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Data clustering study of information and communication technology abilities among adolescents and adults in indonesia

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ABSTRACT

Information and communication technology (ICT) has become an integral part of daily existence in the digital age. Internet penetration, smartphone usage, and the adoption of technology-based applications have all accelerated the growth of ICT usage in Indonesia. Nonetheless, not everyone has the same level of proficiency with ICT. In order to comprehend the characteristics of ICT users in Indonesia, the research seeks to classify ICT proficiency among adolescents and adults in Indonesia. This study classifies ICT proficiency data among adolescents and adults in Indonesia using data mining techniques, specifically the K-Means clustering algorithm. The classification of ICT proficiency data among adolescents and adults in Indonesia based on predetermined characteristics is the outcome of this study. The results indicate that provinces close to the capital city center tend to have a high proportion of 15- to 24-year-olds with ICT skills. The region of Papua that is farthest from the capital city has the lowest percentage of ICT proficiency. Rural areas typically possess fewer ICT skills than urban ones.

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1. INTRODUCTION

Information and communication technology (ICT) has become an integral part of daily existence in the current digital era. ICT plays a crucial function in numerous facets of human life, including business, education, health, and entertainment (Ernawati et al., 2022; Ernawati & Azahra, 2021; Fauzi et al., 2023; Kartini et al., 2022). In this digital age, it is undeniable that ICT proficiency is a necessity that must be mastered. In Indonesia, the use of information and communication technologies has developed very rapidly. Along with the increase in internet penetration, smartphone usage, and the adoption of technology-based applications, adolescents and adults in Indonesia are becoming more acquainted with and proficient with ICT.

However, the capacity to utilize ICT varies among individuals. Some individuals may be very familiar with ICT and able to utilize the technology to its fullest extent, while others may require additional time to become proficient. In order to comprehend the characteristics of ICT users in Indonesia, it is necessary to categorize the ICT capabilities of adolescents and adults in Indonesia(Livana et al., 2020; Tutik & Rosadi, 2022).

Issues regarding the use of Information and Communication Technology (ICT) in Indonesia are very important things to pay attention to. In the digital era like today, ICT has become an inseparable part of people's daily lives, both in the field of education(Aziz, 2016), work, entertainment, or social interactions. However, the problem that occurs is that there is still an imbalance in the use and ability of ICT among adolescents and adults in Indonesia. This can be seen from the data showing that there is a significant digital divide between cities and villages, as well as between groups of people who have different access and capabilities in using ICT.(Dewi et al., 2021). Some research(Damanik et al., 2022; Simanjuntak et al., 2023)explained the urgency regarding the use and ability of ICT among youth and adults in Indonesia, namely social inequality in the use and ability of ICT, there are still many groups of people who have limited access to information so that it affects individual abilities related to ICT(Putri, 2018).

So based on the problems in this study it aims to conduct a study of Information and Communication Technology Ability Data Grouping among Adolescents and Adults in Indonesia by applying data mining techniques. Some research (Iskandar et al., 2020; Joko Suntoro, 2019; Wahyuddin et al., 2023; Wijaya, 2021)explained that Data Mining is an iterative and interactive process to find patterns or new models that are perfect, useful and understandable in a very large database. The output of data mining can be used to improve decision making in the future(Musadat et al., 2020; Putra & Widjaja, 2023; Widjaja, 2019). To solve the problem, use the K-Means Clustering Algorithm. The K-Means algorithm is one of the simplest and most popular clustering algorithms.(Harahap, 2019; Rahman & Suroyo, 2021; Sungkar, 2020; Sungkar & Qurohman, 2021). This algorithm works by dividing the data into several clusters or groups based on the similarity of certain characteristics or attributes. In this study, the K-Means algorithm will be used to classify ICT ability data on adolescents and adults in Indonesia.

The study of classifying ICT ability data on adolescents and adults in Indonesia has considerable importance which can be used as a reference for application and software developers to adapt their products to the characteristics of ICT users in Indonesia.(Qurohman et al., 2020; Sungkar et al., 2020; Zakhra et al., 2023). In this study, data will be collected regarding ICT skills in adolescents and adults in Indonesia from the official website of the Central Statistics Agency, which will then be processed and analyzed using the K-Means algorithm in the Python application. After the data is collected and analyzed, data will be grouped on ICT abilities in adolescents and adults in Indonesia based on predetermined attributes.

2. RESEARCH METHOD

2.1 Research Framework

Central Bureau of Statistics website data on the Proportion of Adolescents and Adults with Information and Computer Technology (ICT) Skills in Provinces in Indonesia, 2019-2022 are utilized for the research. In implementing the k-means clustering method using the Python programming language and visualizing data on the Google colab platform(Hartama, 2018; Mertha et al., 2021; Sudipa et al., 2023). This platform makes it simple for users to combine data from various sources, perform data processing, and generate interactive, understandable visual reports. Figure 1 provides a research framework to facilitate the explanation of the systematics of the research.

