



Implementation K-Means Algorithm in Promotional Media Destination Tour Minahasa Web Based

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Abstract

Minahasa Regency has great tourism potential with a variety of destinations including cultural, natural, and man-made tourism. However, tourism promotion efforts still face obstacles due to the lack of integrated media capable of grouping destination information based on tourist interests and preferences. This study aims to apply the K-Means clustering algorithm in web-based promotional media to group Minahasa tourist destinations based on the level of user interaction, which is represented by the number of likes and comments on promotional content for each destination. The research method is carried out through several stages, namely collecting tourist destination data, pre-processing interaction data, implementing the K-Means algorithm with a specified number of clusters of three according to the main categories of tourism (cultural, natural, and man-made), and implementing the clustering results into a web-based evaluation system that uses the Silhouette Coefficient to evaluate the quality of cluster formation. The results show that the K-Means algorithm is able to effectively group tourist destinations into three clusters that reflect the level of popularity, making it easier for users to find destination recommendations according to their interests. Implementation in a web-based system also provides an interactive display in the form of a list of destinations per cluster and recommendations for popular destinations. Thus, this study proves that the application of K-Means can increase the effectiveness of Minahasa tourism promotion, and in the future it can be developed with the integration of real-time data from social media and comparison with other clustering algorithms..

Introduction

Tourists are one of the important sectors in economic development areas, because they are capable of giving a big contribution to improving original area income, open field work, and introduce local potential to public areas (Briedenhann & Wickens, 2004; Rogerson, 2006). According to data from the Ministry of Tourism and Economy Creative, development current digital technology This gives new opportunities for areas For optimizing promotion tour through online media. With the existence of digital promotional media, information about tour destinations can be accessed more easily, quickly, and reachable more widely compared to conventional promotion (Puspawati & Ristanto, 2018; Khasanah et al., 2024; Minanda et al., 2024; Syahrin & Yuwita, 2025).

Regency Minahasa in North Sulawesi Province is one of the areas that has potential rich and diverse tourism. This region is known with beauty nature, heritage culture, as well as object

tour continuous creation developed (Xiong et al., 2023; Gordon, 2018; Zhang et al., 2022; Katelieva & Muhar, 2022). Examples of popular nature tour destinations in Minahasa include Lake Tondano, Kanonang Hill of Love, and Mount Tampusu. In terms of culture, there is Waruga Sawangan and the Tomb of Imam Bonjol in Lota which has a high historical mark. Meanwhile, for artificial tours, Prayer Hill Warembungan and several park recreations have become the main choice for tourists. Although its potential is big, promotion tourism in Minahasa still faces challenges, one of which is limitations in grouping destinations in a way systematically to suit the interests and needs of travelers Potential for Sustainable Tourism and Inclusive Economy in Talawaan Village.

Llodra-Riera et al. (2015) and Narangajavana et al. (2019) In the era of social media, user interaction in the form of likes and comments to tour content becomes an important indicator for measuring a traveler's interest in a destination. However Pancras & Sudhir et al. (2007), interaction data is often not yet utilized optimally in promotional strategies. This is the cause of the gap, namely Not yet the existence of a data-based system capable of grouping tour destinations based on a certain level of popularity and category (Wang, 2024). Research previously used K-Means clustering algorithm has proven its effectiveness in grouping numeric data, including in fields tourism, but its application in the context of promotion destination tour Minahasa Still rarely done.

To answer the problem said, research This applies K-Means clustering algorithm in a web-based tour promotion system (Yee et al., 2019; Kim & Ahn, 2008; Sarker et al., 2022). The K-Means algorithm was chosen because it is simple, efficient, and effective in grouping data in large amounts to clusters based on similarity marks (Ahmed et al., 2020; Raykov et al., 2016; Haraty et al., 2015). In study This data is in the form of number of likes and comments from content promotion destination tour Minahasa used as main attribute in the clustering process. Next, the tour destinations are grouped into three main categories, namely cultural, natural, and artificial (Petroman, 2015; Sardak et al., 2020; Liu et al., 2022; Alsaahafi et al., 2023; Alsaahafi et al., 2023). The results of the grouping are displayed in a web-based platform to make it more easily accessed by users.

