2030. Therefore, sustainable management of fish resources is needed to make it happen [2].

Fishery resources need to be managed in a correct and appropriate way because they are one of the renewable biological resources, but they can also experience depletion or extinction [3]. Reproductive factors, fish growth, migration, emigration, natural mortality, and mortality due to fishing activities are phenomena that result in changes in the potential of fishery resources every year [4].

Currently, fishing for fish resources in Indonesia is still open access. Hence, it might cause overfishing problems and habitat destruction [5]. These problems will affect the sustainable potential and the results of efforts to fishery resources utilization in Indonesian waters. The level of utilization in the condition of fishery resources in certain water can be predicted and known so that exploitation that exceeds its sustainable potential can also be known.

Indonesian territorial waters have abundant and diverse fishery resources. Based on the Minister of Marine Affairs and Fisheries Regulation, Indonesian Fisheries Management Areas (FMA) are divided into 11 regions shown in Table 1.

Table 1. Indonesian Fisheries Management Areas (FMA)

FMA Number	Location
571	Malacca Strait – Andaman Sea
572	Indian Ocean (West of Sumatera) – Sunda Strait
573	Indian Ocean (South of Java) – South of Nusa Tenggara – Sawu Sea – West of Timor Sea
711	Karimata Strait – Natuna Island – South China Sea
712	Java Sea
713	Makassar Strait – Bone Bay – Flores Sea – Bali Sea
714	Tolo Bay – Banda Sea
715	Tomini Bay – Maluku Sea – Halmahera Sea – Seram Sea – Berau Bay
716	Sulawesi Sea – North of Halmahera
717	Cendrawasih Bay – Pacific Ocean
718	Aru Sea – Arafuru Sea – East of Timor Sea

The division of this area aims to achieve optimal and sustainable use in fisheries management that ensures the sustainability of fish resources and the environment throughout Indonesia. In addition, FMA includes functions as a basis for estimating potential, conservation efforts, control processes, and supervision of fish resources. FMA of the Republic of Indonesia is prepared based on the characteristics, diversity of fish resources, rules of sea toponym, seabed morphological conditions, and Indonesia's maritime boundaries.

Each area has several different potential resources and management. According to the Decree of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia Number 50/Kepmen–Kp/2017 concerning Potential Estimation, Number of Permitted Catches, and Utilization Level of Fish Resources in the Fisheries Management Area of the Republic of Indonesia, fishery resources caught in the FMA are classified into nine groups, such as squid, demersal fish, reef fish, large pelagic fish, small pelagic fish, crab, lobster, crab, and penaeid shrimp. The following is data regarding the estimated potential of fish resources in Indonesia (million tonnes/year).

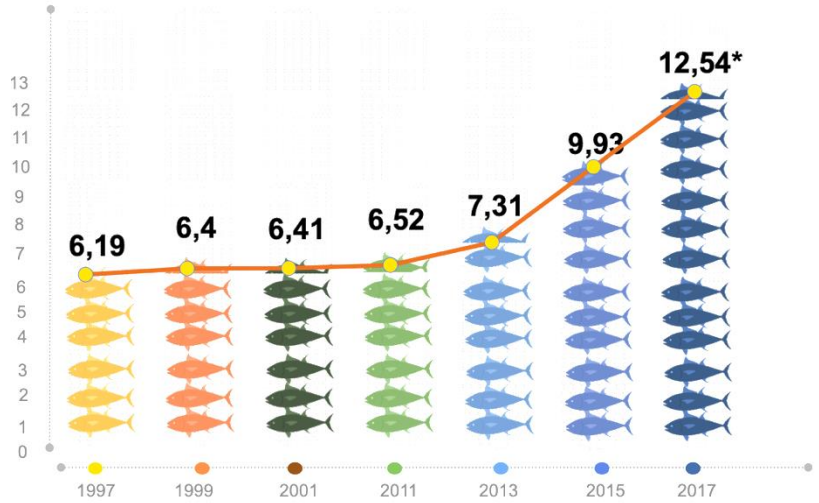

Figure 1. Potential Figures of Fish Resources in Indonesia (million tonnes/year)
Source: Kepmen KP No. 50/KEPMEN-KP/2017