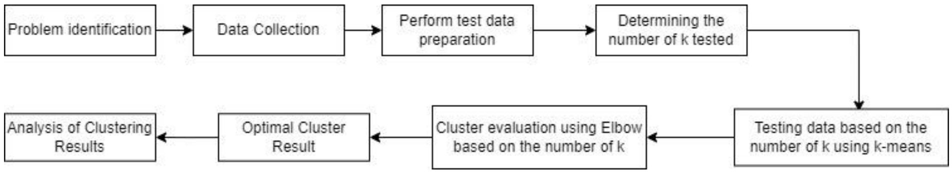

Figure 1. Research Framework

2.2 K-Means Algorithm

K-Means is an algorithm in data mining that can be used to group/cluster data. K-Means clustering is a method that belongs to non-hierarchical clustering where every object included in the group is the same and correlated objects. Data belonging to groups has a greater degree of similarity and also has a greater degree of difference from other groups(Harahap, 2019; Sungkar et al., 2019). Basically clustering is a method for categorizing or grouping a group of objects according to the same attributes or characteristics as other data. Clustering is a method in data mining where the work process on this algorithm is unsupervised.(Anwar et al., 2020; Cahyono et al., 2022; Pardede et al., 2019), meaning that this method no longer requires training and without a teacher, output is not needed. In data mining, there are two types of clustering methods for grouping data, namely hierarchical clustering and non-hierarchical clustering.

The K-Means process steps use the K-Means method. The process stages in the clustering algorithm using the K-Means method are as follows: (a) Choose the number of clusters k. (b) Initializing k cluster centers is generally many ways in this process, but the main choice at the cluster stage is by random method. (c) Allocate all data/objects to the closest cluster. (c) The next process is to recalculate the cluster center with the latest cluster membership. the average of all data/objects in the cluster is the center of the cluster. So the mean is not the priority parameter used. (d) Reassign each object using the new cluster center, whether the cluster center changes until the clustering process is complete, repeat process "c" until the value at the cluster center is found to have not changed.

3. RESULTS AND DISCUSSIONS

3.1 Data Preparation

The following is a data set from the central statistical agency related to the Proportion of Teenagers and Adults Aged 15-24 Years With Information Technology and Computer (ICT) Skills by Province and Area of Residence (Percent).

Table 1. Data on the Proportion of Youth and Adults with ICT Skills by Provinces in Indonesia(BPS - Statistics Indonesia, 2022).

Province Name	Provincial initialization	Data for 2019 (%)	Data for 2020 (%)	Data for 2021 (%)
Aceh	1	46.77	54.25	60.21
Bali	2	65.48	72.56	77.09
Banten	3	66.96	69.35	75.69
Bengkulu	4	48.70	53.42	62.10
Di yogyakarta	5	75.04	81.36	84.72
Dki jakarta	6	85.17	88.08	91.79
Gorontalo	7	50.62	55.68	61.94
Jambi	8	50.83	56.87	64.47
....	...	....	...	....
West papua	25	52.37	59.45	62.31

Table 1 shows data on the proportion of adolescents and adults aged 15-24 years with information technology and computer (ICT) skills by province and area of residence (percent), then the data is prepared by naming each column and adding a new column "initialization_province" to initialize province names with numeric representation, because k-means can only manage data in the form of integers or floats or in the form of numbers.

3.2 Import Modules

This stage is the import module process used in modeling which can be seen in Figure 2 below.

```
from sklearn.cluster import KMeans
import pandas as pd
from sklearn.preprocessing import MinMaxScaler
from matplotlib import pyplot as plt
%matplotlib inline

from sklearn import metrics
from scipy.spatial.distance import cdist
import numpy as np
```

Figure 2. Import Module Process

3.3 Read Process and Data Info

At this stage is the process of loading data (load data) with integer and float types, which will be processed as shown in Figure 3 below.

```
[13] df.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 34 entries, 0 to 33
Data columns (total 5 columns):
 #   Column               Non-Null Count  Dtype
---  ------               --------------  -----
 0   provinsi             34 non-null     object
 1   inisialisasi_provinsi 34 non-null     int64
 2   tahun_2019           34 non-null     float64
 3   tahun_2020           34 non-null     float64
 4   tahun_2021           34 non-null     float64
dtypes: float64(3), int64(1), object(1)
memory usage: 1.5+ KB
```

Figure 3. Load Process and Data Info

3.4 Determining the value of k

To find out the value of k or the number of clusters you want to form. Here is the code to see the right number of clusters to use. Here we compare the 2 attributes namely "Initialization_province" and "year 2021" can be seen in Figure 4.

```
sse = []
k_rng = range(1,10)
for k in k_rng:
    km = KMeans(n_clusters=k)
    km.fit(df[['inisialisasi_provinsi','tahun_2021']])
    sse.append(km.inertia_)
```

```
plt.xlabel('K')
plt.ylabel('Sum of squared error')
plt.plot(k_rng,sse)
```

Figure 4. Determining the value of k

3.5 Define Elbows

The Elbow method is a method for determining the right number of clusters through the percentage of comparison results between the number of clusters that will form an angle at a point. The results of Elbow determination for data for 2019, 2020 and 2021 can be seen in Figure 5 below.

