

SENTIMENT ANALYSIS FOR THE 2024 PRESIDENTIAL ELECTION (PILPRES) USING BERT CNN

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ABSTRACT

The 2024 presidential election in Indonesia has generated tremendous enthusiasm on social media, particularly on the X platform. This research aims to analyze public sentiment regarding the 2024 presidential election by utilizing BERT and CNN methods. Sentiment analysis in the digital era is key to understanding the diverse social perspectives within society. The use of BERT, which has proven effective in understanding natural language context, and CNN, initially used for image analysis, will help in understanding public sentiment on X leading up to the 2024 presidential election. This is expected to lead to a more comprehensive understanding of the topic. Referring to previous studies that used techniques such as Naive Bayes, CNN, and BERT, this research explores the advantages of BERT and CNN in improving the accuracy of sentiment analysis on X related to political issues, particularly leading up to the 2024 presidential election. The research results show that the BERT model provides the best performance with an average accuracy of 90.02%, while CNN achieved 88.19%. The sentiment-based predictions using BERT for the three presidential candidates indicate that Prabowo Subianto is predicted to receive the highest support at 43.82%, followed by Ganjar Pranowo with 33.83%, and Anies Baswedan with 22.35%. A comparison of the prediction results with the actual election results shows that Prabowo Subianto was predicted to receive 43.82% of the vote, while the actual election results reached 58.58%, a difference of 14.76%. Ganjar Pranowo was predicted to receive 33.83% of the vote, while the actual results were 16.47%, with a difference of 17.36%. Anies Baswedan was predicted to receive 22.35% of the vote, with the actual result being 24.95%, a difference of 2.60%. This study indicates that the BERT model is effective in providing an accurate depiction of the 2024 Indonesian presidential election results.

KEYWORDS Sentiment, X, 2024 Presidential Election, BERT, CNN, Sentiment Analysis.



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INTRODUCTION

Indonesia has a democratic system, and elections are held regularly for various positions such as President, DPR member, Governor, Regent, and Village Head. These elections are the most important pillar of democratic development in Indonesia. The year 2024 will be the most important moment in Indonesia's democratic development with the highly anticipated presidential election. The public's enthusiasm for the elections is reflected in the increased participation on social media, especially on platforms such as X. X has become the main platform for Indonesians to participate in political discussions, express opinions, and follow developments related to the Presidential election (Vonega et al., 2022).

In the digital era, sentiment analysis on X is key to understanding and measuring people's diverse views on political issues, especially in the context of the 2024 presidential election. Statistics show that more than 132 million people in Indonesia use the internet, with 77% of X users considered active (Kurniawan & Susanto, 2019a). Sentiment analysis on the X platform helps identify trends in public opinion, such as support for political issues, evaluation of government performance, and perceptions of candidates. This information will be a key element in providing detailed understanding of voters in formulating campaign strategies and political policies that are responsive to the needs of the community in preparation for the 2024 presidential election (Jungherr et al., 2012).

However, sentiment analysis in X has been done by many researchers. Two methods used in sentiment analysis research are Convolutional Neural Network (CNN) and BERT (Bidirectional Encoder Representations from Transformer). CNN has been used in research to classify sentiment in text (Rakhlin, 2016). The results show that CNN has good performance and high accuracy. BERT using transformer approach is also popular in natural language processing (Devlin, 2018). CNN was originally used for image analysis and was useful in classifying images related to elections (Lecun et al., 1998). BERT can outperform many natural language processing tasks, including sentiment analysis. Combining BERT and CNN methods in Twitter sentiment analysis is a promising step. BERT, as a transformer-based model in natural language processing, has been proven effective in understanding natural language context. Combining these two methods can provide a more comprehensive and in-depth understanding of people's sentiment on X.

Based on this, this research proposes to use the BERT (Bidirectional Encoder Representations from Transformers) and CNN (Convolutional Neural Network) methods to analyze sentiment related to the 2024 presidential election. The purpose of this study is to determine the effectiveness of using natural language processing technology in analyzing political sentiment on social media. Previous research on Twitter sentiment analysis has used methods such as Naïve Bayes and Convolutional

Neural Networks (CNN). In addition, the results from sentiment classification can be used in predicting presidential candidate voters by analyzing the positive and negative sentiments towards each candidate. This sentiment data can help in identifying the level of support for each presidential candidate in Indonesia. By analyzing public sentiment, it not only classifies voters, but can be useful as a prediction tool in determining the final outcome of presidential voters.

