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Research Article

Sentiment Analysis of the Trending Topic #Indonesiagelap on X Using a Naive Bayes Algorithm Based on Particle Swarm Optimization

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Abstract: The rise of social media has created a digital public sphere that enables users to express their opinions on social and political issues openly and in real-time. One of the most discussed topics on social media platform X is the trending hashtag #IndonesiaGelap, which reflects public concern and criticism regarding various governmental and societal conditions. This study aims to conduct sentiment analysis on tweets containing the hashtag to determine the overall sentiment trend among users. The method employed in this research is the Naive Bayes classification algorithm, known for its simplicity and effectiveness in text classification. To enhance the model's performance, Particle Swarm Optimization (PSO) is applied to optimize feature selection and parameter tuning. The dataset consists of public tweets collected via the Twitter API, followed by preprocessing, feature extraction using TF-IDF, and sentiment classification into three categories: positive, negative, and neutral. The results indicate that the integration of PSO significantly improves the classification accuracy of the Naive Bayes model compared to the baseline. The majority of tweets related to #IndonesiaGelap exhibit a negative sentiment, indicating widespread public dissatisfaction and criticism. This research is expected to contribute to a better understanding of public perception and serve as valuable input for stakeholders in addressing social issues in the digital age.

Keywords: #IndonesiaGelap; Naive Bayes; Particle Swarm Optimization (PSO); Sentiment Analysis; Social Media X.

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1. Introduction

The development of information technology has transformed the way people express opinions and participate in social issues. One of the most actively used platforms is X (formerly Twitter), where users can express opinions, criticism, and support for various events in real time. This makes social media a highly valuable source of data for analysis, particularly in understanding public perceptions of trending issues.

One example of a social issue that attracted significant public attention was the trending topic #IndonesiaGelap, which reflected public concerns regarding social conditions, political situations, or government policies. This trend not only served as an indicator of public unrest but also generated thousands of tweets containing diverse emotional expressions, such as anger, disappointment, and sarcasm. To gain a deeper understanding of how public sentiment is formed regarding this issue, a scientific approach through sentiment analysis is required.

Sentiment analysis is an automated process of classifying opinions or emotions expressed in a text, typically into positive, negative, or neutral categories. One of the commonly used methods for text classification is the Naive Bayes algorithm due to its simplicity and effectiveness in handling document classification problems. However, the performance of Naive Bayes is highly dependent on feature selection and parameter settings, which often results in suboptimal accuracy when dealing with complex and diverse data such as tweets.

To address these limitations, Particle Swarm Optimization (PSO) is employed as an optimization method. PSO is a population-based metaheuristic algorithm inspired by the social behavior of bird flocks searching for food. By integrating PSO into the training process of the Naive Bayes model, it is expected that sentiment classification performance can be improved, particularly in selecting relevant features and optimizing parameters more accurately.

Based on this background, this study aims to conduct sentiment analysis of the trending topic #IndonesiaGelap on social media platform X using the Naive Bayes algorithm optimized with Particle Swarm Optimization (PSO), in order to obtain a more accurate understanding of public opinion emerging in the online environment.

2. Literature Review

Social Media

Social media refers to digital platforms that enable users to create, share, and exchange information, ideas, and content in the form of text, images, videos, and audio quickly and interactively. Social media facilitates two-way communication and real-time interaction among users. In the context of research, social media serves as a rich source of data due to its open nature and its ability to directly reflect public opinion.

Twitter / X

Twitter, now known as X, is a microblogging-based social media platform that allows users to post and read text-based messages of up to 280 characters, known as "tweets." This platform is widely used as a data source in research because of its ability to provide real-time opinions and information about current events from users around the world.

Naïve Bayes

Naïve Bayes is a probabilistic classification algorithm based on Bayes' Theorem, which assumes that each feature is independent of all other features. Despite its simplicity, Naïve Bayes has proven to be effective in various text classification tasks, including sentiment analysis. In this study, the Naïve Bayes algorithm is used to classify sentiment data from the X social media platform, with performance enhancement achieved through optimization techniques.

Particle Swarm Optimization

Particle Swarm Optimization (PSO) is a population-based optimization algorithm inspired by the social behavior of bird flocks or fish schools when searching for food collectively. PSO operates by utilizing a number of "particles" that represent potential solutions within a search space. Each particle moves and adjusts its position based on both its own best experience and the best experience of the swarm as a whole.

