Application of The Hierarchical Cluster Method in Analyzing The Characteristics of Parenting Patterns for Early Childhood in Indonesia

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Abstract: Improving the quality of human resources through education is one of the government's focuses in realizing the Indonesian golden generation and is one of the goals of the Sustainable Development Goals. This can be realized starting from early childhood development. The application of parenting to early childhood greatly affects the growth and development of children in the future. Therefore, a study was conducted to analyze the characteristics of parenting patterns for early childhood in Indonesia using the hierarchical cluster method. The hierarchical cluster method used is Single Linkage, Complete Linkage, Average Linkage, and Ward. The cluster results from the four methods were compared for each number of clusters to determine the best cluster result based on the Pseudo-F value and icd rate. The results showed that the Average Linkage method with 5 clusters was the best cluster result. This shows that 5 regional groups have different characteristics of parenting patterns for early childhood according to the characteristics of the activities parents do with their children. Thus, parents can apply the ideal parenting pattern for early childhood according to the characteristics of their respective regions to produce a young generation that excels in the future.

Keywords—early childhood; hierarchical cluster; icd rate; parenting patterns; pseudo-F

1. INTRODUCTION

One of the pillars of realizing Golden Indonesia in 2045 is human development and mastery of science and technology (Bappenas, 2019). Therefore, efforts to improve the quality of human resources continue to be carried out in Indonesia by providing learning and training programs that are in accordance with the needs of the times. Furthermore, the government also focuses on the quality of early childhood education in Indonesia. This is done by carrying out three actions, namely overseeing the development, skills, and basic literacy in early childhood (Kemdikbudristek, 2021). This step is in line with the vision of Golden Indonesia because today's young children will become the nation's successors in 2045. In addition, early childhood development is also one of the main focuses of the Sustainable Development Goals (SDGs). Thus, parents' parenting style for early childhood must be appropriate because it plays an important role in child development.

However, the facts show that 3.73% of young children have received improper care in Indonesia (Central Bureau of Statistics, 2021). In addition, many early childhood activities are not carried out with parents or guardians. Data from the Central Statistics Agency shows that 89.16% of early childhood eat or learn to eat with parents or guardians, 50.23% of early childhood play or recreation or exercise with parents or guardians, 31.15% of early childhood learn or read books with parents or guardians, and 9.85% of young children play games with their parents or guardians in Indonesia. The data shows that many young children do minimal activities with their parents or guardians. In fact, the presence of parents or guardians in activities with early childhood is very important in the growth and development of children. Parental support from an early age will build positive emotions in children. Failure or delay in building positive emotions will make children aggressive, tend to be anti-social, and can cause children to be oriented towards giving sanctions for any violations committed by others. Furthermore, if the role of parents is not functioning, the child will experience maternal deprivation (Harmaini, 2013). In the end, this can disrupt the physical and mental development of children so that the quality of human resources produced decreases. Therefore, research is needed that analyzes the characteristics of parenting styles for early childhood in Indonesia as a foundation in efforts to realize ideal parenting styles so that superior and quality future generations are formed.

In previous research, Satrianingrum and Setyawati (2021) explained that differences in parenting styles for early childhood can be seen from the proximity of ethnic groups in Indonesia. Research conducted by means of a literature review shows that differences in parenting tend to influence a number of factors such as customs, habits, and so on. In addition, other research shows that parents adopt parenting styles that are democratic, permissive, and authoritarian by 56%, 33%, and 11% respectively in West Aceh District (Mainnah, et al, 2021). This previous research has not shown the characteristics of parenting patterns for early childhood as a whole in every region in Indonesia. In addition, these characteristics have not been reviewed from the activities carried out by parents with children specifically. Therefore, this research was conducted by grouping regions in Indonesia based on the characteristics of parents' upbringing of early childhood. With these groupings, the characteristics of parenting styles in each province in Indonesia can be clearly described.