With the existence of this study, it is hoped that it can give a real contribution in increasing the effectiveness of promotion of the Minahasa tour destination. Besides that, this research also aims to enrich study implementation of data mining algorithms, especially K-Means clustering, in the field of digital tourism (Damos et al., 2024; Sukmana & Oh, 2024; Yildirim et al., 2022; Ramadhan et al., 2025). Destination main study is applying K-Means algorithm in web-based promotional media for grouping Minahasa tour destinations based on user interaction, so that promotion becomes more directed, interactive, and appropriate to tourists' needs.

Methods

Type Study

This study is a quantitative study with an experimental method applied a quantitative approach chosen because the data analyzed takes the form of numeric in the form of number of likes and comments on content promotion destination tourism. Method experiment applied used Because study This is not only theoretical in nature, but also implements the K-Means Clustering algorithm in a web-based system (Katarya, R., & Verma, 2017; Ricca et al., 2008; Kraj et al., 2008; Singh & Kaur, 2021).

Location and Object Study

Study implemented at the destination tourism in the Regency area Minahasa. The object of study is the interaction of audience data to content promotion destination tourism, which consists of the number of likes and comments.

Data and Data Sources

Data used in study This consists of on two types First, primary data, namely interaction data users in the form of number of likes and comments obtained through direct observation towards digital destination promotion media tour Minahasa. Second, secondary data, namely additional data in the form of information regarding the destination list tour from publication official government areas and tourism sites.

Data Collection Technique

Data collection was carried out through two main techniques: online observation recording number of likes and comments and studies literature collection information supporting from journals, books, and official reports.

Variables Study

Variables study consists of on two main indicators used as input in the grouping process (Rosyada & Utari, 2024); (1) Variables first X1: Number of likes, which describes the audience's level of appreciation; (2) Variables second X2: Amount comments, which reflects the level of involvement of the active audience.

Method Data analysis

Data Preprocessing

Stage This crucial For ensuring data quality before analysis This process covering data cleaning from duplication empty data and irrelevant data is relevant The criteria "data is not relevant " in study This is defined as (1) Test datatest entries created by the developer during development system; (2) Identified interaction data as spam; and (3) Destination tourism that has the amount of interactions likes and comments is the same as zero, because No information variance is provided for the clustering process. Related missing values , research This uses aggregate datatotal likes and total comments so that transactional data is lost No become an issue For outliers destinations with very high interaction, the data No discarded It was decided that this outlier represents a phenomenon of real popularity and precisely important For identification by cluster. Potential influence of this outlier to sensitivity of the K-Means algorithm will be discussed in the analysis section (Shrifan et al., 2022; Cassisi et al., 2013). Finally, a data normalization process is carried outsuch as Min-Max Scaling so that the like and comment values own comparable scale, considering sensitive K-Means algorithm to difference scale variable

Implementation K-Means Algorithm

Determine Number of Clusters $K = 3$ According to with Category Destination Tour

For set $k = 3$ based on the goal strategic and practical from study this, namely For segmentation promotion Three clusters are considered the most intuitive For followed up by stakeholders interests authority tourism, which will represent three levels strategic; (1) Destination Popular priority tall for maintenance; (2) Less Popular Destinations potential For driven, and (3) Destination No Popular requires promotion intensive. Although method such as the Elbow Method or Silhouette Analysis can used For find the optimal 'k' mathematical research This prioritize 'k' that can interpreted and applied in a way directly Validation quality

from this $k=3$ option furthermore measured using Silhouette Score: (1) Determining the initial centroid in a way random; (2) Count Euclidean distance of each data to the centroid; (3) Grouping cluster data based on the nearest centroid; (4) Updates the centroid based on the average value in each cluster; (5) Repeat the process until the centroid No Again experience change significant Convergent.