PSO is known for its simplicity of implementation, fast convergence, and strong global exploration capability. In the context of this research, PSO is employed to optimize the parameters of the Naïve Bayes algorithm in order to achieve more accurate classification performance in the sentiment analysis process. This optimization includes selecting the optimal parameter values that significantly influence the performance of the classification model.

Previous Research

Based on previous studies, sentiment analysis on social media has become an important approach for understanding public opinion on various issues. Several studies have applied the Naïve Bayes algorithm to classify sentiment from Twitter data, user reviews, and other textual sources. However, many researchers have reported limitations in the performance of the Naïve Bayes algorithm, particularly due to feature independence assumptions, data imbalance, noise in text data, limited datasets, and difficulties in capturing contextual meaning and semantic relationships within texts [1], [4], [5],. These challenges often result in suboptimal classification accuracy and highlight the need for optimization techniques to improve model performance.

To address these limitations, many studies have integrated Particle Swarm Optimization (PSO) with Naïve Bayes to perform feature selection and parameter optimization. The results consistently demonstrate that PSO can significantly improve classification performance across different domains and datasets. For example, the combination of Naïve Bayes and PSO increased classification accuracy in studies related to Google Meet and Zoom user reviews , public sentiment toward the Indonesian House of Representatives (DPR RI) [2], the Omnibus Law issue [3], Genose COVID-19 screening [6], the 2024 Indonesian Election [7], the PeduliLindungi application [9], Formula E Jakarta [14], presidential election opinions [16], customer reviews of delivery services [17], and public opinion regarding layoffs during the COVID-19 pandemic [19]. These findings indicate that PSO effectively enhances the capability of Naïve Bayes by selecting the most relevant features and optimizing model parameters.

In addition to optimization techniques, previous studies have emphasized the importance of comprehensive text preprocessing stages, including case folding, tokenization, stopword removal, stemming, lemmatization, normalization, and TF-IDF weighting to improve data quality before classification [8], [15]. Some studies also employed additional methods such as SMOTE to address class imbalance and improve model robustness [20]. Furthermore, researchers have suggested the use of larger and more diverse datasets, advanced Natural Language Processing (NLP) techniques, and alternative machine learning algorithms to further improve sentiment classification performance [10], [15], [18].

Overall, the literature demonstrates that sentiment analysis using the Naïve Bayes algorithm can effectively classify public opinion from social media data. However, its performance can be significantly improved through the integration of Particle Swarm Optimization (PSO), particularly for feature selection and parameter tuning. Therefore, the combination of Naïve Bayes and PSO has emerged as a promising approach for sentiment analysis tasks involving large-scale, dynamic, and unstructured social media data, making it suitable for analyzing public sentiment toward trending topics such as #IndonesiaGelap.

3. Method

Research Period

This study was conducted over a specific period covering the stages of planning, data collection, analysis, and final report preparation. The research was carried out from April 2025 to July 2025.

Research Location

This research was conducted online because all data used in the study were obtained from the X (Twitter) social media platform, which can be accessed through the internet. Therefore, the research location was not geographically limited. All processes of data collection, data processing, algorithm implementation, and result analysis were carried out using software applications operated in a digital environment (personal computer) that supports programming and data mining experiments.

Data Collection Method

The data collection method in this study consists of two types of data sources, namely primary data and secondary data, which were used to support sentiment analysis of the trending topic **#IndonesiaGelap** on X (Twitter). The explanation of each data source is as follows:

Primary Data

The primary data in this study consist of public tweets containing the hashtag #IndonesiaGelap, obtained directly from the X (Twitter) platform. These data were collected using web scraping methods through tools such as Tweepy or snscrape (Python), Search parameters based on the hashtag #IndonesiaGelap, Indonesian language filters and specific date ranges (for example, within 7 days after the topic became trending).

The primary data collection process was conducted digitally without direct interaction with users, as tweets are publicly accessible. The collected data include: Tweet text, Posting date, Other relevant information used for sentiment analysis.