In this case, the grouping is done using a hierarchical cluster analysis approach. The use of the hierarchical cluster method was chosen because the results of hierarchical grouping have proven to show better results than nonhierarchical grouping (Rusli, 2017). In addition, this study considers a number of hierarchical cluster methods such as Single Linkage, Complete Linkage, Average Linkage, and Ward. These four methods are methods that are widely used in various case studies and are capable of producing accurate groupings (Wierzchon and Klopotek, 2018; Andreas, et al, 2021). By considering a number of these methods, the most accurate grouping results can be obtained. In this study, the criteria for selecting the most optimal clusters and cluster methods were carried out using the Pseudo-F indicator and the internal cluster dispersion rate (icd rate). This is as applied in the research of Andreas, et al (2021) who applied the icd rate in determining the most optimal number of clusters. In addition, Rahayu, et al (2014) also apply the Pseudo-F indicator in selecting the most optimal cluster method.

In this study, the parents' parenting style was reviewed from 8 variable activities carried out by children with their parents or guardians. The novelty of this research is the analysis of the characteristics of parenting patterns for early childhood in terms of each region in Indonesia. In addition, grouping using the hierarchical cluster method in case studies in the field of education, especially related to parenting of early childhood, is also a novelty of research. This research resulted in a statistical review and mapping of provinces in Indonesia based on the characteristics of these parenting styles. In general, this research is very useful as a basis and reference in formulating policies to achieve ideal parenting in Indonesia.

2. LITERATURE REVIEW

2.1 Early Childhood Parenting Theory

The parenting style applied to early childhood consists of three types, namely democratic, authoritarian and permissive (Mahmud et al, 2013).

a. Democratic Parenting

Democratic parenting is a parenting style carried out by parents with an attitude of accepting, responding to, and paying attention to the needs and lives of children. In daily activities, children are given freedom by their parents, but there is an agreement made together. In learning activities, parents monitor children's development and learning, but do not make demands on learning outcomes. Often, children are invited to do activities together, such as watching television, reading books, playing, and talking together. Parents are more open, guiding, and appreciating children, so that children's communication with parents is more intense.

b. Authoritarian Parenting

Authoritarian parenting style is parenting done by parents with an attitude of forcing rules according to the wishes of parents. Usually, there are limits or rules and the child has to do it so if not done, then gets punished. In some cases, children are sometimes punished in the form of verbal or physical violence. This will affect the child's psychology, such as children who are more closed, anxious, and so on. In addition, parents are more demanding of children's learning outcomes. Then, the communication relationship between parents and children is very rare, so there is usually little involvement in activities with children, such as when eating, studying, and playing.

c. Permissive Parenting

Permissive parenting is a parenting style that is carried out by parents with an attitude of total freedom for children. As a result, children decide everything without discussion with parents. Parents have an attitude that usually ignores children and sometimes gives too much affection, so that all the wishes of children are fulfilled. This parenting style does not impose rules on children, so children are free to do whatever they want. The impact is that children are getting spoiled and cannot understand the rules. During learning activities, parents often do their children's assignments and children spend their time playing. On the other hand, mutual relations tend to be close and are more towards giving affection, but communication interactions are less intense. Therefore, children's daily activities and play are freed by parents.

2.2 Hierarchical Cluster Analysis

Cluster analysis is a part of multivariate analysis, namely a statistical method that analyzes data with many variables (Afifi, et al., 2020). Cluster analysis aims to group data based on similarities in characteristics or characteristics. Basically, the cluster analysis approach consists of hierarchical grouping and non-hierarchical grouping. In practice, hierarchical grouping is preferred over non-hierarchical grouping because the results of the grouping can be visualized clearly through a tree diagram known as a dendrogram.

The distance measure used in this study is the Euclidean distance. The Euclidean distance from the i-th object to the j-th object of data that has variable p is defined as follows:

$$d_{ij} = \sqrt{\sum_{k=1}^{p} (x_{ik} - x_{jk})^2}$$
(1)

There are a number of methods that can be applied in carrying out a hierarchical cluster analysis, namely as follows (Wierzchon and Klopotek, 2018):

a. Single Linkage (Nearest Neighbour)

Single linkage performs cluster formation by combining the smallest distances.

