Utilization of Public Sentiment Analysis on Electric Vehicles to Assist Government Policy

[redacted]

Abstract— The Indonesian government has committed to reducing greenhouse gas emissions. One of the efforts made is to encourage the use of electric vehicles. However, the level of acceptance of electric vehicles depends on public sentiment. This study aims to determine the sentiment of the Indonesian people towards electric vehicles and recommendations so that the adoption of electric vehicles can develop in Indonesia. Sentiment analysis was conducted using the Naïve Bayes classification algorithm and an accuracy of 82% was obtained. The results of the sentiment analysis on electric vehicles show that of the 717 test data, 334 tweets were classified as positive sentiment, 196 tweets as negative sentiment, and 187 tweets as neutral sentiment. Based on the results of sentiment analysis, several recommendations so that the adoption of electric vehicles can continue to grow in Indonesia, namely developing battery technology, solutions for handling electric vehicle battery waste, adequate infrastructure development, and increasing public awareness and insight into electric vehicles.

Keywords: Sentiment Analysis, Naïve Bayes, Electric Vehicles, Battery

I. Introduction

The Indonesian government has shown a commitment to reducing greenhouse gas emissions. This is evidenced by the NDC (Nationally Determined Contribution) target submitted in an international forum [1]. Land transportation is the largest contributor to greenhouse gas emissions in the transportation sector, with a share of more than 90% [2]. The government has pursued various strategies to reduce greenhouse gas emissions in Indonesia, such as encouraging the use of environmentally friendly vehicles such as electric vehicles, and establishing regulations and policies to address greenhouse gas emissions. However, the existence of electric vehicles in Indonesia is still a matter of debate. Some believe that electric vehicles are seen as an effective solution to combat air pollution, while others believe that the switch to electric vehicles requires careful preparation, especially in terms of infrastructure [3].

The Ministry of Energy and Mineral Resources has set a target by 2030 of 2 million electric cars and 13 million electric motorcycles for the penetration of electric vehicles [4]. To achieve this target of electric vehicle adoption, the government needs to know the sentiment or perception of the Indonesian people towards electric vehicles. Sentiment from this community can be a benchmark of the level of adoption of electric vehicles [5]. By knowing people's perceptions of electric vehicles, the Indonesian government can make regulations and policies that are by people's perceptions, so it is hoped that the vehicle adoption target in Indonesia can be achieved.

Previous research was conducted by Laurensz & Sediyono in 2021 which discussed analyzing public sentiment towards vaccination measures to overcome the Covid-19 pandemic. The data used in this study were 845 tweets, with the keywords "vaccinemerahputih" and "vaksinsinovac". Furthermore, the data is divided into 253 training data and 592 test data. Classification of community sentiment was carried out using the SVM and Naïve Bayes methods. By using the Naïve Bayes method, an average accuracy of 85.59% was obtained while SVM was 84.41%. The Naïve Bayes method with the keyword "vaksinsinovac" obtained a positive sentiment of 66% and negative 34%, while "red and white vaccine" obtained a positive sentiment of 89% and negative 11%. SVM method with the keyword "vaksinsinovac" gets 96% positive sentiment and negative 4%, while "vaksinmerahputih" received 98% positive and 2% negative sentiment [6].

Through sentiment analysis of electric vehicles, this research will provide an overview of the Indonesian public's perception of electric vehicles as well as recommendations to increase the adoption of electric vehicles in Indonesia. From these recommendations, it is hoped that it can help the government in establishing regulations and policies to support the use of electric vehicles in the future.

Sentiment analysis is performed using the Naïve Bayes method by utilizing Twitter data using keywords related to electric vehicles and the sentiment is classified into three classes: positive sentiment, neutral sentiment, and negative sentiment.

II. Literature Study

A. *Sentiment Analysis*

Sentiment analysis aims to obtain opinions or opinions from users, be they positive, negative, or neutral opinions [7]. Sentiment analysis can predict a person's emotions, attitudes, and personality shown in the form of different aspects.

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B. Data Crawling

Data crawling or also called web crawling is the process of extracting and collecting data either from the World Wide Web (www), big data collections, documents, files, and others. Web crawling uses bots or spiders to read and store all website content so that it can be entered and indexed.

C. Snscrape

The Snscrape library requires Python with a minimum version of 3.8. This library can also set the time range of data to be crawled [8]. Snscrape requires a query that can be used to collect tweet data as needed. The query can be determined by using the advanced search feature on Twitter.

D. Python

Python is a popular programming language created in 1991 by Guido Van Rossum. Python can be used to create server-side web applications, software development, handle big data, and solve complex math problems.

