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Cluster of Foreign Tourists Using the K-Means Method Based on Arrival Data at I Gusti Ngurah Rai Airport (2018-2024)

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Abstract
Tourism is a vital sector in the economic development of Bali Province, with the number of international tourist arrivals through I Gusti Ngurah Rai International Airport as the main indicator. According to data from the Central Statistics Agency (BPS), the number of international tourists reached its peak in 2019 with over 16.1 million visits. However, in 2020–2021, there was a drastic decline due to the COVID-19 pandemic. In 2022, the number of international tourist arrivals began to show a significant recovery. In 2023, the number of international tourist arrivals to Indonesia reached 11.68 million, most of whom entered through major airports such as I Gusti Ngurah Rai Airport (Bali). The inaccuracy of the tourist arrival grouping process has had a negative impact on business growth and tourism revenue. This study aims to classify the countries of origin of international tourists based on the number of visits using the K-Means Clustering method, an effective unsupervised data mining algorithm for data segmentation. Data was obtained from the Central Statistics Agency (BPS), covering the number of tourist arrivals and their countries of origin from 2018 to 2024. The analysis process involves determining the optimal number of clusters using the Elbow Method, followed by grouping countries based on visit characteristics. The results of the study indicate that tourist countries of origin can be grouped into three main clusters: high-visit countries (Australia and China), medium-visit countries, and low-visit countries. This study provides strategic insights for the government and tourism industry stakeholders in developing more targeted policies, such as improving transportation infrastructure and implementing more effective marketing strategies to maintain and increase the number of tourist visits to Bali.

Keywords:
K-Means; International Tourists; I Gusti Ngurah Rai Airport; Data Mining; Clustering.

1. INTRODUCTION

Tourism is the main source of economic development in Bali Province. The Ministry of Tourism and Creative Economy is targeting 7 million tourists by 2024. The inaccuracy of the tourist arrival grouping process has had a negative impact on business growth and tourism revenue.

The arrival of international tourists to Indonesia has fluctuated due to various factors, such as government policies, global economic conditions, and the pandemic situation. According to data from the Central Statistics Agency (BPS), the development of tourism in Bali in April 2018 showed an increase in the number of international tourists visiting Bali.

Some of the countries with the highest number of tourists are China, Australia, India, the United Kingdom, and Japan. The number of foreign tourists peaked in 2019 with more than 16.1 million visits.

However, in 2020–2021, there was a drastic decline due to the COVID-19 pandemic, which caused global travel restrictions.

The number of international tourists (wisman) who arrived directly in Bali Province in April 2020 was recorded at 327 visits. Of these, 273 arrived via I Gusti Ngurah Rai Airport and 54 via seaports. The number of international tourists to Bali Province in April 2020 dropped by -99.79 percent compared to March 2020. Compared to April 2019, the number of international tourists to Bali dropped by -99.93 percent. Foreign tourists from Indonesia (16.21 percent), the Philippines (16.21 percent), China (12.23 percent), India (10.40 percent), and Russia (8.56 percent) were the top five nationalities of foreign tourists visiting Bali in April 2020 (Central Bureau of Statistics. 2020).

The number of international tourists (wisman) arriving directly in Bali Province in April 2021 was recorded at 9 visits, a decrease of 97.63 percent compared to April 2020, which recorded 379 visits. Compared to March 2021, the number of international tourists to Bali increased by 200.00 percent, from 3 visits in March 2021 to 9 visits in April 2021 (Central Statistics Agency, 2021).

In 2022, with the gradual easing of travel restrictions and the reopening of international flight access, the number of tourist arrivals began to show a significant recovery. International tourists (wisman) who arrived directly in Bali Province in April 2022 were recorded at 58,335 visits, an increase of hundreds of percent compared to the previous month, which recorded 14,620 visits. Tourists from Australia dominated international tourist arrivals to Bali in April 2022 (Central Statistics Agency, 2022).

In 2023, the number of international tourist arrivals to Indonesia reached 11.68 million, with the majority entering through major airports such as I Gusti Ngurah Rai Airport (Bali), Soekarno-Hatta Airport (Jakarta), and Kualanamu Airport (Medan). International tourists (wisman) who visited Bali Province directly in April 2023 totaled 411,510 visits, an increase of 11.01 percent compared to the previous month, which recorded 370,695 visits. Tourists from Australia dominated international tourist arrivals to Bali in April 2023 with a share of 24.97 percent (Central Bureau of Statistics, 2023).