Evaluation of the utilization level of fish resource utilization in each FMA of the Republic of Indonesia needs to be carried out in order to achieve sustainability and utilization. The level of total use is symbolized by the letter E, i.e. with a value of $E \geq 1$ indicating the status of overfishing or over-exploited (limitation efforts must be reduced), a value of $0.5 < E < 1$ indicates that the status is fully exploited (maintenance efforts are maintained with strict monitoring), and E value < 0.5 indicates the moderate status (fishing effort can be added) [5].

In line with the large potential of fish resources, both capture fisheries and aquaculture, which are reflected in each FMA, Indonesia is faced with various challenges in utilization and management [6]. Therefore, this study is aimed at evaluating the similarities in the characteristics of eleven FMA of the Republic of Indonesia in 2017 based on the level of utilization of fishery resources. Thus, it is hoped that the results of this research can be taken into consideration by the government to optimize the FMA of the Republic of Indonesia in the utilization and management of its fishery resources, especially in the capture fisheries sector in Indonesia.

Fisheries system management consists of three dimensions that are related to one another, namely (1) dimensions of fishery resources and their ecosystems; (2) dimensions of the utilization of fishery resources for the socio-economic interests of the community; and (3) the dimensions of fisheries policy itself [7]. Related to these three dimensions, fisheries management is currently not

balanced in the implementation, where the interests of utilization for the social and economic welfare of the community are still considered to be greater when compared to other dimensions.

According to fisheries management policies in Indonesia, the territorial waters of Indonesia that spread from the Malacca Strait in western Indonesia to the Arafura Sea in eastern Indonesia are divided into eleven Fisheries Management Areas of the Republic of Indonesia. This division of territory can become the basis for fisheries governance in Indonesia, which is expected to become an area for implementing an ecosystem approach in fisheries management. Fisheries with an ecosystem approach that adopts all three dimensions are needed for the sustainability of resources and the welfare of coastal communities.

Based on the Minister of Marine Affairs and Fisheries Regulation, the State Fisheries Management Area of the Republic of Indonesia consists of eleven regions where the area is arranged based on characteristics, diversity of fish resources, rules of sea toponym, seabed morphological conditions, and Indonesia's maritime boundaries [8]. The numbering and naming are in accordance with the International Maritime Organization (IMO), the International Hydrographic Organization (IHO), and the Food and Agriculture Organization (FAO). Indonesian marine waters are in two areas, namely area 57 (Indian Ocean, Eastern) and area 71 (Pacific, The Western Central).

Figure 2. 11 Fisheries Management Area of the Republic of Indonesia
Source: maritimenews.com

FMA of the Republic of Indonesia, which begins with numbering 57, consists of three regions, namely FMA 571 (Malacca Strait and the Andaman Sea), FMA 572 (Indian Ocean (West of Sumatera) and Sunda Strait), and FMA 573 (Indian Ocean (South of Java), South of Nusa Tenggara, Sawu Sea, and West of Timor Sea).

FMA of the Republic of Indonesia which starts with numbering 71 consists of eight regions, namely FMA 711 (Karimata Strait, Natuna Sea and South China Sea), FMA 712 (Java Sea), FMA 713 (Makassar Strait, Bone Bay , Flores Sea and Bali Sea), FMA 714 (Tolo Bay and Banda Sea), FMA 715 (Tomini Bay, Maluku Sea, Halmahera Sea, Seram Sea, and Berau Bay), FMA 716 (Sulawesi Sea and North of Halmahera Island), FMA 717 (Cenderawasih Bay and Pacific Ocean), and FMA 718 (Aru Sea, Arafuru Sea, and East Timor Sea).