E. Data Preprocessing

The purpose of the preprocessing stage is to remove words that are not important or irrelevant [9]. In this stage, several processes are carried out starting from case folding, removing users, removing emoticons, stemming, stopwords, and tokenizing.

F. Naïve Bayes

Naive Bayes Classifier is widely used in text classification, especially for filtering email spam, sentiment analysis recommendation systems, and others [10]. Bayes' theorem comes from the idea that data attributes are statistically uncorrelated. This method performs classification by knowing the value of the probability P (X|Y) by knowing the probability of class X. Then, the value of P (X|Y) is chosen based on the probability of class Y.

$$P(X|Y) = \frac{P(Y|X) . P(X)}{P(Y)} \quad (1)$$

Keterangan:

Y: Data with unknown class
X: Hypothesis is class specific
P(X|Y): Probability of hypothesis X based on Y (posterior)
P(X): Probability hypothesis X (prior probability)
P(Y|X) : Probability Y base on X
P(Y) : Probability Y

Some types of classification using the Naïve Bayes algorithm are described as follows.

1. Naïve Bayes Multinomial is one type of Naive Bayes method which is mostly used to classify document types.
2. Bernoulli Naïve Bayes, this type is similar to the multinomial type, but the classification focuses on a yes or no outcome. Predictors are entered as Boolean
3. Gaussian Naïve Bayes, this type uses the Gaussian distribution where the Gaussian distribution theory assumes that the distribution of continuous values associated with each feature contains numerical values.

G. TF-IDF

TF-IDF or Term Frequency and Inverse Document Frequency are defined as two metrics that are closely related and used to find and identify the relevance of a particular word in a document.

H. Feature Selection Using Chi-Square

Feature selection is a commonly used data mining technique at the preprocessing stage. In the context of feature selection, the Chi-Square method is used as a filter approach method for feature selection. Feature selection using Chi-Square aims to reduce the dimensionality of the data by selecting relevant words.

I. Measurement Method

The measurement method contains how the measurement results from the performance of classification and analysis of community sentiment in the form of text obtained through Twitter data using several references such as accuracy, precision, recall, and f1-score.

III. METHOD/DESIGN

A. System Overview

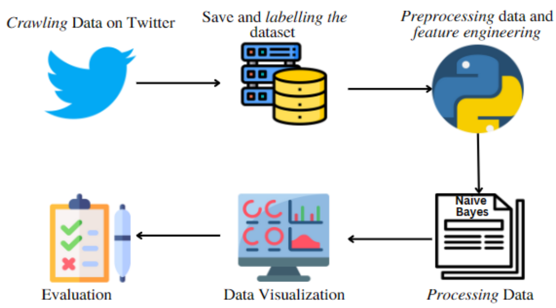

Figure 1. System Overview

The following is an overview of the system to be created, this research requires a dataset to train the machine learning model so the data collection process needs to be carried out, the data used in this study is tweet data originating from Twitter related to electric vehicles and collected using Snscrape. After the data crawling process is complete and the Twitter data has been collected, the data is stored in CSV format, which is then followed by a manual data labeling process.

The next process is data preprocessing, where the data that has been labeled is then cleaned before being used to perform sentiment classification. After going through the data preprocessing process, then the feature engineering process is carried out which includes the word weighting stage using a combination of TF-IDF and N-gram and conducting feature selection using Chi-Square. The next stage is data processing, in this stage the data analysis process is carried out, namely classifying positive sentiment, neutral sentiment, and negative sentiment using the Naïve Bayes algorithm.

After processing the data, data visualization is then carried out to present the data in graphical form so that the information provided can be more easily understood. In this study, data visualization was carried out using the Matplotlib and Seaborn libraries in Python. After visualizing the data, the last step is evaluation by measuring the performance of the sentiment analysis system in classifying data. Performance measurement is done using a confusion matrix to get results in the form of accuracy, precision, recall, and f1-score.

B. Data Crawling

Crawling data is done with the Snscrape library in the Python programming language using keywords related to electric vehicles. The tweet data collected amounted to 4.500 tweet data. Data that has been successfully collected, is then stored in CSV format and manually labeled the data.

C. Data Analysis Using Naïve Bayes

The initial stage in performing classification with the Naïve Bayes algorithm is inputting the preprocessing dataset. Where preprocessing is a stage of removing words and symbols that are not needed.

