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Analysis of User Comment Sentiment on the Siwaslu Application Using the Naive Bayes Method

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Abstract

This study aims to identify sentiment in user comments on the Siwaslu application by utilizing the Naive Bayes model. The Siwaslu application itself is a digital platform developed to support election supervision, with the aim that the public can provide input that can be used to improve the quality of the application's services. The data analyzed consisted of 2,926 comments that had gone through the pre-processing stage, such as converting text to lowercase, removing punctuation and stopwords, and implementing stemming using the Literary algorithm. After that, the text features are extracted using the method (TF-IDF) and then fed into the Naive Bayes classification model. The results of the evaluation showed that from the overall data, as many as 1,642 comments were classified as negative and another 1,284 as positive. The Naive Bayes classification model used succeeded in providing an accuracy of 88%, with a precision of 0.84 in the negative class and 0.94 in the positive class. The resulting F1-score is 0.90 for the negative class and 0.85 for the positive class, respectively. Overall, these results show that the Naive Bayes model is quite effective in analyzing sentiment and can make a real contribution to efforts to improve the quality of Siwaslu application services in the future.

Keywords: *sentiment analysis; siwaslu application; Naïve Bayes; text preprocessing; TF-IDF*

1. Introduction

Developments in the field of information technology have brought about significant changes in various fields, both at the scale of individuals, organizations, institutions and the public service sector, including in the context of supervision of the implementation of general elections [1]. This digital transformation not only changes the way supervisory institutions work, but also encourages the active involvement of the public in monitoring and reporting on the implementation of elections directly through online platforms that are more open, participatory, and transparent[2]. One of the concrete manifestations of the use of technology in election supervision in Indonesia is the development of the Siwaslu (Election Supervision Information System) application by the Election Supervisory Agency (Bawaslu), which aims to increase the accountability, transparency, and effectiveness of the election supervision process [3].

As a digital platform designed to reach all elements of society, the success of the Siwaslu application is not only determined by the technical quality of the system itself, but also highly depends on the perception, satisfaction, and real experience of its users in interacting with the application [4]. Therefore, feedback from users, in the form of comments and reviews, is an important asset that can be used to assess service performance and formulate a more targeted development strategy [5]. In this case, sentiment analysis of user reviews is one of the relevant and effective approaches, as it allows researchers and developers to identify public opinion, measure satisfaction levels, and uncover functional areas that need improvement[6].

The urgency of this research is even higher considering the increasing number of incoming review data, along with the increase in application users over time. If analyzed manually, the data will not only take a lot of time and effort, but also risk subjective bias [7]. Therefore, an automated approach is needed with the support of machine learning technology that is able to work efficiently, consistently, and can handle data at scale. One of the classification algorithms that is widely used in sentiment analysis is Naive Bayes, because it has advantages in terms of simplicity of implementation, processing efficiency, and its ability to manage high-dimensional data effectively[8].

In order for text classification performance to be maximized, an effective feature extraction process is needed in converting text data into informative numerical representations. In this case, the TF-IDF method is often chosen because of its ability to give high weight to words that have high relevance, while reducing the influence of general words that are less of informational value[9]. The combination of TF-IDF and the Naive Bayes algorithm has shown effective results in various text analysis studies and has been shown to provide considerable accuracy in sentiment classification. In response to the identified problems and urgency, this study aims to apply sentiment analysis to the comments of Siwaslu application users through the use of the Naive Bayes algorithm supported by the TF-IDF feature extraction technique[10]. This research focuses on several important stages, namely data pre-processing, feature extraction, training and testing of

classification models, and performance evaluation using appropriate metrics. Through this approach, it is hoped that the research results can make a real contribution to the development of a digital surveillance system that is adaptive and responsive to the needs of the community. In addition, the findings of this study are also expected to be strategic inputs for Bawaslu in improving the quality of Siwaslu application services in a sustainable manner based on objective and measurable public perception[11].