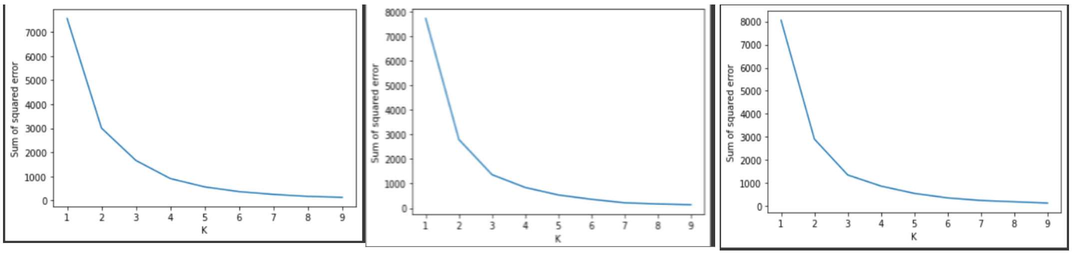

Figure 5. Elbow Data for 2019, 2020 and 2021

From the visualization in Figure 5 it can be explained that the sum of squared errors does not experience a significant decrease when K = 5 , therefore we can divide the cluster into 5 clusters. It can be seen that the data is included in 5 clusters namely cluster 0, cluster 1, cluster 2, cluster 3 and cluster 4.

3.6 Defines the Cluster Center Centroid

In determining the centroid or data center that will be the cluster center of each cluster, there are 5 centroid centers which can be seen in Figure 6 below.

```
km.cluster_centers_

array([[26.        , 72.87444444],
       [ 6.        , 57.93222222],
       [16.        , 65.25363636],
       [ 1.        , 30.58      ],
       [32.5       , 86.685     ]])
```

Figure 6. Determining the Cluster Center Centroid

3.7 Data Visualization Results

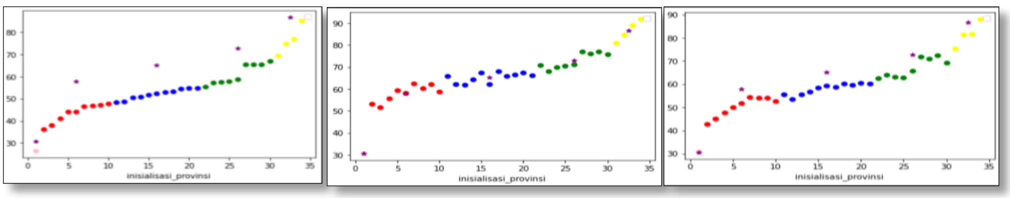

Figure 7. Data Visualization Results for 2019, 2020 and 2021

Based on Figure 7, it can be continued at the analysis stage, the analysis is divided into 2, namely analysis of the results of clustering the proportion of Proportion of Teenagers and Adults Aged 15-24 Years with Information Technology and Computer (ICT) Skills by Province and according to place of residence in Indonesia.

3.8 Analysis for provincial data

From the visualization of the three years (2019,2020,2021) it can be said that: (a) The pink color indicates cluster 3. province with code 1 namely: The province has a very small percentage related to the proportion of adolescents and adults aged 15-24 years with information technology and computer (ICT) skills, which ranges from 30%. (b) The red color indicates cluster 1 . Provinces with codes 2 - 10, namely: The province has a slightly lower percentage in relation to the proportion of adolescents and adults aged 15-24 years with information technology and computer (ICT) skills, ranging from 43% - 55%. (c) The blue color indicates cluster 2 . province with code 11-22, namely the province has a percentage figure that is related to the proportion of adolescents and adults aged 15-24 years with information technology and computer (ICT) skills, which range from 59% - 65%. (d) The green color indicates cluster 0 . provinces with codes 23-31 namely: The province has a slightly high percentage in relation to the proportion of adolescents and adults aged 15-24 years with information technology and computer (ICT) skills, ranging from 60% - 75%. (e)The yellow color indicates cluster 4 . provinces with codes 32 - 34, namely: The province has a very high percentage related to the proportion of adolescents and adults aged 15-24 years with information technology and computer (ICT) skills, ranging from 70% - 90%.