Each Fishery Management Area is assumed to be one stock unit, so it must be managed jointly by the surrounding administrative areas. With joint management, it is ensured that management implementation will run well and goals will be achieved. The fishery resource commodities caught in the FMA are classified into nine groups, namely squid, demersal fish, reef fish, large pelagic fish, small pelagic fish, crabs, lobsters, small crabs, and penaeid shrimp. The level of utilization of fishery resources is divided into three states, namely overfishing or over-exploited, fully-exploited, and moderate [9]. The criteria for determining the level of utilization of the three states can be seen in Table 2.

Table 2. The Criteria for Determining the Level of Utilization

Level of Utilization (E)	States
$E \geq 1$	*Overfishing* or *over-exploited*
$0,5 < E < 1$	*Fully-exploited*
$E < 0,5$	*Moderate*

Based on data from the Statistics of the Ministry of Marine Affairs and Fisheries of the Republic of Indonesia, it is stated that the utilization of fishery resources in Indonesia is already in an irrational phase and results in threats to the long-term sustainability of fishery resources in

Indonesia. This is caused by the pattern of fisheries resource management in its implementation is not based on sustainability principles and research results. Rationally, the consequences that will occur if this is not followed up are degradation of stocks and threat to fishermen's welfare.

This study is aimed to form clusters of fisheries resource utilization levels in the Indonesian State Fisheries Management Area by applying descriptive analysis. The method used is the agglomerative hierarchical cluster method with calculations based on the distance between clusters. The agglomerative hierarchical cluster method consists of four types of grouping procedures, namely Single Linkage (based on the closest distance), Complete Linkage (based on the farthest distance), Average Linkage (based on the average distance), and Ward's Method (based on sum squares of error). The analysis was done by using R software.

The results of the agglomerative hierarchical cluster method can be visualized in the form of a diagram called a dendrogram. Dendrogram describes the merging or division of clusters that will be made at successive levels. It is important to cluster the level of utilization of fishery resources in the Fisheries Management Area of the Republic of Indonesia in order to assist related parties in making appropriate plans and policies.

2. RESEARCH METHODOLOGY

2.1. Data Collection

The data used in this study is secondary data sourced from the Ministry of Marine Affairs and Fisheries of the Republic of Indonesia Statistics published by the Center of Data, Statistics and Information of the Ministry of Marine Affairs and Fisheries.

2.2. Research Variables

The data “The Level of Fishery Resources Utilization in the State Fisheries Management Area (FMA) of the Republic of Indonesia 2017” describes the level of utilization of fishery resources in eleven State Fisheries Management Areas of the Republic of Indonesia from various commodities based on the Decree of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia Number 50/Kepmen-Kp/2017 shown in Table 3.

Table 3. Research Variables

Variables	Commodity
X_1	Squid
X_2	Demersal Fish
X_3	Reef Fish
X_4	Large Pelagic Fish
X_5	Small Pelagic Fish
X_6	Crab
X_7	Lobster
X_8	Rajungan
X_9	Penaeid Shrimp

2.3. Agglomerative Hierarchy Cluster Analysis

One of the multivariate analysis methods aimed at grouping is cluster analysis. The characteristic of cluster analysis is that there's no distinction between independent and dependent variables. Cluster analysis has the main objective of grouping based on the similarities of characteristics of objects for each group. Cluster formation is carried out based on the level of closeness of the relationship between objects [10]. The proximity measurement tool used in cluster analysis is the Euclidean distance, where the smaller the distance between an object and another object, the greater the similarity of the individual [11].

In cluster analysis, two assumptions must be fulfilled, namely a representative sample (able to represent the population well) and there should be no indication of multicollinearity problems (linear relationships that occur between each variable), while assumptions such as normality, linearity, and homoscedasticity do not have much effect. Multicollinearity can be seen from the Variance Inflation Factor (VIF) value, with the criteria that if the VIF value exceeds the number 10, it can be concluded that there is multicollinearity [11].