2. Literature review

2.1. Siwaslu Application

Siwaslu (Election Supervision Information System) is a digital-based application developed by the Election Supervisory Agency (Bawaslu) of the Republic of Indonesia. This application functions as a forum for reporting election violations online by the public, as well as facilitating participatory and transparent supervision.[12]
As a public service platform, users' experience and perception of the Siwaslu application is important to evaluate. Publicly available user comments are a valuable source of data to analyze using sentiment analysis approaches. This study aims to evaluate these perceptions with a sentiment classification approach, so that it can provide data-based recommendations for the development of application services in the future. [13]

2.2. Sentiment Analysis

Sentiment analysis is a branch of Natural Language Processing (NLP) that focuses on the process of identifying, extracting, and classifying subjective opinions in text.[14] This approach is used to find out the emotions, views, and attitudes of users contained in text, especially in data from social media, product reviews, and application comments. In general, sentiment analysis is classified into three main types, namely positive, negative, and neutral. In this study, a sentiment analysis technique was applied to evaluate public opinion on the Siwaslu application based on open user comments. [15]

2.3. Preprocessing Text

Text preprocessing is an essential initial stage in text data processing, which aims to clean and normalize the data before entering the process of extracting features or classification. [16]This step is important to reduce noise in the data, such as irrelevant words or non-uniform text formatting, so that a cleaner and more meaningful representation of text can be obtained. An optimal pre-processing process will have a major impact on improving the performance and accuracy of the classification model. [17]

2.4. Method (TF-IDF)

TF-IDF is a technique used to transform text data into numerical form, relying on two main elements: Term Frequency (TF) and Inverse Document Frequency (IDF). Term Frequency is used to calculate how often a word appears in a particular document, while the IDF assigns weights based on the rarity of those words across the entire document in the corpus. [18]
This approach allows for high weight to words that have high relevance even though they appear infrequently, while common words that appear frequently but are less informative will get lower weight. The mathematical calculations of this method are presented in the following formula:

$$TF"\{-\}IDF(t,d) = TF(t,d) \times IDF(t)$$

$$\mathrm{IDF(t)} = \log \left(\frac{\mathrm{N}}{\mathrm{df(t)}} \right)$$

Information:

- *ft,d*: Frequency of the term *t* in document *d*
- $\sum_{k} f_{k,d}$: all terms in document *d*
- *DF(T):* Term T Document
- *N*: total documents

The TF-IDF method has been shown to be effective in recognizing keywords that have a significant role in distinguishing one document from another. Because of its capabilities, this technique is widely used at the feature extraction stage to assist in the classification process in text data analysis. [19]

2.5. Naive Bayes

Naive Bayes is a classification algorithm that works based on the probabilistic principle of Bayes' Theorem. [20]This approach assumes that each feature (e.g. a word) is independent or non-dependent in determining the category of a data. In the context of sentiment analysis, this algorithm is used to determine the type of sentiment whether positive, negative, or neutral of a comment by analyzing the words contained in it.[21] The general form of Bayes' Theorem that is the basis for calculations in this algorithm is as follows:

$$P(C_i \mid x) = \frac{P(C_i) \cdot \prod_{j=1}^{n} P(x_j \mid C_i)}{P(x)}$$

With a caption:

- $P(C_{i|x})$ = Probability of data x belonging to class *Ci*
- $P(Ci)$ = Initial (prior) probability of class *Ci*
- $P(x/Ci)P$ = Probability of feature *x* appearing in class *Ci*
- $P(x)$ = The overall probability of the feature *x*

2.6. Confusion Matrix

The Confusion Matrix is an evaluation table used to measure the performance of a classification model by comparing the model's prediction results against the original label in the test data.[22] These matrices play an important role in the calculation of various evaluation metrics, including accuracy, precision, and recall, which aid in assessing the effectiveness of the classification model as a whole.[23]

- **Accuracy**

$$\frac{TP+TN}{TP+TN+FP+FN}$$

Measures how many predictions are correct from the total total of the predictions.

3. Methodology

3.1. Stages of research

This research was carried out through a series of structured steps that included several core stages, namely data collection, pre-processing, feature extraction, classification model development, and comparative analysis of results. Each stage is systematically designed to maintain accuracy and reliability in the sentiment analysis process.