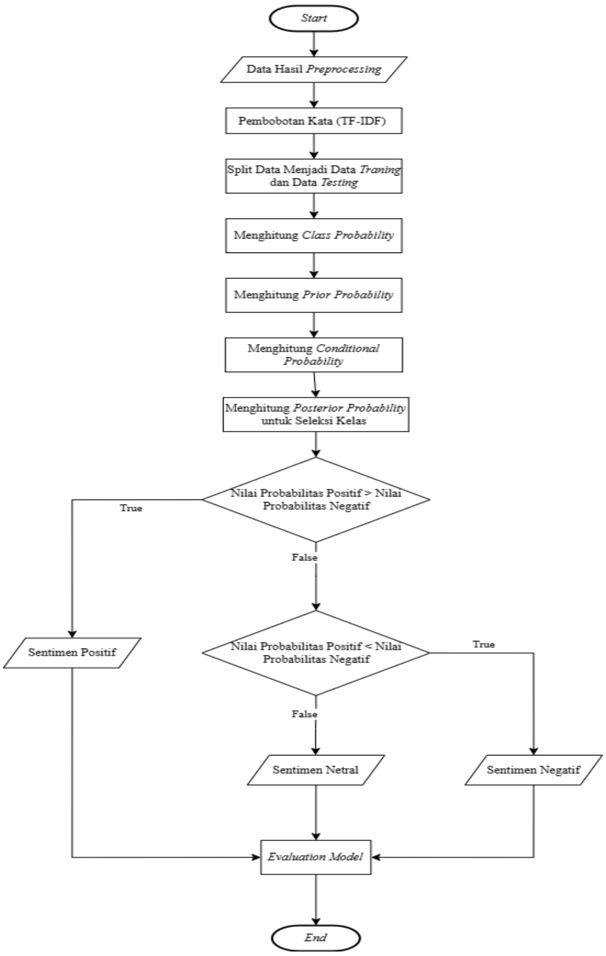

Figure 2. Flowchart of Naïve Bayes Model

After the preprocessing stage is complete, the next stage is to perform word weighting or TF-IDF using the TfidfVectorizer method. Python programming can use the scikit-learn and MultinomialNB libraries.

After converting the data into the TF-IDF Vectorizer form, then split the data or divide the data into training data (training data) and testing data (test data). This training data will be used for model deployment while the testing data will be used to evaluate the model.

The next stage is modeling with the Naive Bayes algorithm which starts by calculating the probability of existing classes and calculating the prior probability or hypothesis probability then calculating the conditional probability and finally calculating the posterior probability value or the probability of event A based on event B.

The Naïve Bayes algorithm will classify sentiment into three classes: positive sentiment, neutral sentiment, and negative sentiment. Sentiment will be categorized as positive sentiment if it has a positive probability value greater than the negative probability value, while sentiment with a positive probability value smaller than the negative probability value will be categorized as negative sentiment. Meanwhile, sentiments that do not meet both requirements will be categorized as neutral sentiments. After the classification process is complete, the next step is to measure the performance of the model in the form of accuracy, precision, recall, and f1-score to see the success rate of the model created. The confusion matrix is one of the evaluation methods that can be used to calculate the performance or accuracy of the classification process. Data from the confusion matrix is used to calculate the F1-score, accuracy, precision, and recall values as shown in the equation [11].

$$\text{Accuracy} = \frac{TP+TNg+FNt}{TP+FNg1+\cdots+FNg2+TNt} . 100\%$$

$$\text{Precision positive} = \frac{TP}{TP+FP1+FP2} . 100\%$$

$$\text{Precision negative} = \frac{TNg}{FNg1+TNg+FNg2} . 100\%$$

$$\text{Precision neutral} = \frac{TNt}{FNt1+FNt2+TNt} . 100\%$$

$$\text{Recall positive} = \frac{TP}{TP+FNg1+FNt1} . 100\%$$

$$\text{Recall negative} = \frac{TNg}{FP1+TNg+FNt2} . 100\%$$

$$\text{Recall neutral} = \frac{TNt}{FP2+FNg2+TNt} . 100\%$$

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

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Dimana TP = True Positive, TNg = True Negative, TNt = True Neutral, FP = False Positive, FNg = False Negative, dan FNt = False Neutral.

		Prediction		
		Positive	Negative	Neutral
Actual	Positif	True Positive (TP)	False Negative1 (FNg1)	False Neutral 1 (FNt1)
	Negative	False Positive 1 (FP1)	True Negative (TNg)	False Neutral 2 (FNt2)
	Neutral	False Positive 2 (FP2)	False Negative2 (FNg2)	True Neutral (TNt)

Gambar 3. Confusion Matrix

IV. Result and Discussion

A. *Realization of Collecting Twitter Data*

The process of collecting data from the Twitter social media platform can be done with a method called data crawling. Tools that can be used to collect data Snscrape. Snscrape is an open-source tool capable of retrieving data from several social media platforms, including Twitter, Instagram, and Reddit.