Researchers realize limitations inherent from K-Means algorithm First K-Means is sensitive against outliers, which can distort centroid position In case In this case very popular destinations such as ' Ranowanko Beach' in Figure 2 can " pull " their cluster centroids However as has been mentioned identification of positive outliers This precisely is part from objective analysis Second K-Means assumes that the cluster is shaped spherical round and sized same Assumption This Possible No fully applies to real -world interaction data Therefore that the clustering results are validated No only in a way quantitative(Silhouette Score) but also quantitatively qualitative interpretation strategic for ensure its meaning

Implementation Web System

The results of the data grouping then integrated to in system web- based system This designed For display destination tour in accordance clustering results with category popular less popular and not popular

Evaluation of Results

Evaluation clustering results are carried out with use Silhouette Score metrics for evaluate quality grouping A Silhouette Score value approaching 1 indicates good clustering quality whereas mark approaching 0 indicates existence overlapping overlap between clusters (Hasan, 2024).

Research Flowchart Design

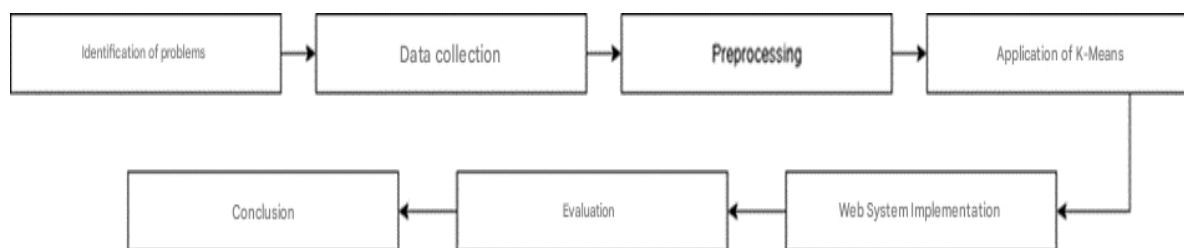


Figure 1 Research Flow

Results and Discussion

Clustering Results

K-Means algorithm with parameter $k = 3$ was successful. grouping destination tour Minahasa to in three clusters based on number of likes and comments For evaluate validity and quality grouping this used method internal evaluation with Silhouette Score metric Metric This measure how much similar data with its cluster itself cohesion compared with other clusters separation.

Table 1. 1 Tour Minahasa

Cluster	Label	Amount Destination	Average Likes	Average Comments	Silhouette Score
1	Popular	4	261	12	0.78
2	Less Popular	2	159	90	0.65
0	No Popular	22	14	2	0.59

Based on Table 1, cluster 1 Popular contains 4 destinations with highest like interaction average (261 likes). Cluster 2 Less Popular represents 2 destinations unique with medium like average (159 likes) but interaction very high comments average (90 comments). Lastly Cluster 0 No Popular accommodates 22 destinations the rest with interaction lowest average (14 likes and 2 comments). Silhouette Score value adopted from analysis beginning shows that separation between clusters already good and the clusters formed Enough dense cohesive. This is strengthen justification selection of $k=3$, because produce unstructured grouping only meaningful in a way strategic but also valid in terms of statistics. When K-Means algorithm is complete grouping data, it is necessary done evaluation For ensure that results grouping the truly good valid and not origin formed Evaluation This important because K-Means is unsupervised learning, so No there is an “ answer” true “ ground truth” for compared to.

Clustering Visualization

Clustering results are visualized in scatter plot form with X- axis number of likes and Y- axis number of likes comments Every color shows different clusters.