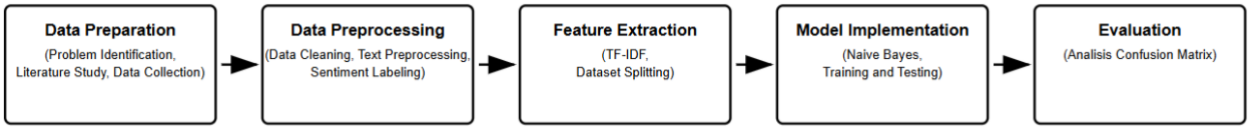


Figure 1: Flow of sentiment analysis research methodology using Naive Bayes

3.2. Data preparation

A total of 3,498 comments from users of the Siwaslu application were successfully collected through a web scraping process carried out using Google Colab. After the data was collected, it was manually labeled to group comments into two sentiment categories, namely positive and negative.

	userName	komentar	score	at
0	Mohammad Fahmi	ok	1	2/10/2024 22:46
1	didi 08	Habis disarankan update di profil yg sebelumny...	1	2024-08-02 3:27:00
2	Ruci	Cs no repon , maklum aplikasi pemerintah	1	2024-08-02 3:15:00
3	wiwin nuraeni	Aplikasi untuk IOS gk ada ya ? Server down, ke...	1	2/13/2024 8:17
4	Abas Abas	Ini eror terus, gabisa uplod foto. Uplod foto ...	1	2/8/2024 1:26

5 Baris Terakhir:

	userName	komentar	score	at
3494	Sofi Jaya	Ok	5	1/30/2024 12:25
3495	Jamal	Tolong diberi fitur edit profil untuk koreksi ...	5	1/30/2024 11:49
3496	Tulam galaxy	Mantap salam awas	5	1/30/2024 10:13
3497	Said Zabir	Saya pkd tp gak bisa masuk untuk pkd	5	1/30/2024 10:04
3498	Zainal Abidin	Baik	5	2/15/2024 12:15

Figure 2: Data Collection Process

3.3. Preprocessing Data

The preprocessing stage is very important in the processing of text data, as it serves to filter and standardize the information before it is applied to classification methods such as Naive Bayes.The results of the preprocessing show that the comment data has been successfully cleaned, normalized, and simplified in the form of meaningful tokens. This process includes six main stages, namely: data cleansing, tokenization, letter normalization, stopword removal, token length filtering, and stemming. Each stage is described and summarized in Table 3.1 below.

Table 1: Summary of User Comment Preprocessing Stages

Stages	Process Description	Example Results
Data Cleaning	Remove URLs, mentions, hashtags, emojis, special characters, and punctuation	"This siwaslu application cannot be opened, always errors and is very slow, how to report a violation if the application is problematic"
Tokenizing	Splitting sentences into individual words (tokens)	['Application', 'siwaslu', 'this', 'not', 'can', ..., 'application', 'aja', 'problematic'] (19 tokens)

Lowercase Conversion	All tokens are converted to lowercase letters to ensure consistency in the text processing process.	['application', 'siwaslu', 'this', 'no', 'can', ..., 'application', 'aja', 'problematic']
Stopword Removal	Common words that do not contribute significant meaning are filtered using the list of Indonesian stopwords available in the Literature library	['application', 'siwaslu', 'not', 'could', 'opened', ..., 'the application', 'problematic'] (15 tokens)
Filter by Token Length	Delete tokens less than three characters long	['application', 'siwaslu', 'could', 'opened', 'always', ..., 'the application', 'problematic'] (14 tokens)
Vote *(optional)*	Convert words to basic forms using the Indonesian stemming algorithm (Sastrawi Stemmer)	['application', 'siwaslu', 'can', 'open', 'always', 'error', 'slow', 'really', 'gimana', 'report', 'violate', 'kalo', 'application', 'problem'] (14 final tokens)

The above steps aim to eliminate noise in the data and simplify the representation of text into a more dense but still meaningful form. The final result of this preprocessing becomes an important input in the feature extraction process (TF-IDF) and sentiment classification.

3.4. TF-IDF feature extraction

The feature extraction process utilizes the TF-IDF method, which converts text documents into numerical representations by taking into account the relevance of words, both in the context of individual documents and the entire corpus. The visualization in Figure 3 shows the 20 words with the highest TF-IDF weight value in the collection of comments of Siwaslu application users.