B. *Realization of Data Preprocessing*

Preprocessing text data in Natural Language Processing is the first step in processing text data before further processing. Preprocessing aims to remove unnecessary characters such as punctuation marks, change capitalization, remove common words or stop words, perform stemming or lemmatization to convert words to their base form and perform tokenization to break up the text into tokens. Through preprocessing, text data can be organized in a more structured way and easy to analyze so that the analysis results can be better and more accurate.

C. *Feature Engineering Realization*

Feature engineering is carried out to improve data quality, increase prediction accuracy, speed up model training time, and reduce overfitting or underfitting. The feature engineering process carried out is the weighting of words using a combination of TF-IDF and N-Gram then feature selection using Chi-Square

D. *Realization of Naïve Bayes Modeling*

The first step in modeling using Naïve Bayes starts with importing a library such as Scikit-learn, DateTime, and Joblib. Then use train_test_split to divide the dataset into training and testing data with a division of 20% used as testing data and 80% used as training data. The Naive Bayes Multinomial method is applied with the parameters alpha = 0.01 and "fit_prior" = "True". Next, train the Naïve Bayes model using training data, the data that has been successfully trained is saved in Joblib format with the file name "model_nb.joblib". After the model is saved, the next step is to test the testing data. The results of the Naive Bayes model testing process are displayed in the form of an array. The array contains 717 values, the array values range from 0 to 2, where 0 = negative label, I = neutral label, and 2 = positive label

E. *Naïve Bayes Modeling Results*

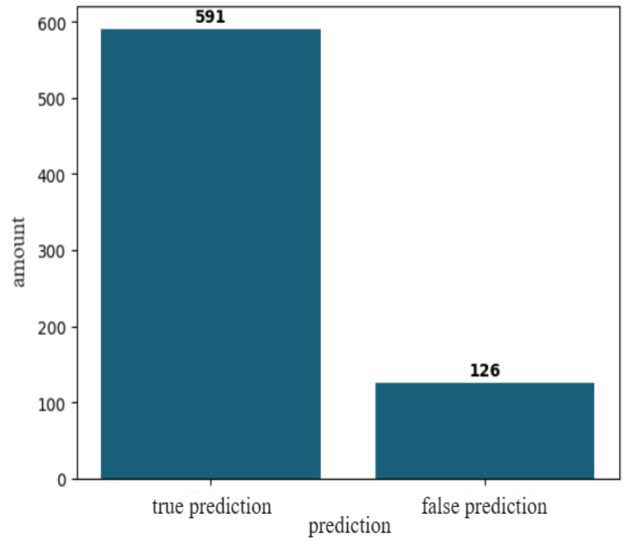

Figure 4. Amount of True and False Predictions of Naïve Bayes Model

Based on system testing using 717 test data on the Naïve Bayes model, 591 tweet data were predicted correctly and 126 tweet data were predicted incorrectly. This shows that sentiment analysis of electric vehicles using Naïve Bayes has a good level of accuracy in classifying sentiment. The figure only displays the number of correct predictions and the number of incorrect predictions.

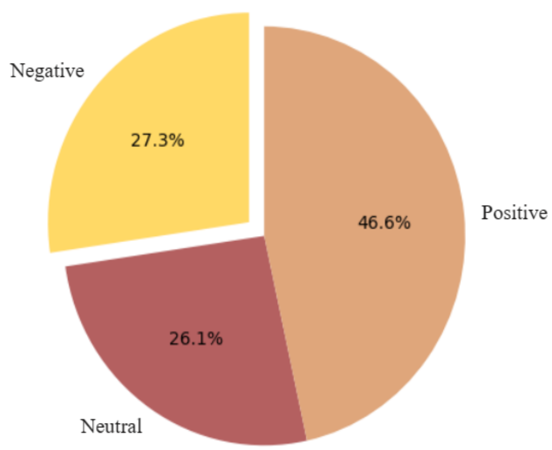

Figure 5. Amount of Sentiment Predictions Naïve Baye Models

From the results of system testing, the number of each sentiment predicted or categorized by the Naïve Bayes model is also obtained. There are 717 test data used to predict or test the sentiment of electric vehicles using Naïve Bayes. Based on the prediction of the Naïve Bayes model, as many as 46.6% or equivalent to 334 tweets can be categorized as having good sentiments or supporting the use of electric vehicles. This shows that the majority of Twitter users in the sample have a good opinion about electric vehicles.

A total of 27.3% or 196 tweets have been classified as having a negative or disapproving view of the use of electric vehicles. In this case, it is clear that some Twitter users still have a poor view of the presence of electric vehicles. Sentiments that do not decide whether they agree or disagree with electric vehicles are classified as neutral sentiments. Where in this case there are 26.1% or as many as 187 tweets classified as neutral sentiment.