Cluster analysis with a hierarchical approach applies similar data groupings to the same hierarchy, while dissimilar data is grouped in a somewhat distant hierarchy. The hierarchical cluster method

is a method grouping with the number of clusters that will be made is unknown. The number of clusters determination depends on the subjectivity of the researcher by looking only at the dendrogram [12]. Clustering in the agglomerative method (sequential merging) is carried out from N (amount of data) clusters into one cluster [13]. The techniques in this method are differentiated according to the procedure for calculating the level of object similarity, consisting of Single Linkage, Complete Linkage, Average Linkage, and Ward's Method.

2.3.1. Single Linkage

The single Linkage clustering method is based on the closest distance between objects. Two objects such as U and V which are separated by a short distance will merge into one cluster W and so on.

$$D = \{d_{ik}\}$$

$$d_{UV(W)} = min\{d_{UW}, d_{VW}\}$$

where

d_{ik} : The distance between the ith object in the cluster (UV) and the kth object in the cluster

d_{UW} : The distance between U object and cluster W

d_{VW} : The distance between V object and cluster W

2.3.2. Complete Linkage

The Complete Linkage clustering method is based on the farthest distance between the objects. Two objects, for example, U and V, which are separated by a large distance, will merge into one cluster W and so forth.

$$D = \{d_{ik}\}$$

$$d_{UV(W)} = max\{d_{UW}, d_{VW}\}$$

where

d_{ik} : The distance between the ith object in the cluster (UV) and the kth object in the cluster

d_{UW} : The distance between U object and cluster W

d_{VW} : The distance between V object and cluster W

2.3.3. Average Linkage

The Average Linkage clustering method is based on the average distance between two clusters, for

example, the UV cluster (a possible pair of observations in one cluster) and W (observations in another cluster).

$$d_{UV(W)} = \frac{\Sigma_i \Sigma_k d_{ik}}{N_{(UV)} N_W}$$

where

d_{ik} : The distance between the i[th] object in the cluster (UV) and the k[th] object in the cluster

$N_{(UV)}$: Number of observations in UV cluster

N_W : Number of observations in W cluster

2.3.4. Ward's Method

Ward's method of clustering is based on calculating the distance between clusters by minimizing the sum squares of error using the variance analysis approach.

$$JKE = \sum_{j=1}^{k} \left(\sum_{i=1}^{n_j} X_{ij}^2 - \frac{1}{n_j} \left(\sum_{i=1}^{n_j} X_{ij} \right) \right)$$

where

X_{ij} : The value of the i[th] object in the j[th] cluster

k : Number of clusters at each stage

n : Number of objects in the j[th] cluster

After performing the clustering process with four grouping procedures, the next step is to test the validity of the cluster. This test is carried out to see the level of accuracy of the results of the cluster analysis that has been done. The measure used is the cophenetic correlation coefficient. The cophenetic correlation coefficient is the correlation coefficient between the original elements of the Euclidean distance matrix and the elements produced by the cophenetic matrix [14] with the following calculation formula.

$$r_{Coph} = \frac{\sum_{i<k} (d_{ik} - \bar{d})(d_{c_{ik}} - \bar{d}_c)}{\sqrt{\left[\sum_{i<k} (d_{ik} - \bar{d})^2\right] \left[\sum_{i<k} (d_{c_{ik}} - \bar{d}_c)^2\right]}}$$

where

r_{Coph} : cophenetic correlation coefficient

d_{ik} : the original distance (Euclidean distance) between object *i* and *k*

$\bar{d}$: average d_{ik}

$d_{c_{ik}}$: *cophenetic* distance of object *i* and *k*

$\bar{d}_c$: average $d_{c_{ik}}$

3. RESULT AND DISCUSSION

Based on the data "The Level of Fishery Resources Utilization in the State Fisheries Management Area (FMA) of the Republic of Indonesia 2017" will be carried out an agglomerative hierarchy cluster analysis using several grouping procedures, namely Single Linkage, Complete Linkage, Average Linkage, and Ward's Method, the analysis is as follows.