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$$d_{(i,j)k} = \min(d_{ik}, d_{jk}) \tag{2}$$

b. Complete Linkage (Farthest Neighbour)

Complete linkage groups all objects in the cluster that are farthest from each other.

$$d_{(i,j)k} = \max(d_{ik}, d_{jk}) \tag{3}$$

c. Average Linkage (Unweighted Pair - Group Average)

The average linkage is based on the distance between two clusters which is equal to the average distance between all pairs of objects in the cluster.

$$d_{(i,j)k} = \operatorname{average}(d_{ik}, d_{jk}) \tag{4}$$

d. Ward (Incremental Sum of Squares)

Ward's method has the principle of minimizing the total number of squares between objects and cluster centers. The sum of the squares of the distances between each object in the cluster from the centroid or cluster center is written as ESS_k . When all clusters are combined into a group consisting of N items with x_j and \overline{x} respectively the data on the jth item and the mean of all items, then the *ESS* value is defined as follows:

$$ESS_k = \sum_{j=1}^{N} (\mathbf{x}_j - \bar{\mathbf{x}})' (\mathbf{x}_j - \bar{\mathbf{x}})$$
(5)

2.3 Hierarchical Cluster Analysis

Selection of the optimal number of clusters is carried out by considering Pseudo-F statistics. The high Pseudo-F statistical value for a certain number of clusters indicates that the number of clusters is optimal (Rahayu, et al., 2018; Andreas, et al., 2021). If R^2 is the value of the coefficient of determination, n is the number of samples, c is the number of clusters, then the Pseudo-F statistic is defined as follows:

$$Pseudo - F = \frac{(n-c)R^2}{(c-1)(1-R^2)}$$
(6)

Furthermore, the selection of the best cluster method is carried out by considering the icd rate value. A small icd rate value indicates that the clustering method used is appropriate and produces good clustering. Mathematically, the icd rate is defined as follows:

with,

$$icd \ rate = 1 - R^2 \tag{7}$$

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$$R^2 = \frac{(SST - SSW)}{SST} \tag{8}$$

$$SST = \sum_{i=1}^{n_c} \sum_{j=1}^{c} \sum_{k=1}^{p} (x_{ij}^k - \overline{x^k})^2$$
(9)

$$SSW = \sum_{i=1}^{n_c} \sum_{j=1}^{c} \sum_{k=1}^{p} (x_{ij}^k - \overline{x_j^k})^2$$
(10)

3. RESEARCH METHODS

3.1 Data Sources and Research Variables

This research is a quantitative research that focuses on data analysis using statistical methods. The research data is secondary data obtained from the publication of the Central Bureau of Statistics entitled "2021 Early Childhood Profile". This data is data on the percentage of young children who carry out activities with their parents or guardians in each province in Indonesia. In this case, the research variable used is parenting styles for early childhood, namely a number of activities carried out by children with parents or guardians which include eating or learning to eat (X_1) , watching television (X_2) , studying or reading books (X_3) , reading story books or telling fairy tales (X_4) , worshiping or praying (X_5) , chatting or chatting (X_6) , playing or recreation or exercising (X_7) , and playing games (X_8) . All of these variables are measured in percent units by the Central Bureau of Statistics in every province in Indonesia.

3.2 Analysis Procedure

Data analysis was performed using multivariate statistical analysis techniques, namely the hierarchical cluster approach. The hierarchical cluster approach is used to group regions in Indonesia along with similar characteristics of parenting styles for early childhood. In this case, the hierarchical cluster approach used is the Single Linkage, Average Linkage, Complete Linkage, and Ward methods. Furthermore, the accuracy of the grouping results from the two methods is compared based on the Pseudo-F and icd rate criteria so that the best grouping results are obtained, namely the most accurate grouping. The best grouping results are used as a basis for analyzing the characteristics of parenting styles for early childhood in every region in Indonesia. The results of the analysis of these characteristics are also used as the basis for forming policy recommendations to realize the ideal pattern of parenting for early childhood in every province in Indonesia. The complete analysis procedure in this study is as follows:

- a. Conduct descriptive analysis on research data.
- b. Grouping provinces in Indonesia based on parenting styles for early childhood using the hierarchical cluster method.
- c. Selecting the optimal number of clusters for each hierarchical cluster method with Pseudo-F statistics.
- d. Choosing the best hierarchical cluster method using the icd rate measure.
- e. Displays the best cluster results in the form of a map.
- f. Analyze the characteristics of parenting styles for early childhood based on the mapping results obtained.

4. RESULTS AND DISCUSSION

4.1 Descriptive Analysis

The general description of the research data can be explained through descriptive statistics by looking at the mean,

standard deviation, minimum values, and maximum values. The summary of the descriptive statistics is presented in Table 1.