Sentiment analysis or opinion mining is the process of understanding, extracting and processing text data automatically to obtain sentiment information contained in opinion text. Sentiment analysis is performed to determine a person's opinion or tendency towards a topic or object, whether the person has more negative or more positive views and opinions (Hulu & Lhaksana, 2019). Sentiment analysis research often uses multiple levels: document-level sentiment analysis and sentence-level sentiment analysis. Based on the level of the data source, sentiment analysis is divided into two main groups: coarse sentiment analysis and fine sentiment analysis. In coarse sentiment analysis, sentiment analysis is performed at the document level. Generally, the main focus of this type of sentiment analysis is to consider the entire content of the document as a positive or negative sentiment. Detailed sentiment analysis is sentence-level sentiment analysis. The main focus of detailed sentiment analysis is to determine the sentiment on sentences.

Table 1. Literature Review

No.	Reference Title	Research Results
1	Implementation of the K-Means Method and Naïve Bayes Classifier for Sentiment Analysis of the 2019 Presidential Election (Pilpres)[15].	The results of this weighting are in the form of positive and negative sentiments. Data was taken from Twitter regarding the 2019 presidential election as much as 500 tweet data. From the test results of 100 and 150 test data, the average accuracy is 93.35% and the error rate is 6.66%.
2	Community Sentiment Analysis on Quick Count Results Indonesian Presidential Election 2019 on Twitter Social Media Using the Naive Bayes Classifier Method[16].	The results show the best accuracy of 82.90% with $\alpha = 0.05$. The classification obtained 34.5% (471) positive tweets and 65.5% (895) negative tweets in the quick count result.
3	Sentiment Analysis on Twitter Social Media Towards Public Figures Participating in the 2019 Presidential Election[17].	From the results of these experiments, the best accuracy results can be obtained, namely using the third proportion with random data retrieval by getting an average accuracy value of 99.75%. As for the sentiment ranking of each public figure, it can be seen that the first rank is KHMa'ruf Amin,

		the second is Sandiaga Salahudin Uno, the third is Joko Widodo, and the last is Prabowo Subianto.
4	Sentiment Analysis of 2019-2024 Presidential and Vice Presidential Candidates after the Presidential Election Debate on Twitter[18].	The results of this study are that presidential candidate Joko Widodo-Makruf Amin received 25% positive sentiment, 4.5% negative sentiment, and 70.5% neutral sentiment. while the Prabowo Subianto-Sandiaga Uno pair received 5.1% positive sentiment, 2.5% negative sentiment and 92.4% neutral sentiment.
5	Sentiment Analysis of Public Perceptions of the 2019 Election on Twitter Social Media using Naïve Bayes[19].	Naive Bayes classification found that the 2019 election tweet dataset has a negative perception pattern of 52% which is much greater than the positive perception of 18% and neutral perception has a value of 31% higher than positive perception. The accuracy rate of Naive Bayes classification on the training dataset is 81% and the testing dataset is 76%, the average precision value for positive sentiment is 86.65%, negative sentiment is 77.15%, and neutral sentiment is 80.95% while the average recall value on positive sentiment is 36.8%, negative sentiment is 93.2% and neutral sentiment is 86.8%.
6	Sentiment Analysis of 2019 Presidential Election on Twitter using Maximum Entropy Method[20].	Maximum Entropy is the method used in this research with the evaluation method used is Confusion Matrix which will calculate the Macro and Micro averaging value of the resulting evaluation value. The results of the evaluation carried out in this study resulted in a fairly high Macro accuracy value of 89.16% with precision and recall values of 100% and 89.16% and also an F-measure value of 94.27%.

This research was conducted based on several references from previous studies that have links to the methods and topics raised. Research references are needed as a basis of knowledge, and can be a comparison material with the research to be carried out.