3.1. Multicollinearity Problem Detection

Multicollinearity is a phenomenon where there is a correlation or a strong linear relationship between the independent variables. One of the methods used to detect multicollinearity problems is the Variance Inflation Factor (VIF). The decision criterion in detecting multicollinearity problems is that if the VIF value is < 10, then there is no indication of multicollinearity. However, if the VIF value is > 10, then there is an indication of multicollinearity.

Tabel 4. Variance Inflation Factor (VIF) Values for each Variable

Commodity	VIF
Squid	1,786658
Demersal Fish	4,517070
Reef Fish	9,273301
Large Pelagic Fish	3,169652
Small Pelagic Fish	3,419127
Crab	6,668299
Lobster	4,947191
Rajungan	3,950637
Penaeid Shrimp	5,450808

Based on Table 4, it can be seen that the VIF value of each variable does not exceed 10. Furthermore, it can be concluded that the data "The Level of Fishery Resources Utilization in the State FMA of the Republic of Indonesia 2017" does not show indications of multicollinearity. Thus, hierarchical cluster analysis with agglomerative methods can be continued.

3.2. Determining the Measure of Distance between Data

The distance of each object (nine fishery resource commodities) can be calculated using the Euclidean distance. The criterion is that the smaller the distance between two objects, the more similar the two objects are.

Table 5. Tables of Euclidean Distance from Proximity Matrix Table

	1	2	3	4	5	6	7	8	9	10
2	1.1878131									
3	1.5986870	1.5880491								
4	2.2932946	2.6132164	1.6940484							
5	1.8977355	2.0714005	1.9167159	1.6642115						
6	1.8282779	1.9905024	1.6801786	1.3018448	1.4331085					
7	1.5987495	2.1176638	2.4467530	2.0194554	1.6531183	1.3538833				
8	1.5651837	2.0983565	1.9300259	1.6037456	1.4132233	1.5085092	1.3301128			
9	2.0201485	1.8883591	1.7761194	1.4747203	1.1984991	1.3550646	1.7628953	1.7447063		
10	1.4954932	1.7472264	1.6732902	1.3448048	1.5037619	1.0618380	1.1487820	1.1472140	1.1913438	
11	1.4482058	1.5261717	1.5155527	1.3645146	0.9968450	0.9862555	1.2329234	1.2238055	0.9026073	0.7315736

Based on Table 5. Above, is shown the distance between two variables, namely fishery resource commodities based on Euclidean size. The smaller the value, the more similar the two variables are.

3.3. Hierarchy Clustering Process with Agglomerative Method

Hierarchical cluster analysis with agglomerative method consists of four types of grouping procedures, namely Single Linkage, Complete Linkage, Average Linkage, and Ward's Method. Of

the four groupings, it will be determined which grouping procedure is most suitable in forming clusters of the eleven State Fisheries Management Areas (FMA) of the Republic of Indonesia. Determination of the most appropriate grouping procedure is seen from the value of the largest cophenetic correlation coefficient or the one closest to value one.

The following are the results of hierarchical cluster analysis with an agglomerative method using four grouping procedures, namely Single Linkage, Complete Linkage, Average Linkage, and Ward's Method.