Variable	Mean	Standard Deviation	Minimum	Province	Maximum	Province
<i>X</i> ₁	89.92	3.02	82.71	Papua	95.70	North Kalimantan
<i>X</i> ₂	72.62	11.62	32.66	Papua	83.78	Bali
<i>X</i> ₃	28.23	7.09	12.47	Papua	46.64	DI Yogyakarta
X_4	14.90	7.37	6.68	Central Sulawesi	35.76	DI Yogyakarta
X_5	37.70	11.27	15.00	Southeast Sulawesi	60.37	North Sulawesi
X_6	66.01	7.80	48.37	Central Sulawesi	81.72	Bali
<i>X</i> ₇	48.54	7.93	34.18	Papua	65.77	DI Yogyakarta
X_8	9.25	3.87	2.82	West Sulawesi	19.31	Riau Islands

Table 1: Summary of Descriptive Statistics from Research Data.

Based on Table 1, the activities that most children do with their parents or guardians on average in Indonesia are eating or learning to eat (X_1) , watching television (X_2) , and chatting or chatting (X_6) respectively by 89, 92%, 72.62% and 66.01%. Meanwhile, the activities that were not carried out by children with their parents or guardians on average were studying or reading books (X_3) , reading story books or telling fairy tales (X_4) , and playing games (X_8) , each of which was 28.23 %, 14.90%, and 9.25%. Based on the minimum value of each variable studied, it can be seen that the lowest percentage of young children who carry out activities with their parents or guardians is found in the province of East Indonesia. Meanwhile, the highest scores can be found evenly in several regions such as Yogyakarta which has maximum scores in the variables of learning activities or reading books (X_3) , reading story books or being told fairy tales (X_4) , and playing or recreation or exercising (X_7) .

4.2 Clustering Results with Hierarchical Cluster Method

Furthermore, a grouping of provinces in Indonesia was carried out based on parenting styles for early childhood. The grouping was carried out using 4 hierarchical cluster methods in the number of clusters of 3, 4, and 5 respectively. The summary of the evaluation of the grouping results for each method and each number of clusters determined is presented in Table 2.

Based on Table 2, it can be seen that the highest Pseudo-F value for the Single Linkage method is formed in the number of clusters of 4. This shows that the use of the Single Linkage cluster method in this study achieves optimality in the number of clusters of 4. Likewise with other cluster methods such as

Complete Linkage, Average Linkage, and Ward are optimal for the number of clusters of 3, 5, and 3 respectively.

The cluster formation process in each of these methods can be visualized through a dendrogram. A dendrogram of the results of cluster formation in each method with the optimal number of clusters is presented in Figure 1. Next, the selection of the best cluster results is carried out by comparing the grouping results of each method on the optimal number of clusters. The selection of the best cluster results is based on the icd rate value. The icd rate for each method and the optimal number of clusters are presented in Table 3.

The lowest icd rate occurs in the Average Linkage method with a total of 5 clusters. This indicates that the method and the number of clusters are the best cluster results. The cluster results are visualized through a regional distribution map as shown in Figure 2. Figure 2 shows the mapping of parenting patterns for early childhood. Cluster 1 region consists of 25 provinces namely Aceh, North Sumatra, West Sumatra, Riau, Jambi, South Sumatra, Bengkulu, Lampung, Bangka Belitung Islands, West Java, Central Java, East Java, Banten, Bali, East Nusa Tenggara, West Kalimantan, Central Kalimantan, South Kalimantan, East Kalimantan, North Kalimantan, North Sulawesi, South Sulawesi, Gorontalo, North Maluku and West Papua. Cluster II region consists of 3 provinces, namely the Riau Archipelago, DKI Jakarta, and DI Yogyakarta. Clusters III and V each consist of 1 province, namely West Nusa Tenggara and Papua. Meanwhile, the Cluster IV region consists of 4 provinces, namely Central Sulawesi, Southeast Sulawesi, West Sulawesi, and Maluku.

Table 2: Evaluation of Grouping Results.