The prediction results of the Naïve Bayes model can provide an overview of how the Indonesian people think about electric vehicles. It can be concluded that the majority of Twitter users in Indonesia have a favorable opinion of electric vehicles. However, some people still have a negative or neutral view of electric vehicles.

F. Confusion Matrix

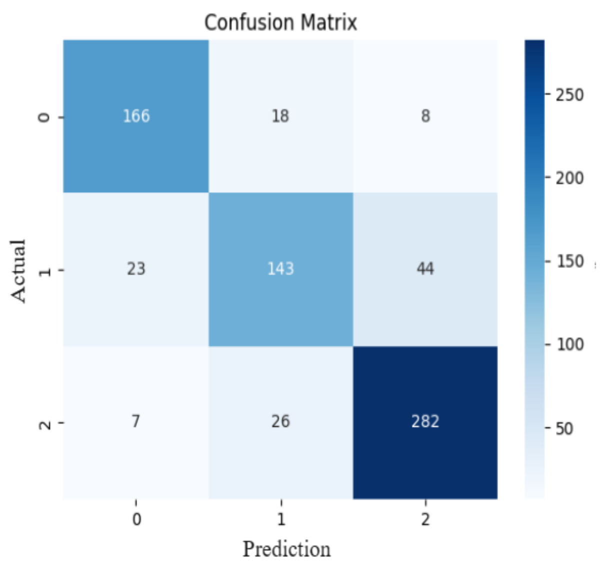

Figure 6. Naïve Bayes Confusion Matrix Result

The confusion matrix results for the Naïve Bayes model are shown in Figure 6. The confusion matrix for the Naïve Bayes model also has three columns and three rows in the matrix. The rows of the matrix show the actual labels of the data, while the columns show the labels predicted by the Naïve Bayes model.

In the first row of the matrix, there are 192 tweets with negative actual labels, where 166 tweets were correctly predicted as negative by the Naïve Bayes model. Meanwhile, 26 data are still mispredicted, where 18 negative data are predicted as neutral and 8 negative data are predicted as positive. Furthermore, in the second row, there are 210 data with neutral actual labels, and the Naïve Bayes model successfully predicts 143 data correctly. Meanwhile, there are still 67 incorrectly predicted data, where 23 data with neutral actual labels are predicted as negative and 44 data with neutral labels are predicted as positive. Finally, the third row of the matrix has 315 data with actual labels positive. 282 data were correctly predicted as positive, while 33 data were still mispredicted. In this case, 7 data with positive actual labels were predicted as negative and 26 data with positive labels were predicted as neutral.

In addition, the value of the confusion matrix can also be used to determine the accuracy, precision, recall, and f1-score of each model.

Tabel 1. Classification Report Naïve Bayes

Classification report: Naïve Bayes				
	Precision	**Recall**	**F1-Score**	**Support**
Negative	0,85	0,86	0,86	192
Neutral	0,76	0,68	0,72	210
Positive	0,84	0,90	0,87	315
Accuracy			0,82	717
Macro Avg	0,82	0,81	0,82	717
Weighted Avg	0,82	0,82	0,82	717

Based on Table 1, it can be seen that the accuracy of the Naive Bayes model is 0.82, which means that this model can correctly predict 82% of the total samples. Accuracy measures how well the Naïve Bayes model classifies overall. Accuracy is calculated as the ratio between the number of correct predictions and the total number of samples.

Precision is used to measure the extent to which the model that has been created can make predictions correctly. It shows how good the model is at classifying samples into the right sentiment class. Then, the precision of the Naïve Bayes model for the "Negative" class is 0.85, which means 85% of the predictions made by the Naive Bayes model for the "Negative" class are correct. For the "Neutral" class, the precision is 0.76, which means 76% of the predictions made by the Naive Bayes model for the "Neutral" class are correct. For the "Positive" class, the precision is 0.84, which means 84% of the positive predictions made by the Naive Bayes model for the "Positive" class are correct.

Recall measures the extent to which the model can correctly identify existing sentiment classes. Simply put, recall describes how well the model detects samples that belong to the correct sentiment class. In the Naïve Bayes model for the "Negative" class, the recall is 0.86, which means that the Naive Bayes model can identify 86% of the total samples belonging to the "Negative" class. For the "Neutral" class, the recall is 0.68, which means the Naive Bayes model can identify 68% of the total samples belonging to the "Neutral" class. For the "Positive" class, the recall is 0.90, which means the Naive Bayes model can identify 90% of the total samples belonging to the "Positive" class.