International tourists (wisman) who arrived directly in Bali Province in April 2024 totaled 503,194 visits, an increase of 7.24 percent compared to the previous month, which recorded 469,227 visits. Tourists from Australia dominated the arrival of international tourists to Bali in April 2024 with a share of 23.35% (Central Statistics Agency, 2024). The number of international tourists arriving through the I Gusti Ngurah Rai International Airport can be categorized based on various factors. This data is important for monitoring the development of Bali's tourism industry and planning further development strategies.

K-means Clustering is one of the unsupervised learning methods used to group data into a number of Clusters based on their similar characteristics. This algorithm works by determining a number of initial Clusters (k), then grouping the data based on the closest distance to the Cluster center (centroid), which is iteratively updated until convergence. K-means is suitable for research because it can handle large amounts of data with high efficiency, provides clear and structured clustering results, and is easy to implement for various types of data, such as numerical and image data. In addition, the flexibility in determining the number of clusters allows researchers to tailor the analysis to the needs of the research, making it a popular tool in various fields, including marketing, image processing, and social data analysis.

There are various previous studies on the Cluster method. Previous research by Paper on the grouping of tourist attractions in Teluk Wondama Regency. The research was conducted because of the considerable distance between tourist attractions in Teluk Wondama Regency, reaching 1-2 hours of travel between destinations. The purpose of this grouping was to make it easier for the regency government to improve the quality of tourist attractions. The results of the Cluster analysis showed that there were two main Clusters. The first Cluster, consisting of the districts of Kuri Wamesa, Raisey, Roswar, Wasior, and Wondiboy, had fewer visits. Meanwhile, the second Cluster, consisting of the districts of Teluk Duairi, Roon, and Windesi, showed a higher number of visits. Furthermore, this target implies that within four years, the number of visitors needs to be doubled to around 20 million tourists. This study discusses the implementation of the Clustering technique, specifically using the K-means method, in grouping the number of foreign tourist visits based on nationality and month of arrival. The research data comes from the National Statistics Agency, which records the number of foreign tourist visits. The results show that from 2017 to 2018, there were two main clusters. Cluster 1 (high cluster) includes four countries, namely China, Malaysia, Singapore, and Timor Leste. Meanwhile, Cluster 2 (low cluster) involves 87 other countries.

Based on the above, the author has chosen the title “Analysis of K-means Clustering in Grouping Based on Trends in the Number of International Tourist Arrivals Through the Arrival Gate of I Gusti Ngurah Rai Airport” for this thesis proposal.

2. RESEARCH METHOD

2.1. Data Sources and Research Variables

The data used in this study are international tourist arrival data in Indonesia according to the Ngurah Rai International Airport entry point in Bali. The data were obtained from the official website of the Bali Provincial Central Statistics Agency. The variables used in this study are the trend in the number and country

of origin of tourists arriving through the I Gusti Ngurah Rai Airport arrival gate, using data from January 2018 to December 2024.

2.2. Research Type

This type of research is descriptive research. It is said to be quantitative descriptive because the data used in this research is data that already exists in numerical form (numerical data), which is then analyzed and arranged based on the needs and rules of the research.

2.3. K-Means Analysis Method

The method used in this study is K-means Clustering, which is an unsupervised learning technique that aims to group data into several Clusters based on similar characteristics. This method was chosen because of its ability to group large amounts of data efficiently and effectively. Although K-Means is one of the most popular clustering algorithms due to its simplicity and efficiency. K-Means has several important drawbacks that should be considered before use. These include the need to manually determine the number of clusters (K), sensitivity to outliers, and results that depend on the initialization of the initial centroids, which are selected randomly, leading to different clustering results each time the algorithm is run. To address these issues, the author combines the Elbow Method to improve accuracy. The steps for analyzing using K-means Clustering are as follows:

a. Data Preparation
   Data on the number of foreign tourists from January 2018 to December 2024 and data on the tourists' countries of origin from 2018 to 2023 were collected, cleaned, and processed to ensure that no data was missing or invalid.
b. Data Normalization
   The normalization process is carried out to ensure that all variables have the same scale, so that no variable dominates the clustering results.
c. Determining the Number of Clusters (K) using Elbow/Silhouette Score
   Elbow / Silhouette Score method is a technique used to determine the optimal number of clusters (K) in K-Means Clustering. It works by calculating the Sum of Squared Errors (SSE) or Within-Cluster Sum of Squares (WCSS) for various values of KKK, then plotting the results on a graph (1).

$$WCSS = \sqrt{\sum_{i=1}^{K} \sum_{j=1}^{n} (x_j - c_i)^2} \quad (1)$$

x_j = Data points in a cluster

c_i = Cluster centroid

K = Number of clusters

n = Number of data points in a cluster

Both the K values used and the corresponding WCSS values are plotted against each other on a graph and visualized through a curve. The elbow graph Figure 1 shows the WCSS values on the y-axis corresponding to different K values on the x-axis. When we observe an elbow shape on the graph—where the curve appears curved or sharply decreasing/increasing—we select the K value where the elbow is formed. We can refer to this as the elbow point. Outside the elbow point, increasing the 'K' value does not result in a significant decrease in WCSS.