Method Number of Clusters SST SSW R-Square Pseud	o-F
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	3	264.0001	216.2047	0.181043	3.42651
Single Linkage	4	264.0001	153.348	0.419137	7.215749
	5	264.0001	137.8088	0.477997	6.638814
Complete Linkage	3	264.0001	141.3276	0.464669	13.45402
	4	264.0001	124.094	0.529947	11.2742
	5	264.0001	101.6812	0.614844	11.57354
	3	264.0001	168.4179	0.362054	8.796716
Average Linkage	4	264.0001	153.348	0.419137	7.215749
	5	264.0001	109.3264	0.585885	10.25722
	3	264.0001	137.4389	0.479398	14.27324
Ward	4	264.0001	112.877	0.572436	13.3883
	5	264.0001	94.7963	0.640923	12.94067



Figure 1: Dendrogram of Grouping Results with the Optimal Number of Clusters in Methods (a) Single Linkage, (b) Complete Linkage, (c) Average Linkage, and (d) Ward.

Method	Number of Clusters	icd rate
Single Linkage	4	0.580864
Complete Linkage	3	0.535332
Average Linkage	5	0.414115

Table 3: Selection of the Best Cluster Method.

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Figure 2: Mapping Results with the Best Cluster Method.

4.3 Characteristics of Parenting Patterns for Early Childhood in Indonesia

The results of the regional mapping obtained previously, show that 5 regional clusters have different characteristics of parenting styles for early childhood. These characteristics are summarized as follows:

Cluster Characteristics 1

- a. It is an area with a parenting pattern of parents who do a lot of activities with early childhood, but it is still under the cluster 2 area.
- b. Activities that are mostly done together include watching television, studying or reading books, reading story books or telling fairy tales, playing or recreation or exercising, and playing games.

Cluster Characteristics 2

- a. It is the area with the parenting style that does the most activities with early childhood, which has the highest percentage rate compared to other clusters.
- b. Activities that are mostly carried out together are not much different from activities carried out in the cluster 1 area.

Cluster Characteristics 3

- a. It is an area with a parenting pattern of parents who do quite a lot of activities with early childhood. In other words, this cluster area adopts a parenting pattern with a percentage of activities carried out with early childhood at the secondary level, namely below clusters 1 and 2, but above clusters 4 and 5.
- b. Activities such as eating or learning to eat, and chatting or chatting, are mostly done with parents or guardians.

Cluster Characteristics 4

a. It is an area with a parenting pattern of parents who do little activity with early childhood.

b. Activities that are rarely done with parents compared to other cluster areas include worship or prayer, chatting or chatting, and playing games.

Cluster Characteristics 5

- a. It is an area with parenting style that has the least amount of activities with early childhood.
- b. Activities that are the least done with parents compared to other cluster areas include eating or learning to eat, watching television, studying or reading books, reading story books or telling fairy tales, and playing or recreation or exercising.
- c. Nonetheless, in this cluster area, parents or guardians do the most activities with early childhood in terms of worship or prayer compared to other cluster areas.

Based on this description, it is found that the characteristics of parenting styles for early childhood are not the same in every region in Indonesia. Each province in Indonesia has certain characteristics of activities that are often carried out by children with their parents. This reinforces the results of research by Fitria (2016) which shows that parenting patterns are strongly influenced by cultural factors and living habits in their respective regions.

In general, the ideal parenting style is parenting that combines various types of parenting that exist situationally (Utami, 2017). In other words, the parenting style that is applied can be adapted to the needs and conditions of each child. Democratic parenting needs to be applied so that children have freedom, but not absolute and responsible. Meanwhile, authoritarian parenting can be applied with strict rules and educational punishments such as cleaning toys, and so on. The authoritarian parenting style aims to make children understand good and bad rules. Therefore, it is necessary that there are certain activities that children carry out with their parents as part of implementing this parenting style. These activities may vary according to the characteristics of each region. By applying ideal parenting, children can grow and develop optimally so that these children can become superior individuals in the future.

5. CONCLUSION

By comparing the Pseudo-F and icd rates in selecting the best cluster method and the optimal number of clusters, it is found that the Average Linkage method with a total of 5 clusters is the best cluster result. Cluster 1 consists of 25 provinces, cluster II consists of 3 provinces, cluster III consists of 1 province, cluster IV consists of 4 provinces, and cluster V consists of 1 province. This shows that parenting styles for early childhood in every province in Indonesia are not the same. In general, there are 5 regional groups that have different parenting characteristics. Each parenting characteristic that is reflected through certain types of activities that parents and children carry out can be combined with existing parenting theory approaches to form an ideal parenting style for children. With ideal parenting, early childhood can grow and develop optimally.

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