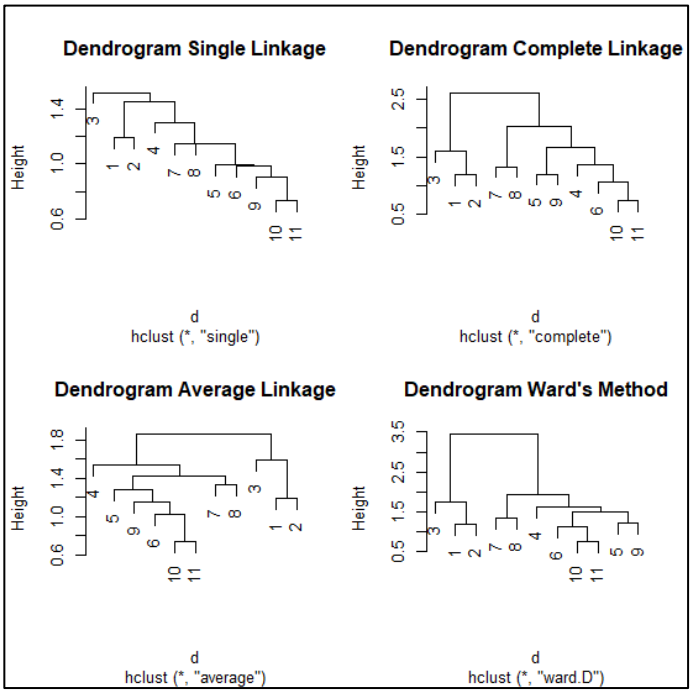

Figure 3. Dendrogram of Each Method

3.4. Determination of the Best Clustering Method

Based on the cluster results obtained, the cophenetic correlation coefficient is used to determine the best clustering method provided that if the cophenetic correlation coefficient is close to the value of one, the solution generated from the clustering process is quite good and representative.

Table 6. Cophenetic Correlation Results

Single Linkage	*Complete Linkage*	*Average Linkage*	*Ward's Method*
0,7284312	0,7266451	0,768267	0,7285214

Based on Table 6, the results show that the highest cophenetic correlation value is in the average linkage method with a value of 0.768267. Therefore, it can be said that the average linkage method is the best and representative cluster method of the data.

3.5. Fishery Management Areas (FMA) Grouping using Average Linkage Method

The grouping of Fisheries Management Areas (FMA) of the Republic of Indonesia using the average linkage method can be seen in Table 7.

Table 7. Fishery Management Areas (FMA) Grouping

No.	FMA	4 Clusters	3 Clusters	2 Clusters
1.	FMA 571	4	3	2
2.	FMA 572	4	3	2
3.	FMA 573	3	2	2
4.	FMA 711	1	1	1
5.	FMA 712	2	1	1
6.	FMA 713	2	1	1
7.	FMA 714	2	1	1
8.	FMA 715	2	1	1
9.	FMA 716	2	1	1
10	FMA 717	2	1	1
11.	FMA 718	2	1	1

In Table 7, it can be seen the process of grouping the Fisheries Management Areas (FMA) of the Republic of Indonesia based on the level of utilization of fishery resources, as follows:

1. If 4 clusters are formed, then cluster 1 consists of FMA 711. For cluster 2 consists of FMA 712, FMA 713, FMA 714, FMA 715, FMA 716, FMA 717, and FMA 718. For cluster 3 consists of FMA 573. For clusters 4 consisting of FMA 571 and FMA 572.
2. If 3 clusters are formed, then cluster 1 consists of FMA 711, FMA 712, FMA 713, FMA 714, FMA 715, FMA 716, FMA 717, and FMA 718. For cluster 2, its members consist of FMA 571. and FMA 572.

3. If 2 clusters are formed, then cluster 1 consists of FMA 711, FMA 712, FMA 713, FMA 714, FMA 715, FMA 716, FMA 717, and FMA 718. For cluster 2, the members are FMA 571, FMA 572 and FMA 573.

Furthermore, the visualization of a grouping of Fisheries Management Areas (FMA) of the Republic of Indonesia using dendrogram can be seen in Figure 4.