In the research "Performance Improvement Using CNN" (Nasichuddin et al., 2018). The research uses the CNN method. In this study, the authors tried to improve the accuracy and processing time of sentiment analysis using the CNN model. Meanwhile, in research (Y. Ajitama, S. S. Prasetyowati, 2021) sentiment analysis was conducted to predict presidential candidates for each party in the 2016 presidential election. Data was obtained from 33,708 tweets using the #Election2016 hastag where

the data collected included all existing candidates. After the data is collected, data labeling is done manually. With the naïve bayes method, the accuracy is 95.8%.

BERT has been used in several studies to analyze sentiment. BERT was used to classify whether a flood hashtag tweet was relevant or not to the actual flood disaster that occurred at that time. The training data used are labeled Indonesian tweets. The results of this sentiment analysis research obtained an accuracy of 79%. In research (Putri, 2020) BERT is used for sentiment analysis of movie review text. The training data used amounted to 1000 positive reviews and 1000 negative reviews and this data has been labeled. For several experiments, the highest accuracy of 73% was obtained.

In this research, BERT and CNN will be used to analyze sentiment in tweets, where this method has not been used in previous related research. With this, researchers expect the results of sentiment analysis, will have better quality compared to research that has been done before.

RESEARCH METHOD

This research method is carried out by referring to various references from previous studies that are relevant to the methods and topics raised. This research uses a combination of BERT and CNN methods to analyze sentiment in tweets related to the 2024 Presidential Election, which is a new approach in the context of this research. As a basis of knowledge, previous studies such as "Performance Improvement Using CNN" have shown that CNN can improve accuracy and efficiency in sentiment analysis. Another study used the Naïve Bayes method to analyze the sentiment of tweets related to the 2016 Election with an accuracy result of 95.8%. BERT has also proven effective in classifying sentiment in various contexts, such as tweets related to flood disasters and movie reviews, with accuracies of 79% and 73%, respectively. By combining the advantages of BERT in understanding deep linguistic context and CNN's ability to capture spatial features from text, this study aims to improve the quality of sentiment analysis on tweets compared to previous studies. Data will be collected from relevant tweets, processed, and manually labeled before being used to train BERT and CNN models separately, and then combined to evaluate the improvement in accuracy and efficiency.

RESULT AND DISCUSSION

The dataset that will be used in this research is collected through the Twitter platform. The data that will be taken is tweet data containing related to the 2024 presidential election. The data crawling process is needed first to connect to Twitter through API or Application Program Interface with python programming language. The crawling process is taken from tweets with the keyword Presidential Election 2024. The following are the results of crawling using the keyword Presidential Election 2024:

Table 2. Crawling Data

No.	Tweet
1.	RT @LANGKAHANIES: There should be no political intervention to block the 2024 presidential election, let alone party hacks.
2.	RT @triwul82: A number of representatives of the Coalition of Change who endorsed Anies as the 2024 presidential candidate held a closed meeting on Kaliage Island,
3.	RT @ajengcute16__: An Open Legal Policy, Perludem: It's Very Dangerous When the Election System is Decided by the Constitutional Court!

Labelling

Data labeling occurs before the classification process for the dataset. Each piece of information in the dataset is labeled as positive, negative and neutral by the researcher. In this context, a positive label is assigned if the piece of information reflects a desired state or is considered "true," such as support for a presidential candidate pair in Indonesia. Conversely, a negative label is applied to information that reflects an undesirable state or is considered "wrong," such as criticism in sentiment analysis. Meanwhile, neutral labels are given to pieces of information that do not show positive or negative polarity, such as news that presents facts without personal opinion judgments.

Data Preprocessing

In the pre-processing stage, the quality of the data is improved by various methods so that the classification process can be more accurate. The pre-processing stage includes:

Data Cleansing

The noise removal includes punctuation marks, and numbers to narrow down the redundant data information. The data cleansing process removes characters such as 'RT', '@', '!', '/', ':', by removing punctuation and numbers, the text data becomes cleaner and easier to analyze.

Case Folding

This stage converts all letters in the text to lowercase or uppercase. The purpose of case folding is to eliminate the difference between uppercase and lowercase letters in the text.