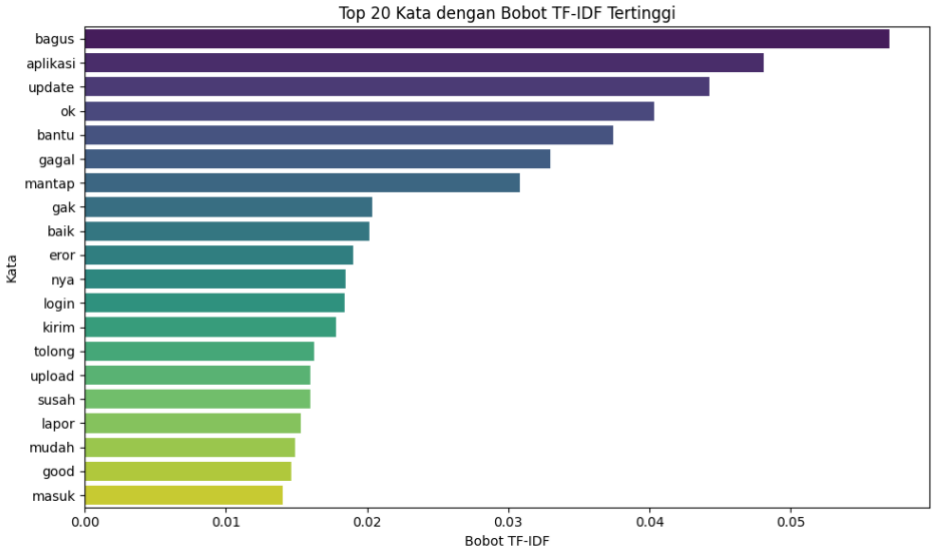


Figure 3: TF-IDF weight distribution

Words such as "good", "application", and "update" obtained the highest TF-IDF scores, indicating that in addition to appearing frequently, they have important meaning in the context of sentiment analysis. Meanwhile, terms such as "failed", "error", and "difficult" also showed high weight, reflecting a tendency for negative sentiment in a number of user comments. The results of this visualization provide an initial insight into the words that are most influential in distinguishing sentiment polarity, and are subsequently used as a feature in the classification process using machine learning algorithms such as Naive Bayes

.

4. Results and Discussion

4.1. Results of naïve Bayes classification

In this study, the Naive Bayes algorithm was used to classify user sentiment towards the application, based on comments that have gone through the pre-processing stage. The feature extraction process is carried out using the TF-IDF method which plays a role in converting text into numerical vector representations so that it can be processed optimally by machine learning algorithms. The selection of the Naive Bayes algorithm was made because of its ability to handle large amounts of data and manage an uneven distribution of data. In addition, this algorithm is also known for its characteristics of being simple, fast, and quite reliable in recognizing word patterns in text data. In the experiment, a total of 2,926 comments from users were analyzed, consisting of 1,642 comments with negative sentiments and 1,284 comments with positive sentiments.

Table 2: Results of the Evaluation of the Naive Bayes Model

Current / Predicted	Negative	Positive	Total
Negative	1,582 (TN)	60 (FP)	1.642
Positive	296 (FN)	988 (TP)	1.284
Total	1.878	1.048	2.926

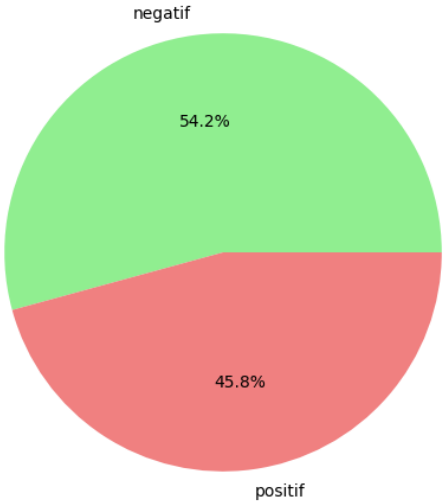


Figure 4: Sentiment Distribution

4.2. Model performance evaluation

To measure the effectiveness of the model in distinguishing positive and negative sentiment, an evaluation was carried out using a confusion matrix, which is the main benchmark in calculating the accuracy of the Naive Bayes algorithm.