Secondary Data

Secondary data are supporting data obtained from various literature sources, scientific journals, textbooks, and online documentation relevant to the research topic. These data are used to Develop the theoretical foundation related to sentiment analysis, data mining, the Naïve Bayes algorithm, and Particle Swarm Optimization (PSO), Compare the findings of previous studies with the results obtained in this research, Support the development of the research methodology and model evaluation techniques.

Some secondary data sources used in this study include: a. Data Mining by Han & Kamber (2012); b. Sentiment Analysis and Opinion Mining by Liu (2012); c. Scientific journals and conference proceedings from IEEE, Springer, Google Scholar, and other academic sources.

Data Sample

The data sample in this study consists of a subset of tweets containing the hashtag #IndonesiaGelap, selected for further analysis in the sentiment classification process. The sample was selected using a purposive sampling technique, which involves selecting samples based on specific criteria determined by the researcher.

The criteria for selecting the data samples are as follows:

a. Contains the hashtag #IndonesiaGelap. Only tweets that explicitly use this hashtag were included in the sample.
b. Written in Indonesian, Tweets written in foreign languages were excluded because the study focuses on public opinion within the Indonesian socio-political context.
c. Does not contain spam or promotional content, Tweets containing advertisements, promotional links, or content unrelated to the issue were filtered out.
d. Contains opinion-based content. Tweets that are purely descriptive or only disseminate information without a clear opinion were considered for classification as neutral or excluded from the sample if they did not meet the requirements for sentiment analysis.

Testing Design

The testing design was conducted to evaluate the performance of the sentiment classification model on tweets containing the hashtag #IndonesiaGelap. The testing process was carried out using several scenarios (routes) to compare the performance of the Naïve Bayes algorithm with and without optimization using Particle Swarm Optimization (PSO).

Table 1. Testing Design

No.	Testing Route	Description	Testing Objective
1	Naïve Bayes (Without PSO)	Uses the Naïve Bayes algorithm directly without any optimization process.	Serves as a baseline model for comparison with the optimized model.
2	Naïve Bayes + PSO	Applies the Naïve Bayes algorithm optimized with Particle Swarm Optimization (PSO) for feature selection.	Measures improvements in model accuracy and efficiency after optimization.
3	K-Fold Cross Validation (K = 10)	Validates the model using the K-Fold Cross Validation technique.	Prevents overfitting and ensures that the model performs consistently.

No.	Testing Route	Description	Testing Objective
4	Sentiment Visualization and Analysis	Conducts an analysis of the classification results (positive, negative, and neutral).	Identifies the distribution of public sentiment regarding the **#IndonesiaGelap** topic.

In this study, the methods used are Naïve Bayes and Particle Swarm Optimization (PSO). The data used in this research consist of tweets collected by searching for the hashtag #IndonesiaGelap. During the research process, initial data collection was first conducted, followed by the data extraction process. After that, data cleansing was performed to remove irrelevant and noisy data.

The next stage involved attribute selection to identify the most relevant features for the classification process. Subsequently, the CRISP-DM (Cross-Industry Standard Process for Data Mining) methodology was applied. This research follows the six stages of the CRISP-DM framework as the main guideline for conducting the study.

4. Results and Discussion

In this study, testing was conducted using the Naïve Bayes algorithm and Particle Swarm Optimization, with the following results:

Naïve Bayes Algorithm

The total dataset used was 431 records. The modeling results using the Naïve Bayes algorithm showed that the precision for correctly predicted positive data reached 100%, while negative sentiment data achieved a precision of 86.36%. Positive sentiment obtained a recall (specificity) of 100%, while negative sentiment achieved a recall of 97.86%. The overall accuracy produced by the Naïve Bayes model was 98.11%, as shown in Figure 1.

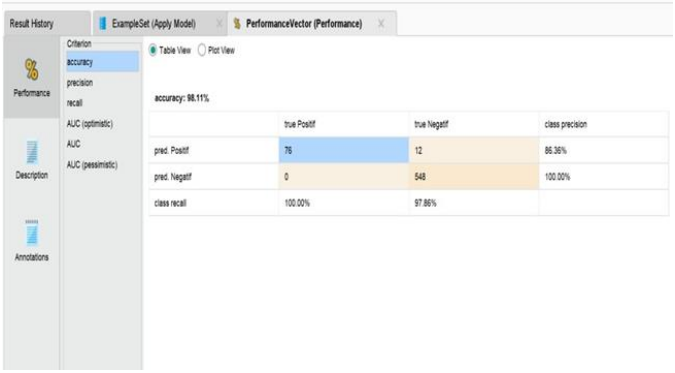

Figure 1. Naïve Bayes Accuracy Results

The results were further described by the RapidMiner application, as shown in Figure 2.