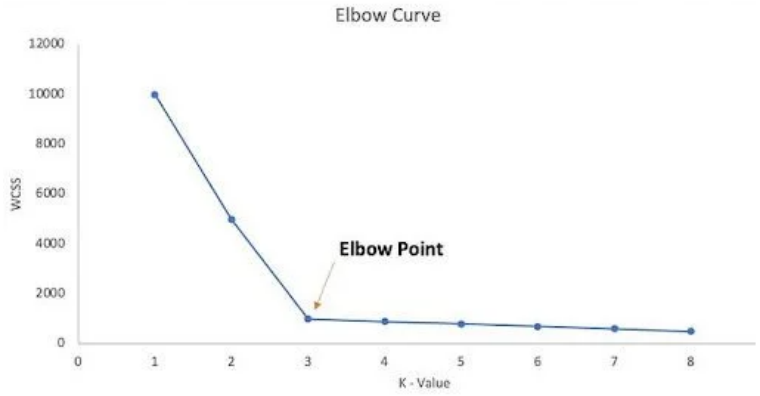

Figure 1. Determining the Number of Clusters (K) using Elbow Method

d. Clustering Process
The K-means Clustering algorithm operates by categorizing data points into clusters using a mathematical distance measure, usually Euclidean, from the center of the cluster. The goal is to minimize the total distance between data points and their assigned clusters. Data points closest to the centroid are grouped together in the same category. A higher value of k, or the number of clusters, indicates smaller clusters with greater detail, while a lower value of k results in larger clusters with less detail. The formula is as follows (2).

$$d(x, c) = \sqrt{\sum_{i=1}^{n}(x_i - c_i)^2} \quad (2)$$

$d(x, c)$ = Distance between data X and cluster center C.

x_i = Coordinates of data points in dimension i

c_i = Coordinates of cluster center in dimension i

n = Number of features in the dataset.

Euclidean distance is one of the most commonly used distance calculation methods in K-Means Clustering algorithms and various other machine learning techniques. This distance measures how far two points are in n-dimensional space. The formula is as follows:

1) In 2-dimensional space (2D): If there are two points A(x1, y1) and B (x2, y2), then the Euclidean distance between them is calculated using the formula (3):
$$d(A, B) = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \quad (3)$$
2) In 3-dimensional space (3D): If there are two points A(x1, y1, z1) and B (x2, y2, z2), then the formula (4):
$$d(A, B) = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2} \quad (4)$$

e. Evaluate the Clustering Results
The clustering results are evaluated to ensure that the clusters formed have clear interpretations and are consistent with the characteristics of the data.

f. Visualize the Results
The clustering results are visualized using graphs to facilitate interpretation, such as scatter plots or bar charts showing the distribution of tourists in each cluster.

By using this method, it is hoped that patterns of grouping the number of foreign tourists arriving through I Gusti Ngurah Rai Airport can be obtained, thereby providing useful information for further analysis.

3. RESULTS AND DISCUSSION

Descriptive analysis aims to provide an initial overview of the characteristics of the data, including measures of central tendency, measures of dispersion, and patterns of distribution for each research variable. The following are descriptive statistics of the number of tourists arriving and according to the country of origin of tourists arriving through the arrival gate of I Gusti Ngurah Rai Airport from 2018 to 2024, as follows.

3.1. Statistical Data on the Number of Foreign Tourist Arrivals

Table 1. Output 1 SPSS Descriptive Statistics Results

N	Minimum	Maximum	Mean	Std. Deviation	
Januari	7	0	533392	296448.4	213520.1
Februari	7	12	454398	287386.9	202053.6
Maret	7	3	484846	276903	212572.8
April	7	9	516143	280570.7	247200.5
Mei	7	8	544492	301392.9	251077.1
Juni	7	1	549483	324345.7	255087.6
Juli	7	0	625569	377420.9	289513.2
Agustus	7	0	613540	369532.3	276825.5
September	7	0	591848	362448.6	267988.7

Oktober	7	2	565966	342960.4	249878.9
November	7	2	492904	293836	211278.1
Desember	7	0	548685	349131.7	245182.9
Valid N (listwise)	7				

Tables 1 explaining that the minimum number of international tourist arrivals during the period from 2018 to 2024 is 1 in June 2021, while the maximum or highest number of international tourist arrivals during the same period is 625,569 in July 2023. Formation of K-Means Clusters, Based on the output number of cases, the number of members in each cluster is presented in the following Table 2.