Stop Word

Next, common words such as which, and, in, to, from, on, with, is, for, in, this, that, me, you, and those that do not contribute significantly to the understanding of the text content are removed. This process is known as "stop word removal". In text analysis, the NLTK library provides a list of stopwords in various languages, including Indonesian, which can be used to remove these words from the text being analyzed.

Stemming

This stage reduces words to their basic form or "root word". The purpose of stemming is to remove word inflection and combine word variations that have the same root into one consistent form. In this study, researchers used the Sastrawi library to perform stemming. Sastrawi is a natural language processing (NLP) library for Indonesian that provides reliable and efficient stemming functions. The following is an example of stemming:

Table 3. Stemming

Before Stemming	After Stemming
Interdiction, some, carry, closed, is, Trick, amount, carry, close, look, dangerous, decided, meeting, do	danger, break, meet, sell

Split Data

The dataset that has been obtained is divided into two parts, namely training data and test data. The distribution ratio of the training data should be higher than the test data. Because the more data used to train the system, the better the results in classifying sentiment analysis. The ratio used to find the best split data ratio of training data and test data is 80:20.

CNN Learning

The model used in this research is a Convolutional Neural Network (CNN), which is implemented to calculate accuracy. The architecture of this model consists of a 1D convolution layer (Conv1D) to extract important features in the text, then there is a pooling layer ('MaxPooling1D') to reduce the dimensionality of the features and select the most relevant ones. Next, there is 'GlobalMaxPooling1D' used to generate a vector representation, then there is a fully connected layer ('Dense').

BERT Tuning

In this study, the BERT model was used to obtain the best accuracy. The BERT model used is pretrained with the 'bert-base-uncased' model, then fine-tuned. The fine-tuning process is based on the prepared sentiment data set. By using 'SparseCategoricalCrossentropy' loss function and 'Adam' optimization algorithm.

Convolutional Neural Network (CNN)

Convolutional Neural Network (CNN) is a deep learning method used to process multi-dimensional data. The advantage of CNN is that it can perform feature extraction. CNN consists of a series of layers that are able to convert a volume into a smaller volume. Usually this method is used to classify images and for now based on related research, many have discussed using CNN to conduct sentiment analysis (Naquitasia et al., 2022). The architecture of the CNN method is convolutional layer, pooling layer, and fully connected layer (Rahmanda & Setiawan, 2022). In sentiment analysis, the input is converted into embedded vectors by the embedding layer. The convolutional layer is the layer used to perform the convolution process used to extract features on the input. After that, it will be forwarded to the pooling layer which aims to reduce the dimensionality of the features which can speed up computation. Finally, the data will be flattened which changes the results in the pooling layer into one column and forwarded to the fully connected layer for classification.

Table 4. Convolutional Neural Network (CNN) Parameters

No.	Parameters	Explanation
1	Convolutional layer	A layer that applies convolution operations to extract features and input. These features can be patterns or structures of the processed text data.
2	Pooling layer	A layer used to reduce the dimensionality of convolved features, helping to speed up computation and reduce model complexity.
3	Embedding layer	A layer that converts words in the input text into numerical vectors that represent relationships between words.
4	Fully Connected layer	A layer that connects each neuron from the previous layer to each neuron in the next layer, allowing the model to make decisions based on the extracted features.