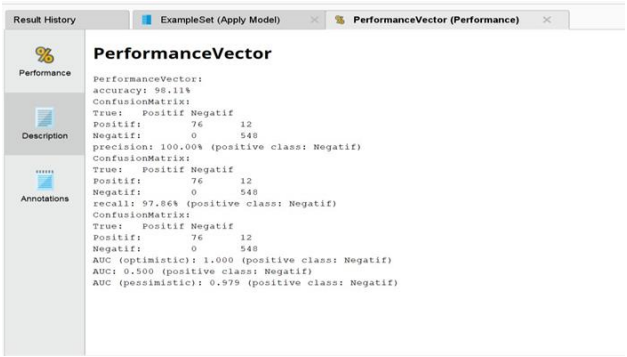

Figure 2. Naïve Bayes Accuracy Description

The plot view generated by the Naïve Bayes algorithm is shown in Figure 3.

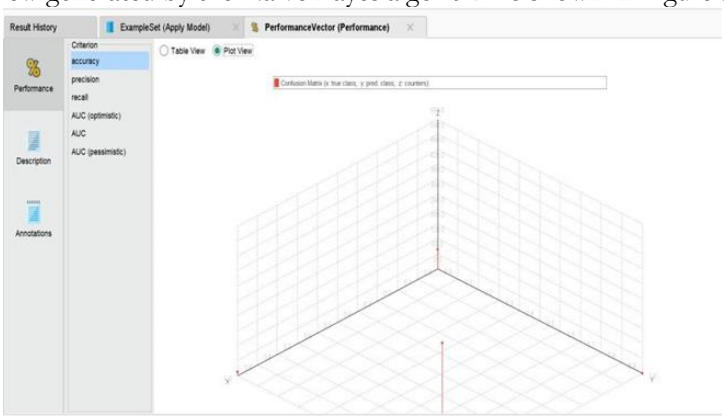

Figure 3. Naïve Bayes Plot View

The AUC (Optimistic) graph for the Naïve Bayes algorithm is shown in Figure 4.

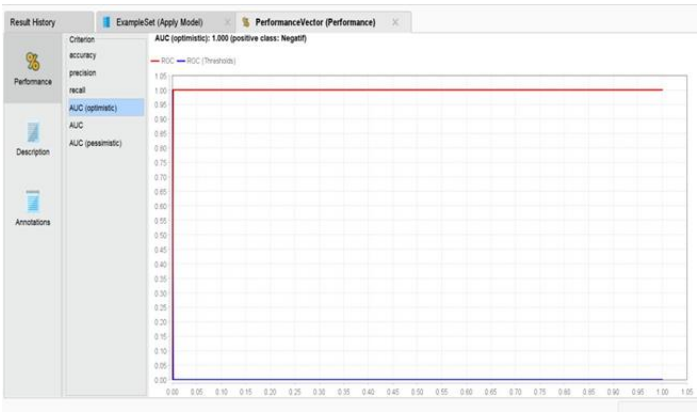

Figure 4. Naïve Bayes AUC (Optimistic) Graph

Based on the results above, it can be concluded that the Naïve Bayes algorithm is capable of classifying sentiment effectively using Indonesian-language data.

Particle Swarm Optimization (PSO) Algorithm

The total dataset used was 638 records. The modeling results using the Particle Swarm Optimization algorithm showed that the precision for correctly predicted positive data reached 90.71%, while negative sentiment data achieved a precision of 24.19%. Positive sentiment obtained a recall (specificity) of 48.39%, while negative sentiment achieved a recall of 76.88%. The overall accuracy produced by the Particle Swarm Optimization model was 73.11%, as shown in Figure 5.