Table 2. Number of Cluster Members

Cluster	1	1.000
	2	4.000
	3	2.000
Valid		7.000
Missing		.000

Table 2 illustrates seven categories (each year) of foreign tourist arrivals at the arrival gate of I Gusti Ngurah Rai Airport, which are divided into three clusters. Cluster 1 is the cluster with the largest decrease in tourist numbers, namely one category. Cluster 3 is the cluster that can be said to have a stable number of tourists in terms of arrival trends, and Cluster 2 has the most categories, namely four categories. Thus, out of the total 7 categories, tourist arrivals exhibit the characteristics of Cluster 2.

Table 3. Number of Cluster Members

Cluster	1	2	3
1		1146919	834479.7
2	1146919		1639556
3	834479.7	1639556	

Tables 3 explaining that the distance between Clusters. Based on the table 3 of distances between cluster centers, the greatest distance was found between Cluster 2 and Cluster 3, which was 1,639,555.977. This indicates that the countries in Cluster 2 are very different in characteristics from those in Cluster 3, both in terms of the number of foreign tourists and their variation. Conversely, the shortest distance was found between Cluster 1 and Cluster 3, at 834,479.681, indicating that the two clusters share similarities in their data characteristics. These differences between clusters provide a strong foundation for the conclusion that the K-Means clustering results have successfully distinguished the profiles of countries of origin of tourists based on the similarity of their visit behavior.

Table 4. Number of Cluster Members

Case Number	Tahun	Cluster	Distance
1	2018	2	99194.14
2	2019	2	111609
3	2020	3	332043.1
4	2021	3	332043.1
5	2022	1	0
6	2023	2	210393.6
7	2024	2	108772.9

Tables 4 explaining that the cluster membership, Cluster 1, categorized as “Consistent,” consists of the year 2022 with a total of 2,154,045 tourists. Cluster 2, categorized as “Increasing,” consists of 2018 with 6,027,159 tourists, 2019 with 6,239,543 tourists, 2023 with 5,248,113 tourists, and 2024 with a total of 6,308,541 tourists. Cluster 3, categorized as “Declining,” includes the years 2020 and 2021, with 1,059,198 and 43 tourists visiting Bali.

3.2. Statistical Data on the Number of Foreign Tourist Arrivals by Country

Table 5. Number of Cluster Members

N	Minimum	Maximum	Mean	Std. Deviation	
Tahun_2018	26	1704	1361512	274143.9	372971.2
Tahun_2019	26	1705	1241128	241759.8	309459.9
Tahun_2020	26	321	226945	41334.88	48132.81
Tahun_2021	26	0	0	0	0
Tahun_2022	26	341	605955	83084.65	120169.8
Tahun_2023	26	1244	1324410	203241.6	260402.5
Valid N (listwise)	26				

Tables 5 explaining there are 26 countries and regions analyzed. With 6 years of data used to analyze the descriptive values, it can be explained that Cluster 1, consisting of Australia, is the country with the highest contribution of tourist visits to Bali. Cluster 2, consisting of China and New Zealand, is the country with the highest contribution of tourist visits to Bali. Cluster 3, consisting of Asian countries such as Malaysia, the Philippines, Singapore, Thailand, other ASEAN countries, Saudi Arabia, India, Japan, South Korea, Taiwan, other Asian countries, the United States, Canada, other American countries, and France, Germany, the Netherlands, the United Kingdom, Russia, other European countries, other Oceania countries, Southern Africa, and other African countries also show significant contributions.

Formation of *K-Means Clusters*, based on the *output number of cases*, the number of members in each cluster is presented in the following table;

Table 6. Number of Cluster Members

Cluster	1	2.000
	2	1.000
	3	23.000
Valid		26.000
Missing		.000

Tables 6 explaining based on the annual grouping results from a total of 26 countries analyzed, three clusters were obtained that represent the characteristics of tourist visits to each country. Cluster 2 consists of countries with the highest number of tourist arrivals. Cluster 1 consists of countries with relatively stable tourist arrivals to Bali, where the graphs of increases and decreases in the number of arrivals for each country are not significantly different. Meanwhile, Cluster 3 consists of countries with relatively low tourist arrivals to Bali, including 23 countries within this cluster.