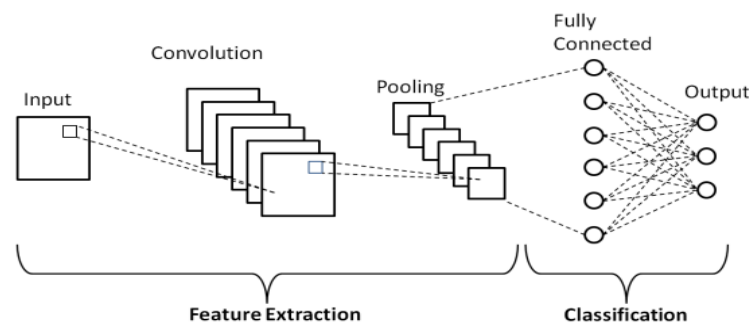
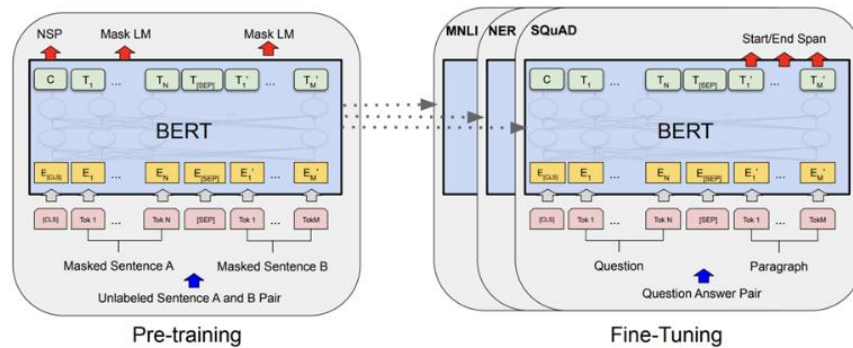


Figure 2. Convolutional Neural Network (CNN)

Bidirectional Encoder Representations from Transformer (BERT)

Bidirectional Encoder Representations from Transformers (BERT) is a language representation model using a fine-tuning approach (Sun et al., 2019). BERT is pre-trained unsupervised by conditioning the left and right contexts simultaneously for each layer. As a result, the pre-trained BERT model only needs a fine-tuning process by adding one output layer to be able to handle various tasks.



Bidirectional Encoder Representations from Transformer (BERT)

Evaluating Convolutional Neural Network (CNN) and BERT models for a specific task involves analyzing the confusion matrix with respect to metrics such as True Positive (TP), True Negative (TN), False Positive (FP), and False Negative (FN). The next step is to calculate the power values, such as accuracy, precision, recall, and F1-Score, which will provide a thorough understanding of the performance of both models.

$$\text{accuracy} = \frac{TP+TN}{TP+TN+FP+FN} \tag{1}$$

$$\text{precision} = \frac{TP}{TP+FP} \tag{2}$$

$$\text{recall} = \frac{TP}{TP+F} \tag{3}$$

$$\text{F1-Score} = 2 \times \frac{\text{precision} \times \text{recall}}{\text{precision} + \text{recall}} \tag{4}$$

In the context of CNN using several hyperparameters such as a tokenizer that has a size of 10,000 and an embedding length of 128. The model is trained using K-FOLD Cross validation with 5 folds to ensure accurate model evaluation. Adam optimizer with learning rate 0.001, loss function 'categorical_crossentropy' and metric 'accuracy'.

On the BERT side, it uses several hyperparameters such as 'bert-base-uncased' as a tokenizer. Then, using K-FOLD Cross Validation with fold 5. The BERT model used, 'TFBertForSequenceClassification'. Optimization using Adam optimizer with 'learning_rate=2e-5', equipped with 'epsilon=1e-08' and 'clipnorm=1.0',

By including information on these hyperparameters, this research provides a solid foundation for understanding the extent to which model performance is affected by specific configurations and parameters. This analysis not only supports the

evaluation of the model, but also provides a foundation for further development and improvement on the classification and optimization strategies of CNN and BERT models.

Best Model (BERT)

After conducting an accuracy test between the CNN model and the BERT model, BERT showed better performance than CNN. Therefore, the BERT model was chosen to predict the three 2024 presidential candidates in Indonesia.

Presidential Candidate Predictions

In this study, the prediction of the third presidential candidate uses the best model obtained from the accuracy test. The accuracy test uses two models, the CNN model and the BERT model. BERT model becomes a model for predicting the third presidential candidate. The BERT model used BERT nlptown/bert-base-multilingual-uncased-sentiment.

Mentions Classification

The data set used for mentions classification uses an unlabeled data set containing 18,000 tweets. The mentions classification process uses the BERT model. The BERT model used for mentions classification uses nlptown/bert-base-multilingual-uncased-sentiment. This model is good at determining reviews in the form of tweets.