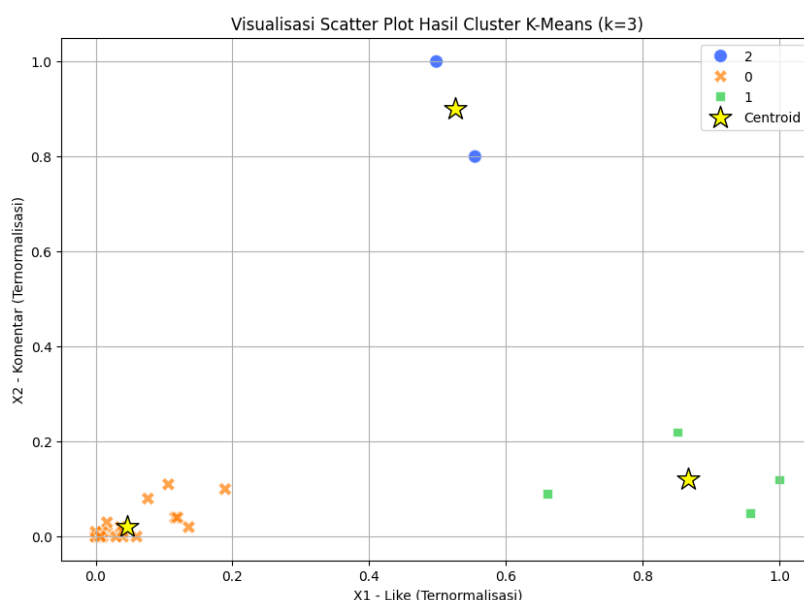


Figure 2. Destination Clustering Visualization Tour Minahasa

Visualization This show sufficient separation clear between three clusters. The Popular Cluster Green/Cluster 1 in the thesis is in the quadrant right shows high likes However comment low-medium The Less Popular Cluster Blue/Cluster 2 in the thesis is in the upper quadrant above showing very high comments Cluster No Popular Orange/Cluster 0 in thesis are collected on the left bottom showing low likes and comments

Implementation System

Result of implementation K-Means algorithm is integrated to in A web promotion system More from just technical data repository system This designed with focus on User Experience (UX) and convenience usage Target users main is stakeholders non- technical interests such as authority tourist local and tourists Therefore that interface designed to be intuitive and informative. System built use architecture web -based with Laravel framework and MySQL database technology This support functionality dynamic and management data. Destination data tourism name category number of likes, number of comments that have been processed by K-Means is displayed visually to user.