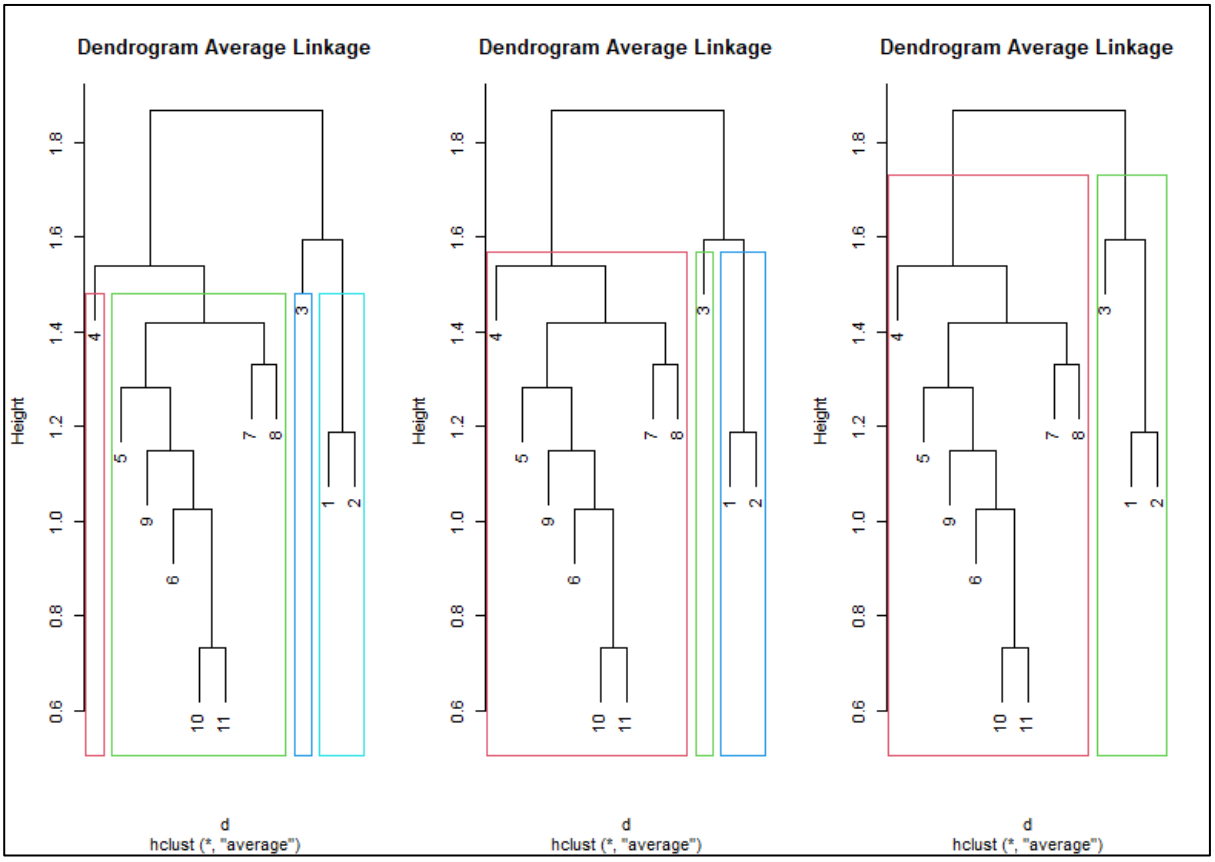

Figure 4. Dendrogram of Fisheries Management Areas (FMA) using Average Linkage Method

Based on the cluster formation on the data "The Level of Fishery Resources Utilization in the State Fisheries Management Area (FMA) of the Republic of Indonesia 2017" which has been carried out, namely with 4 clusters, 3 clusters, and 2 clusters, it can be seen that the optimal number of clusters can represent the level of similarity between variables in each FMA of the Republic of Indonesia is two clusters. This is illustrated in the two-cluster dendrogram showing two initial branches according to the presence of Indonesian marine waters in two areas, namely area 57 (Indian Ocean, Eastern) and area 71 (Pacific, The Western Central).

In the formation of the two clusters, FMA 571, FMA 572 and FMA 573 are included in cluster 2, while FMA 711, FMA 712, FMA 713, FMA 714, FMA 715, FMA 716, FMA 717, and FMA 718 are included in cluster 1. This clustering is based on the level of similarity between variables in each FMA of the Republic of Indonesia, namely at the level of utilization (E) of the fishery resources which are included in the over-exploited category with an indicator value of $E \geq 1$. The most different characteristics between the two clusters are:

1. In Cluster 1, the highest level of utilization is in the squid, reef fish, large pelagic fish, small pelagic fish, crabs, lobsters and small crabs commodity.
2. In cluster 2, the highest level of utilization is in the penaeid shrimp commodity.