Author Sentiment Determination

Data sets that have been classified using the BERT model, then the process of determining author sentiment support manually. After determining the form of author support for the three candidates, the data set is filtered and separated by the form of support for the three presidential candidates.

Author duplication removal

In this research, author duplication removal is useful to avoid the existence of more than one form of author support. The removal of duplicate authors is done manually for the three 2024 presidential candidates in Indonesia.

Presidential Candidate Prediction

This section discusses the prediction of the percentage of the three 2024 presidential candidates in Indonesia based on the classification of mentions using the BERT model "nlptown/bert-base-multilingual-uncased-sentiment". These predictions are used to provide insight into the election results based on sentiment data from social media X.

Determination of the Best Sentiment Model

This research aims to analyze sentiments related to the 2024 presidential election using BERT and CNN. The data set used was obtained from X using the keyword

Pilpres 2024 which amounted to 5000 data. After obtaining the data, a pre-processing process is carried out including data cleansing, tokenizing, stop word, stemming, and case folding. The pre-processed data set is then manually labeled to determine the sentiment class of each tweet. Sentiment classes are divided into three categories, positive, negative, and neutral. After labeling, the results show that there are 2,129 positive, 1,480 negative, and 1,388 neutral.

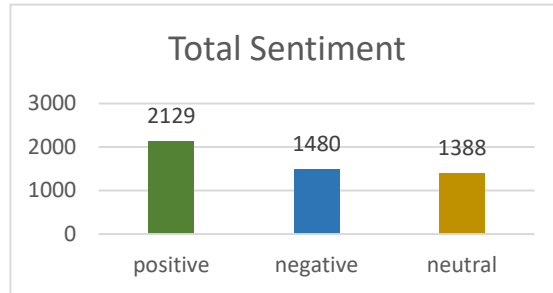


Figure 4. Total Sentiment

Based on Figure 4, the data that has been manually labeled is then divided into 80% training data and 20% test data. Training data is used to train BERT and CNN models in order to recognize sentiment patterns in the data set. Meanwhile, test data is used to evaluate the performance of the model in determining the accuracy of the model's performance in classifying sentiment.

After conducting research on sentiment analysis using the BERT and CNN models, the results show that the two models provide almost similar performance in the accuracy test. The results of the accuracy test show that BERT has an average accuracy of 90.02%, while CNN has an average accuracy of 88.19%. These results show that BERT is slightly superior in classifying sentiment.

Table 5. Comparison of BERT and CNN Accuracy Results

Model	Precision	Recall	F1-Score	Accuracy
BERT	90%	90%	90%	90.02%
CNN	88%	87%	87%	88.19%

Based on the test results in the table, it can be seen that the BERT model produces the best test performance. Research using the BERT model achieved 90% precision, 90% recall, 90% F1-score, and 90.02% accuracy. These proportions indicate an optimal balance between training and testing data, allowing the model to effectively classify sentiment using new data with high accuracy and performance.

Three Presidential Candidates' Predictions

After conducting accuracy tests using the BERT and CNN models, researchers predicted 3 candidates using the BERT model. The BERT model was chosen because

in determining the best sentiment model, the BERT model got better accuracy results compared to the CNN model. The data set used to predict 3 candidates uses an unlabeled data set with a total of 18,000 data. Next, perform the labeling process using the BERT model. The BERT model used to perform the sentiment classification process uses `nlptown/bert-base-multilingual-uncased-sentiment`, this model is good for performing sentiment classification, so the performance in recognizing and classifying sentiment is better. After the classification process, the results are shown in Table 6.

Table 6. Classification of presidential candidate sentiments

Congressman	Positive	Negative	Sum
Prabowo Subianto	5333	2554	7887
Ganjar Pranowo	4336	1754	6090
Anies Baswedan	2649	1374	4023

Based on table 6, sentiment analysis of 18,000 tweets related to the 2024 presidential candidate using the BERT model with keywords according to each candidate "Prabowo", "Ganjar", "Anies". Prabowo Subianto received 5,333 positive and 2,554 negative labels, Ganjar Pranowo received 4,336 positive and 1,754 negative labels, while Anies Baswedan received 2,649 positive and 1,374 negative labels. After performing sentiment classification using BERT, researchers removed duplicate authors, authors who had more than one mention were removed so that the author only had one mention. Then, we predicted the three candidates by counting the number of positives.