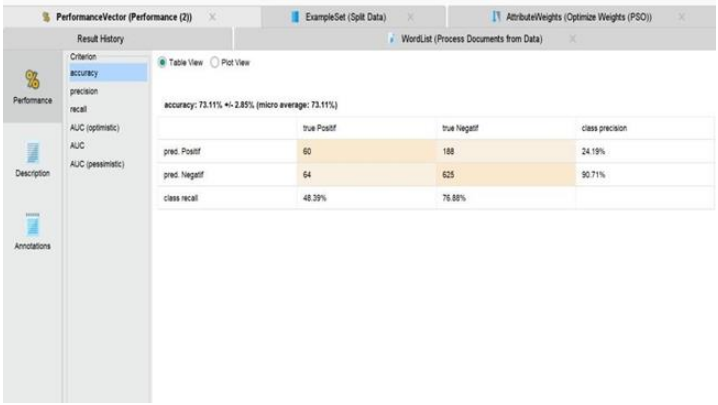

Figure 5. Particle Swarm Optimization Accuracy Results

The results were further described by the RapidMiner application, as shown in Figure 6.

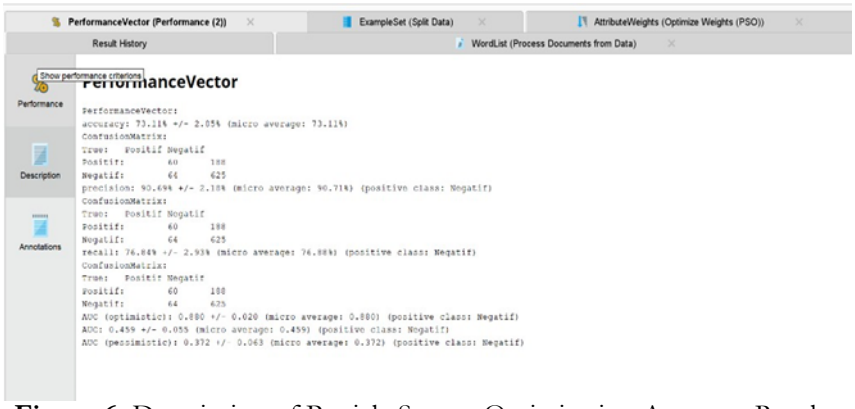

Figure 6. Description of Particle Swarm Optimization Accuracy Results

The plot view generated by the Particle Swarm Optimization algorithm is shown in Figure 7.

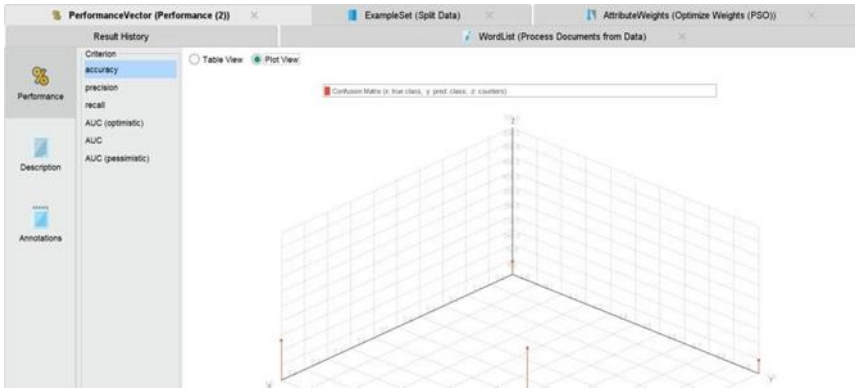

Figure 7. Particle Swarm Optimization Plot View

The AUC (Optimistic) graph generated by the Particle Swarm Optimization algorithm is shown in Figure 8.

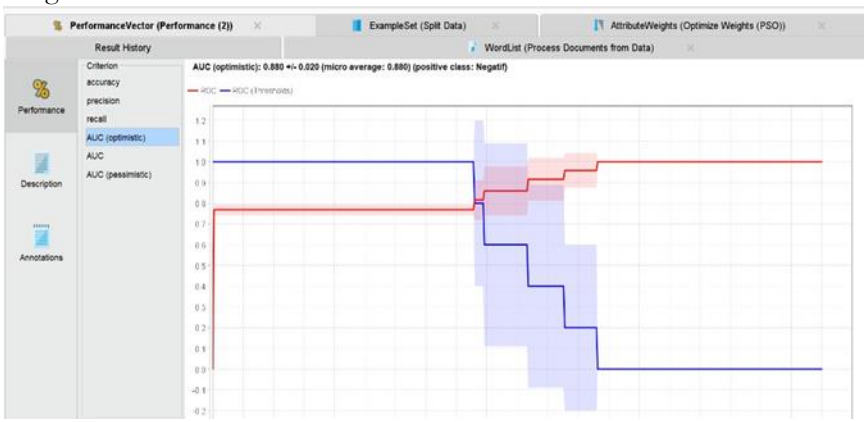

Figure 8. Particle Swarm Optimization AUC (Optimistic) Graph

Deployment

Based on the results above, it can be concluded that the Naïve Bayes algorithm is capable of classifying sentiment effectively using the Indonesia Gelap dataset.