Distance *between clusters* the distance between clusters can be seen in Table 7

Table 7. Number of Cluster Members

Cluster	1	2	3
1		1406758	1223544
2	1406758		1975717
3	1223544	1975717	

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Tables 7 explaining based on the table showing the distance between cluster centers, it can be seen that the furthest distance is between Cluster 2 and Cluster 3, which is 1,975,717.289. This indicates that the characteristics of countries in Cluster 2 are very different from those in Cluster 3, both in terms of the average number of tourists and its fluctuations. Meanwhile, the distance between Cluster 1 and the other clusters is relatively closer, indicating that countries in Cluster 1 have characteristics that lie between the two other clusters. The large distances between clusters show that the segmentation of countries based on the K-Means method successfully grouped countries with significantly different tourist characteristics.

Clustering Membership Details of each cluster's members based on the number of international tourist arrivals by country of origin per year can be seen in the table 8.

Table 8. Number of Cluster Members

Case Number	Country	Cluster	Distance
1	Malaysia	3	77847.86
2	Philipina	3	113677.5
3	Singapura	3	103837.1
4	Thailand	3	190102.7
5	Asean_lainnya	3	99875.28
6	Arab_Saudi	3	242523.3
7	India	3	428226
8	Jepang	3	160562.2
9	Korea_Selatan	3	88900.44
10	Taiwan	3	115603
11	RRC	1	544935.3
12	Asia_lainnya	3	40667.78
13	Amerika_Serikat	3	178349.5
14	Kanada	3	160059.2
15	Amerika_lainnya	3	162942.2
16	Perancis	3	89207.47
17	Jerman	3	71387.51
18	Belanda	3	71000.19
19	Inggris	3	211817.2
20	Rusia	3	51440.96
21	Eropa_lainnya	3	665089
22	Australia	2	0
23	Selandia_Baru	1	544935.3
24	Oceania_lainnya	3	276079.8
25	Afrika_Selatan	3	220154.5
26	Afrika_lainnya	3	234023.3

Tables 8 explaining that the cluster membership table shows that each entity has been grouped into three clusters with a certain distance from the cluster center. Case 1 is located right at the center of Cluster 1, making it representative of its group. Other cases have a relatively small distance from their respective cluster centers, indicating stable grouping results and reflecting similarities in characteristics among members within a cluster.

Meanwhile, areas with the lowest number of visits could be potential targets for the expansion of Bali's tourism market in the future. Bali is visited by many foreign tourists due to its combination of natural beauty, rich culture, friendly people, and complete tourist facilities. The island offers beautiful beaches, charming mountains, and green terraced rice fields. In addition, Bali's unique culture, including traditional dances, wood carving, and Hindu religious ceremonies, attracts tourists to learn and experience firsthand

The number of international tourists arriving through I Gusti Ngurah Rai Airport can be grouped based on various factors, such as country of origin, time period, and type of arrival. This data is important for monitoring the development of Bali's tourism industry and planning further development strategies. It can also be observed that there is instability in visitor numbers from major countries between years, which is likely due to global factors such as pandemics, government regulations, or tourist trends.

4. CONCLUSION

Based on the results of a study on the application of the K-Means Clustering method in grouping the number of international tourists arriving through I Gusti Ngurah Rai Airport, three main clusters were identified that reflect tourist arrival patterns during the period 2018–2024. The first cluster shows the “Consistent” category, which includes the year 2022 with a stable number of tourists. The second cluster is categorized as “Increasing,” where the number of tourists experienced significant growth, particularly in

2018, 2019, 2023, and 2024. Meanwhile, the third cluster is classified as "Declining," covering the years 2020 and 2021, which saw a drastic decline due to the global pandemic that restricted tourist movements. The results of this grouping show that the number of tourists fluctuates based on external factors such as pandemics, government policies, and air transportation infrastructure. The evaluation of the distance between clusters also indicates significant differences between categories, with Cluster 2 as the dominant group in the trend of increasing tourists. There are 26 countries and regions analyzed. Using six years of data to analyze these descriptive values, it can be explained that Australia is the country with the highest contribution to tourist visits in Bali. China and New Zealand are the countries with the highest contribution to tourist visits in Bali. Thus, this study provides strategic insights for the government and tourism industry stakeholders in developing more targeted policies, such as improving transportation infrastructure and implementing more effective marketing strategies to maintain and increase the number of tourist visits to Bali. This study not only serves as data exploration but also as a decision-support tool for airport authorities, local governments, and Bali's tourism industry stakeholders. Its implementation can be dynamic depending on changes in global tourist trends.

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