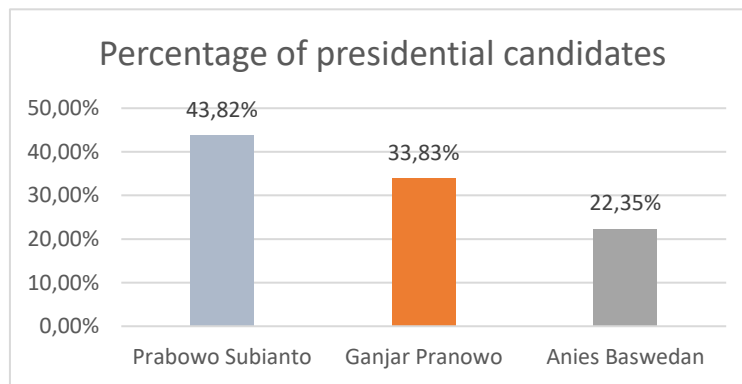


Figure 5: Percentages of the three Candidates

Based on Figure 5, after predicting the three candidates for each of the 2024 Indonesian presidential candidates, it shows that Prabowo Subianto obtained the highest prediction result of 43.82%. Ganjar Pranowo came second with a predicted support of 33.83%, while Anies Baswedan received the lowest predicted support with

a percentage of only 22.35%. Based on the percentage of the three candidates, Prabowo Subianto has the greatest chance of winning the 2024 presidential election in Indonesia.

Table 7. Comparison of Candidate Predictions and Real Election Results

Congressman	Candidate Percentage	
	Prediction	Real election results
Prabowo Subianto	43,82%	58,58%
Ganjar Pranowo	33,83%	16,47%
Anies Baswedan	22,35%	24,95%

In this study, researchers compared the predicted votes of three presidential candidates in the 2024 Indonesian presidential election with the real election results. Prabowo Subianto obtained the highest result of 43.82%, while the real election result obtained 58.58%, with a difference of 14.76%. This result shows that the model is quite accurate in identifying factors that contribute to Prabowo Subianto's victory. Ganjar Pranowo was predicted to get 33.83% of the votes, but the actual results showed only 16.47% of the votes, with a difference of 17.36%, indicating that the model had identified, but some factors were not detected. Meanwhile, the prediction for Anies Baswedan shows very high accuracy, with the model predicting 22.35% of the votes and the real result of 24.95%, with the smallest deviation of 2.60%, this result shows a relatively accurate prediction. Analysis of presidential candidate predictions using the BERT model can provide predictions for the three candidates quite close to the real election results.

CONCLUSION

Based on research regarding sentiment analysis of the 2024 presidential election, this study utilizes the BERT model and CNN to analyze 5000 tweets obtained with the keyword "Presidential Election 2024". The pre-processing process includes data cleansing, tokenizing, stop word removal, stemming, and case folding. The processed data was then manually labeled into three sentiment categories: positive, negative, and neutral, with a distribution of 2,129 positive, 1,480 negative, and 1,388 neutral. The analysis results show that the BERT and CNN models provide almost similar performance in terms of accuracy, with BERT slightly outperforming, achieving an average accuracy of 90.02% compared to CNN which obtained 88.19%. The BERT model also showed the best performance with precision, recall, F1-score, and accuracy scores of 90% each. In predicting the support for three presidential candidates using the BERT model on 18,000 unlabeled data, the results showed that Prabowo Subianto obtained the highest predicted support of 43.82%, followed by Ganjar Pranowo with 33.83%, and Anies Baswedan with 22.35%. The comparison between the predicted results and the real election results showed that the prediction for Anies Baswedan was quite close to the real results with a difference of around 2.60%, while the predictions

for Prabowo Subianto and Ganjar Pranowo showed significant differences of 14.76% and 17.36%. This study shows that the BERT model is effective in sentiment analysis and political support prediction, and provides a fairly accurate picture of the actual election results.

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