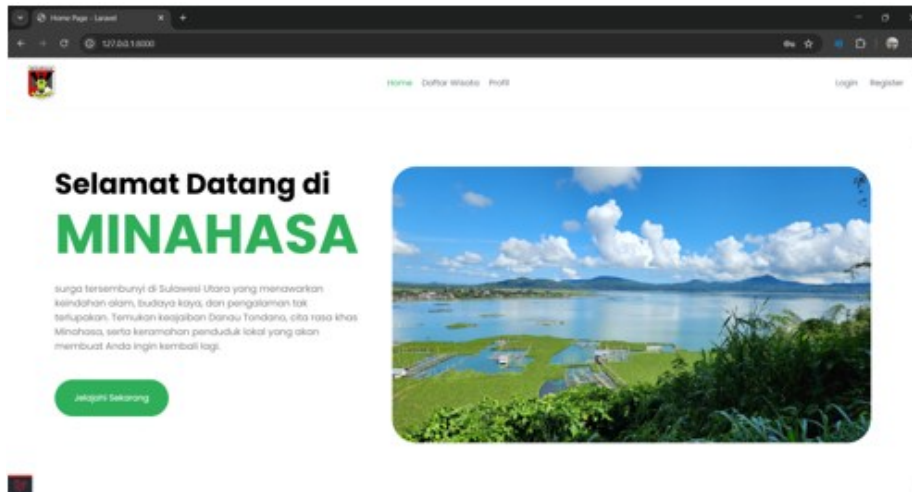


Figure 3. Home Page View

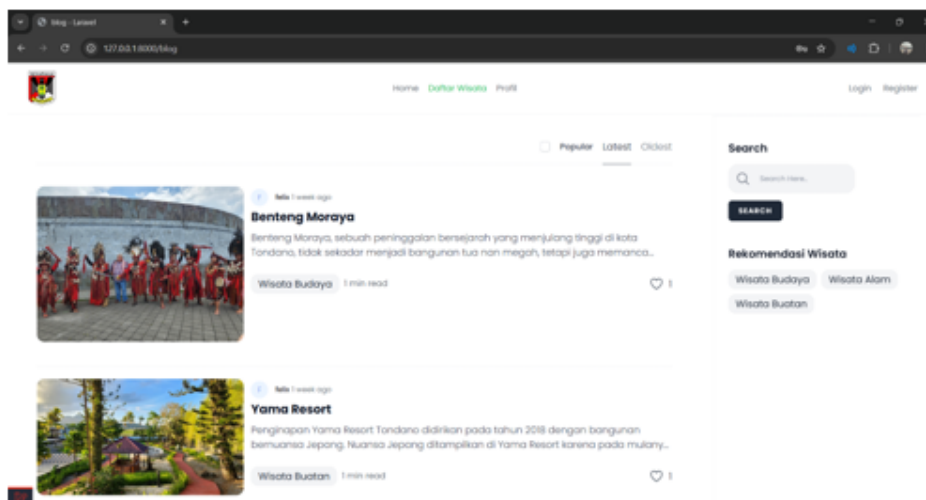


Figure 4. Tour List View

In Figure 4 Tourism List View, the user No only see the standard list but can also interact with functionality system There is "Search" feature for search directly as well as Recommendations "Tourism" that directs users to category specific Tourism Culture Nature Man-made. Appearance this is also in implicit show clustering results through "Popular", "Latest", and "Oldest" sorting features which allow users see destination based on popularity results from cluster).

In Figure 5 Clustering Results Display, the User can see 3 categories tour based on results from amount reviews that have been given by previous users with category the system makes it easier for users to looking for which tourist attractions are currently popular, quite popular, and less popular.



Figure 5. Clustering Results Display

Cluster Interpretation and Implications Strategic

Based on clustering results in Table 1, three segment destination succeed identified: (1) Identification Destination Popular Cluster 1 Contains 4 iconic tourism destinations Minahasa with very high like interaction Promotion strategy for this cluster is maintenance maintenance engagement and making him a brand ambassador for interesting traveler to Minahasa in a way general; (2) Strategy for Less Popular Destinations Cluster 2 Contains 2 destinations with character unique interaction very high comments. This shows deep engagement The right strategy is promote the "community" aspect or discussion unique in destination this; (3) Strategy for Destination No Popular Cluster 0 This are 'hidden gems' or destinations whose promotions Not yet effective covering 22 destinations This cluster requires the most intensive promotional strategy such as campaign specifically in social media creation video content or collaboration with influencers to increase exposure. Relative Silhouette Score values highaverage > 0.59) indicates that grouping This Enough good and valid in statistics strengthening that K-Means is effective For map popularity destination

Discussion of User Experience(UX) and Functionality System

Although implementation the beginningFigure 4 has covers feature base like search and category system This own potential big For improved use maximize User Experience UX. To serve non- technical users in a way effective functional system can enriched:

Advanced Filtering

Users must can filtering destination No only based on categories nature culture but also based on cluster results Popular Less Popular Not Popular) Popular. This allows tourists looking for "hidden gems" to filtering to Cluster 0 No Popular, or those who want visit place popular For filtering to Cluster 1 Popular.

Data Interactivity

Instead of static table cluster results can be served in visualization interactive For example a map Minahasa with popularity heatmap or bar chart interactive that allows users compare destination

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Limitations Scalability and Direction Development

Study This own a number of limitations at the same time open opportunity For future development Limitations main is use of snapshot datadata on one time. Aspect scalability is very important As increase destination tourism and interaction data volume system must capable accommodate improvement burden The use of the Laravel and MySQL framework provides strong foundation For scalability however database query optimization and caching possible needed in the future

For development next the system This can perfected with:

Real-Time Data Integration

Connecting system with social media API if allows to pulling like and comment data in real-time, so that the cluster can updated in a way dynamic for example daily) or weekly.

Analysis Sentiment

Developing Natural Language Processing(NLP) module for analyze text comments no only the amount This will differentiate "popular" destinations in a way negative " many complaints from the "popular" ones in a way positive.

Bait Come back Visitors(UGC): Integrating feature upload Photo or review direct from visitors who can become variables new for future clustering.

Conclusion

This study demonstrates that the K-Means algorithm can be effectively implemented to cluster Minahasa tourist destinations based on user interactions(likes and comments). The clustering process yields three strategic categories: popular, less popular, and unpopular destinations, with good clustering quality validated by the Silhouette Score. The clustering results have been implemented into a web-based system designed as a digital promotional medium. This system not only makes it easier for tourists to find destinations but also assists tourism managers in developing more targeted and data-driven promotional strategies.

Suggestion

Future development recommendations include focusing on improving the User Experience(UX) through filtering and personalization features, as well as real-time data integration and sentiment analysis, to increase the scalability and depth of the analytics system.

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