The similarity in the level of utilization of fishery resources in each cluster is based on the division of the FMA, namely area 57 (Indian Ocean, Eastern) and area 71 (Pacific, The Western Central). In area 57, the spreading area for penaeid shrimp is quite wide, but the level of utilization is also quite high without optimal management and supervision from related parties. This resulted in a high level of exploitation of penaeid shrimp in FMA 57. In area 71, the widest distribution area for fishery resources is squid, which has a very high level of utilization. This is indicated by the exploitation of squid in all FMA in area 71. A fairly high level of exploitation also occurs in other fishery resource commodities, except for demersal fish commodities because exploitation does not occur in these commodities. Thus, a demersal fish commodity is not a differentiator characteristic in the FMA of the Republic of Indonesia clusters.

3.6. Profiling of Cluster Analysis Results with Average Linkage Method

Table 8. Cluster's Profile with Average Linkage Method

Cluster	Number of Members	Average									Average
		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	
1	8	0,707	0,430	0,587	0,843	0,943	0,487	0,947	0,800	1,607	0,817
2	3	1,462	0,589	1,069	0,883	0,754	0,933	1,139	0,849	0,644	0,925

Table 8 provides information that the average value for each variable in each cluster can be interpreted as follows.

1. Cluster 1 consists of 8 FMAs where this cluster has a high average utilization rate in the variables of small pelagic fish and penaeid shrimp, while the variables are squid, demersal fish, reef fish, large pelagic fish, crab, lobster, and rajungan has a relatively lower average when compared to FMA in the other clusters.
2. Cluster 2 consists of 2 FMAs where this cluster has a high average utilization rate in the variables of squid, demersal fish, reef fish, large pelagic fish, crab, lobster, and rajungan, while the variables are small pelagic fish and penaeid shrimp has a relatively lower average when compared to FMA in the other clusters.

In general, it can be concluded that among the two clusters formed using the average linkage method, the highest level of fisheries resource utilization is in the second cluster, namely at FMA 571, FMA 572, and FMA 573 with an average utilization rate of 0.925.

4. CONCLUSION

Based on the results of analysis and discussion, we can conclude that:

1. Cluster analysis using agglomerative hierarchy method for the classification of eleven Fishery Management Areas (FMA) of the Republic of Indonesia based on the level of utilization of fishery resources is carried out using four grouping procedures, namely Single Linkage, Complete Linkage, Average Linkage, and Ward's Method. Based on the resulting cophenetic correlation coefficient, the highest value is found in the average linkage method, so it can be said that the average linkage method is the best and representative cluster method for the data.
2. The number of clusters formed from the average linkage grouping procedure is two clusters, namely cluster 1 consisting of FMA 711, FMA 712, FMA 713, FMA 714, FMA 715, FMA 716, FMA 717, and FMA 718. Cluster 2 consists of FMA 571, FMA 572, and FMA 573.
3. The results of the average calculation for each variable in each cluster show that the highest level of fishery resource utilization is in cluster two that is consist of FMA 571 (Malacca

Strait and the Andaman Sea), FMA 572 (Indian Ocean (West of Sumatera) and Sunda Strait), and FMA 573 (Indian Ocean (South of Java), South of Nusa Tenggara, Sawu Sea, and West of Timor Sea).

The results of the analysis that the highest level of fishery resource utilization is in cluster two consisting of FMA 571 (Malacca Strait and the Andaman Sea), FMA 572 (Indian Ocean (West of Sumatera) and Sunda Strait), and FMA 573 (Indian Ocean (South of Java), South of Nusa Tenggara, Sawu Sea, and West of Timor Sea) it is recommended for parties and related institutions to further develop attention and supervision of the region. This aims to optimize the utilization rate of fishery resources which consists of nine commodities, namely squid, demersal fish, reef fish, large pelagic fish, small pelagic fish, crab, lobster, rajungan, and penaeid shrimp so that their sustainability can be properly maintained without the occurrence of overexploitation.

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CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests.

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