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F1-score shows a measure of the harmonic mean of precision and recall. F1-score can provide information about the balance between precision and recall. A high F1 score indicates a good performance in predicting the sentiment class. The Naïve Bayes model obtained an F1-score of 86% for the negative class, 72% for the neutral class, and 87% for the positive class. In addition, the classification report also presents other metrics such as support, which indicates the number of samples in each class, as well as the average value (macro avg and weighted avg) which provides an average for all classes.

Overall, the results of this Naïve Bayes model evaluation provide information about the model's performance in predicting sentiment classes with detailed precision, recall, and f1-score, as well as overall accuracy. Based on research conducted by Julianto et al in 2022 [12], the following are the accuracy category guidelines shown in Table 2.

Table 2 Accuracy Categories

Accuracy Value	Category
0.90 – 1.00	Excellent classification
0.80 – 0.90	Good classification
0.70 – 0.80	Fair classification
0.60 – 0.70	Poor classification
0.50 – 0.60	Failure

Based on Table 2, it can be seen that the 82% Naïve Bayes accuracy is included in the Good classification category because it is in the accuracy range of 0.80 - 0.90. Through the evaluation process, can know that the method produces a good performance in conducting sentiment analysis on electric vehicles. So it can be concluded that the Naïve Bayes method can solve the problem of sentiment analysis of electric vehicles well. The accuracy of the Naïve Bayes model in sentiment analysis of electric vehicles can be influenced by the amount of data used [13]. In addition, the type and quality of the data used also play an important role in determining accurate results.

Therefore, the accuracy results obtained for sentiment analysis of electric vehicles using Naïve Bayes only apply in the context of this capstone project. This means that the 82% Naïve Bayes accuracy result is not an absolute result for electric vehicle sentiment analysis. So it can be concluded that accuracy can be higher or lower if using the amount of data, type of data, data quality, and different analysis methods. The 82% accuracy produced by the Naïve Baye model is because the amount of data used to perform sentiment analysis is not balanced between the amount of positive, negative, and neutral label data. The number of data labels that dominate in the dataset used is positive labels, so the Naïve Bayes model works well on data with positive labels. Meanwhile, data with neutral and negative labels are less optimal. In addition, inconsistent data labels can also be the cause of less-than-optimal accuracy. This happens because some tweets are difficult to categorize into positive, negative, or neutral sentiments. Examples of tweets that are difficult to categorize are tweets with sentiments that contain sarcasm because Sarcasm usually does not match the actual meaning of a sentence.

G. Increasing Electric Vehicle Adoption in Indonesia Indonesia Based on the sentiment analysis that has been done

By using the Naïve Bayes method, it is known that the amount of positive label data is more dominant than negative or neutral label data, so based on this data, it can be concluded that the majority of sentiment towards electric vehicles in conversation data on Twitter is positive. This shows that Twitter users who are used as samples, support and accept the presence of electric vehicles so that the development of electric vehicles in Indonesia can still be optimized in the future.

The adoption of electric vehicles in Indonesia requires the role and joint support of various parties. The Indonesian government has issued various regulations and policies to encourage the development of electric vehicle adoption, one of which is the Regulation of the Minister of Energy and Mineral Resources Number 13 of 2020 concerning the provision of electric charging infrastructure for battery-based electric motor vehicles. 2020 regarding the provision of electricity charging infrastructure for battery-based electric motorized vehicles. In addition to existing regulations and policies, the government certainly needs to make other regulations and policies so that the adoption of electric vehicles in Indonesia can continue to grow and achieve the targets that have been set. Through the sentiment analysis process that has been carried out and based on conversation data on Twitter related to the adoption of electric vehicles, the following are some recommendations that can be given to assist the government in determining regulations and policies related to electric vehicles in the future, so that hopefully the acceptance of electric vehicles in Indonesia can continue to increase.

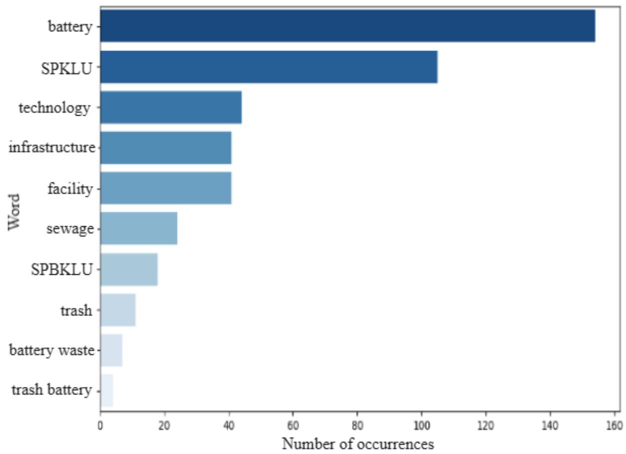

Figure 7. Words related to Electric Vehicle Adoption

Here are some recommendations to increase the adoption of electric vehicles in Indonesia, based on topics that are frequently discussed on the Twitter platform