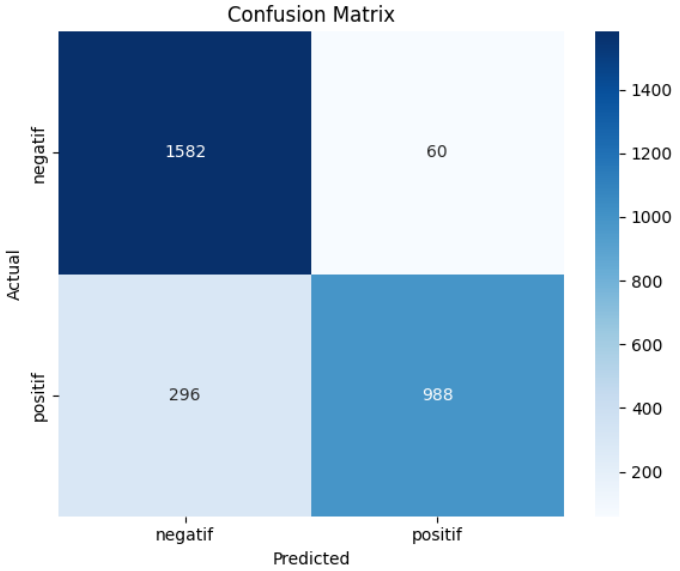
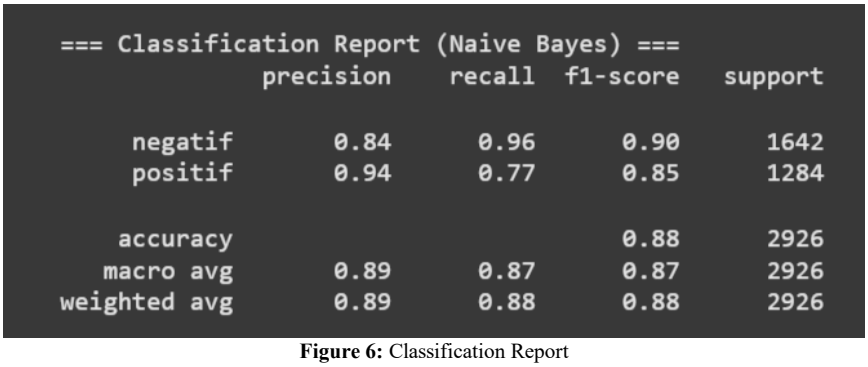


Figure 5: Confusion Matrix



=== Classification Report (Naive Bayes) ===

	precision	recall	f1-score	support
negatif	0.84	0.96	0.90	1642
positif	0.94	0.77	0.85	1284
accuracy			0.88	2926
macro avg	0.89	0.87	0.87	2926
weighted avg	0.89	0.88	0.88	2926

Figure 6: Classification Report

Based on the results of the classification report, the Naive Bayes model shows quite good performance with an accuracy of 88%. The highest precision was achieved in the positive class of 0.94, while the highest recall was in the negative class with a value of 0.96. The F1-score value in both classes is balanced, namely 0.90 for negative sentiment and 0.85 for positive sentiment. These findings suggest that the model is more reliable at recognizing negative than positive comments. In addition, the average values of the F1-score and weighted F1-score were at 0.87 and 0.88, respectively, indicating that the model's performance was stable and consistent in classifying the two sentiment categories.

5. Conclusion

This study successfully applied sentiment analysis to the comments of Siwaslu application users using the Naive Bayes algorithm approach. The resulting classification model showed quite good performance, with an accuracy of 88%, precision of 94.6% for positive sentiment, and 96.3% recall for negative sentiment. The pre-processing stages of text, which include converting letters to lowercase format, removing stopwords, and stemming, have been proven to improve the quality of data before the classification process is carried out. In addition, the use of the TF-IDF method in feature extraction is able to produce relevant word representations and supports the effectiveness of the model in classification. The results of this study indicate that the Naive Bayes algorithm has the ability to recognize user sentiment automatically and systematically. This ability is very useful in gaining insights into public opinion and identifying possible problems that arise in the use of the application. In the future, these findings are expected to be the basis for the development of a more adaptive and responsive feedback system, in order to support the improvement of the quality of Siwaslu application services.

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