The deployment stage of this study focused on presenting sentiment analysis results in the form of WordCloud visualizations. WordClouds are used to help readers understand the most frequently occurring words within each sentiment category, namely positive and neutral sentiments.

Positive Sentiment WordCloud

Figure 9 presents the positive sentiment WordCloud, displaying the words with the highest frequency of occurrence in positively toned tweets.

The word "semangat" appears as the most dominant term, indicating public support and motivation regarding the discussed issue.

The words "pagi," "selamat," and "semoga" reflect an optimistic tone and positive greetings among users.

The words "indonesia" and "pemerintah" indicate that the discussion context is related to national issues.

The words "terbaik," "janji," and "program" reflect public expectations regarding government performance and policies.

Several words such as "tuhan," "ibadah," and "demokrasi" indicate positive sentiments with religious and nationalistic nuances.

The size of each word in the WordCloud represents its frequency of occurrence, while color variations are used to distinguish between words.

Figure 9. Positive WordCloud Results

Negative Sentiment WordCloud

Figure 10 presents the negative sentiment WordCloud, containing dominant words found in negatively toned tweets.

The words "negara," "rakyat," and "indonesia" appear prominently, indicating the central topics receiving criticism.

The words "presiden," "pejabat," "pemerintah," and "rezim" suggest criticism directed toward government figures or institutions.

The words "korupsi," "bayar," "politik," and "hukum" reflect issues that have become subjects of negative public attention.

Several words such as "boneka," "mulyono," and "konoh" indicate sarcasm or ridicule directed toward certain parties.

Various colors are used in the WordCloud, while word size represents the frequency of occurrence in the dataset.

Figure 10. Negative WordCloud Results

This WordCloud visualization is an important part of the deployment stage because it provides a quick and intuitive overview of the dominant words in each sentiment category, making it easier for policymakers, researchers, and the public to understand public opinions regarding trending issues.

6. Conclusion

Based on the analysis and results obtained from this study on sentiment analysis of the trending topic #IndonesiaGelap on X (Twitter), several conclusions can be drawn. First, this study successfully implemented a systematic text mining workflow to classify public sentiment toward the trending topic #IndonesiaGelap. The method used proved effective in managing large volumes of unstructured data. Second, the Naïve Bayes model without optimization demonstrated excellent performance in sentiment classification for this dataset, achieving a very high accuracy rate of 98.11%. This result indicates that the basic Naïve Bayes algorithm is sufficiently reliable for this classification task. Third, the implementation of the Particle Swarm Optimization (PSO) method unexpectedly reduced the model accuracy to 73.11%. This finding suggests that, for the dataset used in this study, PSO was unable to select more optimal features and may have removed important features, resulting in suboptimal performance of the Naïve Bayes model. Finally, the sentiment analysis of tweets containing the hashtag #IndonesiaGelap revealed that the majority of public opinions were negative. This negative sentiment reflects a high level of criticism, disappointment, and public concern regarding the social and governmental issues being discussed.

Recommendations

Based on the findings of this study, several recommendations are proposed for future research. Future studies may expand the data sources by collecting data over longer periods and incorporating additional social media platforms to obtain more representative analytical results. The use of more advanced preprocessing techniques, such as lemmatization and slang word handling, may improve data quality before classification. Future research may also compare the performance of the Naïve Bayes + PSO approach with other algorithms, such as Support Vector Machine (SVM), Random Forest, or deep learning-based models, to evaluate performance differences. In addition, this research can be further developed into an automated sentiment analysis system capable of monitoring public opinion trends in real time to support decision-making processes. Finally, beyond the classification of positive, negative, and neutral sentiments, future studies may incorporate emotion analysis to provide a more detailed understanding of public responses.

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