1) Developing Battery Technology

Batteries are one of the electric vehicle ecosystems that are often discussed by Indonesians on Twitter. The battery is one of the important considerations for the adoption of electric vehicles, this is because the battery is one of the main components of electric vehicles, so the quality of the battery will have a direct impact on the performance of the electric vehicle used. The quality of the electric vehicle battery is very important because it will affect the mileage of the electric vehicle and the battery life itself. The better the quality of the battery, the farther the mileage of the electric vehicle and the longer the battery life. In addition, good battery performance will also minimize the risk of problems such as fire or explosion in electric vehicles. Electric vehicle manufacturers and the government need to ensure that the batteries used in electric vehicles are of high quality and safe. Therefore, there needs to be a collaborative effort between electric vehicle manufacturers and the government in developing cheaper and more efficient battery technology to accelerate the adoption of electric vehicles in Indonesia.

2) Waste Battery Handling Solution

In addition to developing battery technology for electric vehicles, the battery waste generated also needs to find a solution. Waste from electric vehicle batteries is one of the problems that must be handled properly. Electric vehicle batteries contain chemicals that are potentially hazardous to health and the environment if disposed of carelessly. For example, lead, cobalt, and nickel are hazardous chemicals in electric vehicle batteries. Batteries in electric vehicles also have a limited service life, so they will eventually run out and become waste that must be handled. If battery waste is disposed of carelessly, the hazardous chemicals in the battery can pollute the soil and water. In addition, when burned, electric vehicle batteries can also emit harmful gases that can potentially endanger human health and the environment. Therefore, electric vehicle manufacturers and the government need to work together to ensure that electric vehicle battery waste is handled properly. The government needs to make regulations and policies governing the management of electric vehicle battery waste, while electric vehicle manufacturers need to ensure that the electric vehicle batteries produced can be recycled easily. With good handling of electric vehicle battery waste, the adoption of electric vehicles in Indonesia can become more sustainable and environmentally friendly.

3) Adequate Infrastructure Development

Adequate infrastructure development is one of the considerations that must be considered. Based on the opinions of the people on Twitter about the acceptance of electric vehicles, the infrastructure is still inadequate, which is one of the most important considerations. One of the considerations for switching to electric vehicles.

Adequate infrastructure can be achieved by collaborating with private businesses to build charging stations in various locations, including workplaces, open parking lots, and shopping malls. Charging infrastructure is indispensable because electric vehicles require an electrical power source to recharge the battery, so having enough charging stations is essential to allow electric vehicle users to do so quickly and easily. Therefore, to expand the use of electric vehicles in Indonesia, electric vehicle charging infrastructure is one of the things that need to be improved.

4) Improving Public Insight on Electric Vehicles

One of the challenges in the adoption of electric vehicles in Indonesia is the lack of public knowledge about electric vehicles. Based on tweet data obtained from Twitter, there are still people who are less familiar with electric vehicles and still consider electric vehicles as expensive and difficult to operate.

Therefore, the government needs to increase public insight into electric vehicles so that electric vehicles can be adapted significantly. One way to increase public knowledge about electric vehicles is to conduct campaigns and socialization about electric vehicles. This campaign and socialization can be carried out through various media, such as television, the internet, and media social. In addition, the government can also cooperate with electric vehicle manufacturers to organize electric vehicle exhibitions and test drive events so that people can experience driving using electric vehicles. By doing this, it is expected to increase Indonesians' interest in buying electric vehicles, be it electric motorcycles or electric cars, to accelerate the expansion of the electric vehicle sector in Indonesia. Based on these recommendations, it is expected to increase the adoption of electric vehicles in Indonesia and also assist the government in determining regulations and policies related to the use of electric vehicles. The adoption of electric vehicles in Indonesia certainly requires the participation of the following support from various parties, such as vehicle manufacturers’ electricity, the government, and society. Each party has a different role in increasing the adoption of electric vehicles in Indonesia. With the joint role and support between electric vehicle manufacturers, the government, and the community of Indonesia, the expected adoption of electric vehicles in Indonesia can continue to increase and support Indonesia's vision as a sustainable and environmentally friendly country.