3.9 Analysis for residence data

Table 2. Data on the Proportion of Youth and Adults with ICT Skills by Residence in Indonesia(BPS - Statistics Indonesia, 2022).

Classification	Classification Initialization	Data for 2019 (%)	Data for 2020 (%)	Data for 2021 (%)
Urban	1	90.63	92.97	95.83
Rural	2	74.03	79.36	86.19
Urban and Rural	3	83.58	87.17	91.83

For data based on residence, it is processed using the Microsoft excel application due to the small amount of data, the direct data visualization process uses a chart which can be seen in Figure 8 below.

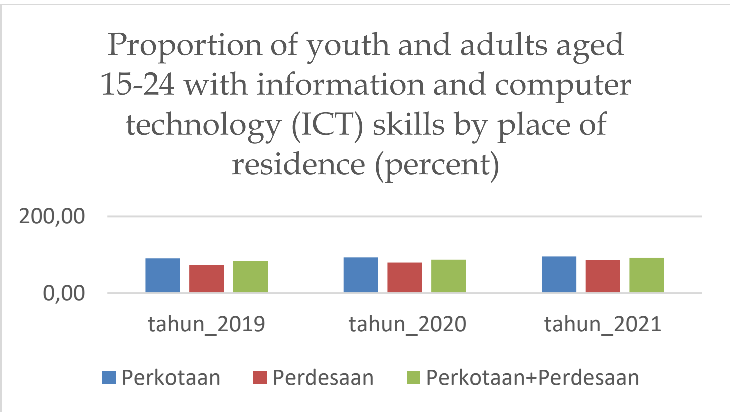

Figure 8. Proportion of youth and adults aged 15-24 with information and computer technology (ICT) skills by place of residence (percent)

Based on Figure 8, an analysis can be given as follows: (a) Urban areas tend to have quite high numbers at 90.63% related to the proportion of youth and adults aged 15-24 years with information technology and computers (ICT) skills. Its value also increases every year. (b) Rural areas tend to have lower numbers than urban areas with a difference of about 20% smaller than the percentage in urban areas regarding the proportion of adolescents and adults aged 15-24 years with information technology and computer (ICT) skills. However, the value also increases every year until it reaches figure 86, percent in 2021.

3.10 Analysis of Interpretation of Cluster Results

Provinces with the highest proportion of adolescents and adults aged 15-24 years with information technology and computers (ICT) skills are the provinces closest to the center of the national capital. This is because as the center of the country, development in terms of economy, technology, and politics is built first from the capital, then slowly spreads to other regions.

The province farthest from the capital is Papua. Has a very low percentage of technological skills. Moreover, we know that access to enter Papua is very expensive, let alone to carry out infrastructure development. This has resulted in delays in several aspects of life, including technology

Provinces that are in the middle distance from the national capital, such as Jambi, have a moderate presentation of technological skills, but if you pay attention, the provinces of North Sumatra and NTT, which have almost the same distance between the provinces and the capital, show that Sumatra has a higher presentation of technological skills than NTT. On average, the eastern regions of Indonesia have a relatively low percentage of technological skills compared to the western regions of Indonesia. Rural areas tend to have lower rates than urban areas related to information technology and computer (ICT) skills.

4. CONCLUSION

The research conclusions can contribute to the visualization of information related to the proportion of adolescents and adults related to ICT skills in provinces throughout Indonesia. From the research results, several conclusions were obtained, namely (1) The provinces in close proximity to the center of the national capital have the highest proportion of 15- to 24-year-olds with information and computer technology (ICT) skills. (2) Papua is the most distant province from the capital. It has an extremely low percentage of technological expertise. In addition, we are aware that access to Papua is prohibitively expensive, particularly for infrastructure development, which has resulted in delays in a variety of facets of life, including technology. (3) Provinces that are equidistant from the national capital, such as Jambi, have a moderate presentation of technological skills. However, if you pay close attention to the provinces of North Sumatra and NTT, whose distances from the capital city are nearly identical, it appears that Sumatra has a higher presentation of technological skills than NTT. (4) In comparison to western Indonesia, eastern Indonesia has a relatively low average percentage of technological expertise. (5) Rural areas tend to have lower rates of information and computer technology (ICT) capabilities than urban areas. (1) To accomplish an equal distribution of technological skills, which is, of course, closely related to the development of educational levels, the government should prioritize the construction of adequate infrastructure in eastern Indonesia. (2) Adequate facilities and infrastructure will undoubtedly promote the growth of technological access. (3) The lack of infrastructure for internet networks in the eastern region causes them to languish behind other parts of the province in terms of technological advancements and information, causing their average level of knowledge to be lower than that of children in major cities. (4) Technology equalization must also be developed in rural areas so that the percentage of technology skills is more equitably distributed and does not fall below the provincial average.

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