V. CONCLUSIONS

Based on the data from the sentiment analysis system test result towards electric vehicles using the Naïve Bayes obtained a model accuracy of 82% where 591 tweet data were successfully predicted correctly and 126 data were predicted incorrectly. Based on the Naïve Bayes model prediction, 334 tweets can be categorized as positive sentiment, 196 as negative sentiment, and 187 as neutral sentiment. Based on the prediction data, it is known that positive sentiment dominates the amount of data. This shows that Twitter users who are used as samples, support and accept the presence of electric vehicles so that the development of electric vehicles in Indonesia can be optimized in the future. Here are some recommendations so that the adoption of electric vehicles can continue to grow in Indonesia, namely developing battery technology, solutions for handling electric vehicle battery waste, building adequate infrastructure, and increasing public awareness and insight into electric vehicles.

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REFERENCES

[1] BPMI, "Government Commits to Reduce Greenhouse Gases by Climate Change Convention," BPMI SetPres, p. 1, 2020, Accessed: Jul. 20, 2023. [Online]. Available: https://www.presidenri.go.id/siaran-pers/pemerintah-komitmen-turunkan-gas-rumah-kaca-sesuai-konvensi-perubahan-iklim/.

[2] IESR, "IEVO 2023: Electrifying Transportation to Reduce GRK Emissions," IESR, 2023. https://iesr.or.id/tag/transportasi-penyumbang-emisi (accessed Jun. 26, 2023).

[3] A. Santoso, A. Nugroho, and A. S. Sunge, "Sentiment Analysis about Electric Cars with Support Vector Machine and Feature Selection Particle Swarm Optimization Methods," J. Pract. Comput. Sci., vol. 2, no. 1, pp. 24–31, 2022, doi: 10.37366/jpcs.v2i1.1084.

[4] A. Pribadi, "Electric Vehicle Trends in the Future, Prepared Early, "Ministry of Energy and Mineral Resources, 2021. https://www.esdm.go.id/id/media-center/arsip-berita/tren-kendaraan-listrik-ke-depan-telah-disiapkan-sejak-dini.

[5] P. Christidis and C. Focas, "Factors Affecting the Uptake of Hybrid and Electric," Energies, 2019.

[6] B. Laurensz and Eko Sediyono, "Analysis of Public Sentiment towards Vaccination Measures to Overcome the Covid-19 Pandemic," J. Nas. Tek. Elektro dan Teknol. Inf., vol. 10, no. 2, pp. 118–123, 2021, doi: 10.22146/jnteti.v10i2.1421.

[7] N. C. Dang, M. N. Moreno-García, and F. De la Prieta, "Sentiment analysis based on deep learning: A comparative study," Electron., vol. 9, no. 3, pp. 1–29, 2020, doi: 10.3390/electronics9030483.

[8] L. Abednego, C. E. Nugraheni, and A. Fedora, "Forex Sentiment Analysis with Python," Int. J. Adv. Res. Econ. Financ., vol. 4, no. 1, pp. 46–55, 2022, doi: 10.55057/ijaref.2022.4.1.5.

[9] L. Mutawalli, M. T. A. Zaen, and W. Bagye, "TWITTER SOCIAL MEDIA TEXT CLASSIFICATION USING SUPPORT VECTOR MACHINE (Wiranto Stabbing Case Study)," J. Inform. dan Rekayasa Elektron., vol. 2, no. 2, p. 43, 2019, doi: 10.36595/jire.v2i2.117.

[10] A. Perdana, A. Hermawan, and D. Avianto, "Sentiment Analysis of Election Postponement Issues on Twitter Using Naive Bayes Clasifier," J. Sisfokom (Sistem Inf. dan Komputer), vol. 11, no. 2, pp. 195–200, Jul. 2022, doi: 10.32736/sisfokom.v11i2.1412.

[11] A. E. S. Saputro, K. A. Notodiputro, and I. A, "Study of Sentiment of Governor's Election Opinion in 2018," Int. J. Sci. Res. Sci. Eng. Technol., vol. 4, no. 11, pp. 231–238, 2018, doi: 10.32628/ijsrset21841124.

[12] I. T. Julianto, D. Kurniadi, M. R. Nashrulloh, and A. Mulyani, "Comparison of Classification Algorithm and Feature Selection in Bitcoin Sentiment Analysis," J. Tek. Inform., vol. 3, no. 3, pp. 739–744, 2022, [Online]. Available: https://doi.org/10.20884/1.jutif.2022.3.3.343%0Ahttp://jutif.if.unsoed.ac.id/index.php/jurnal/article/view/343.

[13] A. Ambarwari, Q. Jafar Adrian, and Y. Herdiyeni, "Analysis of the Effect of Data Scaling on the Performance of the Machine Learning Algorithm for Plant Identification," J. RESTI (Rekayasa Sist. dan Teknol. Informasi), vol. 4, no. 1, pp. 117–122, 2020, doi: 10.29207/resti.v4i1.1517.