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A Sentiment Analysis Using Fuzzy Support Vector Machine Algorithm

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ABSTRACT

The Ministry of Communication and Information and the Ministry of BUMN of The Republic of Indonesia designed a mobile app "Peduli Lindungi" to be used to help the public and related government agencies in carrying out screening and tracing people's movement to stop the spread of Corona Virus Disease (Covid-19).The existence of a mobile app, "Peduli Lindungi" triggers abundant different sentiments from the Indonesian community, either positive or negative sentiments. Based on the positive sentiment, the government of the Republic of Indonesia may have some feedback about the aspects of the app that should be maintained. In contrast, negative sentiments can be used as initial points of the potential improvement of the mobile app. This study applies a Fuzzy Support Vector Machine (FSVM) model to classify the user's reviews on Peduli Lindungi Application. FSVM can classify customers' reviews into two or more classes and relatively results in higher accuracy than other classification approaches. The results of this study indicate that the classification of reviews with FSVM produces quite good accuracy with a value of 77%. A total correct prediction is 2192 reviews out of 2813 reviews.

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1. INTRODUCTION

The spread of the COVID-19 virus in Indonesia has increased drastically since the announcement of the first case in March 2020. In April 2020, the Covid-19 virus had infected and spread to 5000 people [1]. As a result of the virus, the death rate in Indonesia has increased to 140.138, with a Case Fatality Rate (CFR) of 3.4% in September 2021 [2]. The percentage of deaths due to the COVID-19 virus in Indonesia exceeds the global CFR by 2.2% [3]. Considering the increasing daily spread, from 367 cases to 2057 new cases, an average of more than 4.213.414 people are positive for COVID-19 [4]. Due to the spread of COVID-19, the negative impact of the pandemic continues, thus making the Indonesian government have a big responsibility to help the community finish the pandemic. The government needs to take action and/or respond more responsively to the community to resolve the COVID-19 virus problem. The lack of access to information about the spread of COVID-19 confuses the public and the government. On the other hand, the government is experiencing an inability to manage information and the lack of publicly accessible data related to the spread of the COVID-19 virus. Therefore, the government, namely the Ministry of Communication and Informatics and the Indonesian Ministry of SOEs, designed an application (mobile app), Peduli Lindungi, to be used by the Task Force, Ministry of Health, and the public as an effort to prevent the Covid-19 pandemic [1].

The Peduli Lindungi application is an application that is used to assist the community and the government in screening and tracing people's movement to reduce the spread of Corona Virus Disease (COVID-19) [5]. Seeing the urgency of the need for the Peduli Lindungi application to support community activities for daily life, in order to evaluate the application's performance. A classification process is needed to obtain the correct label results. However, if the review classification is performed manually, it is considered less accurate and takes a long time. Thus, a method is needed to classify review texts automatically and efficiently, namely the text classification method with machine learning. Text classification methods function in discovering interesting patterns from complex text data sets. Text classification methods use machine learning techniques, including Naïve Bayes, K-Nearest Neighbors, Neural Networks, Support Vector Machines, and Decision Trees [6]. However, in this study, it is proposed to use the Fuzzy Support Vector Machine method. FSVM is applied as a classifier to avoid unclassifiable areas as a development of the Support Vector Machine (SVM) method, where the SVM method classifies data straightly without paying attention to the degree of data membership to all defined classes [7]. Fuzzy logic is a mathematical method for describing obscurity, which Lotfi A. Zadeh introduced in 1965 [8]. The SVM method with a combination of fuzzy logic is called the Fuzzy Support Vector Machine (FSVM), with a membership function is an essential step in classification [9].

Peduli Lindungi is an application created by Kominfo and the Ministry of State-Owned Enterprises of Indonesia to assist government agencies in tracking the spread of COVID-19 [5]. The Peduli Lindungi application operates with user participation, namely the sharing of location data so that tracing contact history with COVID-19 sufferers can be carried out. One uses a filtering function to enter a place or area, such as places of worship, shopping centers, transportation, workplaces, and the education sector. Through the Peduli Lindungi application, users can see their vaccination status and COVID-19 test results.

Text mining or text analysis is a technique of extracting information from unstructured text data that involves finding patterns to parse text data into standard language components used to acquire quality new knowledge for users. Sentiment analysis helps find unknown information, something that is unknown and cannot be written [10]. Sentiment analysis also assesses a person's attitude toward a topic. The attitudes taken are opinions, judgments, evaluations, and affective states (the author's emotional state when writing). In everyday business, owners want to know the public opinion of a product or service. Using social media as a marketing tool has benefits and challenges, with its nature that invites consumers to be interactive so that we can get feedback [11]. It affects the purchasing decision process by identifying and evaluating products that consumers need [12]. So, sentiment analysis is also useful as a basis for decision-making.

Classification is the stage of recognizing new data. Classification is widely used in fraud detection, CRM, medical diagnosis, and prediction of sales. Classifying by hand will take a long time. So, it requires a machine learning method [13]. In machine learning, there must be input in the form of a training set that is labeled (has a class attribute) and produces a classification model output [14]. The measure most often used to assess classification results is accuracy [15]. The Support Vector Machine (SVM) technique is a prediction technique in classification and regression [15]. The concept of SVM is to find the best hyperplane for separating two or more classes in the input space [16]. SVM will look for a separator function (hyperplane) by maximizing the distance between classes. SVM is included in the classifier type, namely binary, linear, and non-probabilistic. The first thing to understand classification with SVM is to look for the optimal (hyperplane) line [14].

Fuzzy Support Vector Machine (FSVM) is the development of Support Vector Machine for multiclass problems. Using the decision function obtained from SVM for a class pair, each class is defined as a pyramidal polyhedral membership function [17]. If the classification is done in pairs, the decision function for class i and class j with a maximum margin. However, if the classification is done there will be data that cannot be classified. FSVM uses membership function to classify areas that cannot be classified by the decision function.

2. METHODS

The design in this study starts from data labeling using the Textblob library, text preprocessing, building a Fuzzy Support Vector Machine model, and associating words with word cloud. The data used in this case is 34.760 reviews. The data was processed using Jupyter software and using the Python 3.0 programming language, involving several modules such as "pandas", "sastrawi", "nltk", "scikit-learning".

The first stage is labeling the initial data using the Textblob library. Sentiment analysis using TextBlob is only available in English, so analyze sentiment before translating data into English. TextBlob offers natural language (NLP) permissions such as tagging speech passages, noun extraction, sentiment, classification, translation, and more. Sentiment analysis in Textblob is done by returning two properties, namely polarity and subjectivity. Polarity is a value between -1 to 1. The polarity value of -1 is a negative sentiment.

In contrast, the polarity value of +1 is a positive sentiment. The polarity value of 0 is neutral but is not included in determining sentiment in this study. The research focuses on prioritizing opinions or priority values below 0 (aspects that need improvement).

The second stage is text data preprocessing, or the beginning of data processing. The preprocessing stage is extracting interesting and essential knowledge from unstructured text data [18]. The stages of preprocessing text are case folding, stemming, filtering, and tokenizing. Text preprocessing begins by removing emoticons, digits, and usernames. Case folding is the process of changing the letters in the text into lowercase letters so that they are the same [19]. The next stage is stemming, which homogenizes words back to basics by removing affixes using the "literary" module. The next step is to remove punctuation because punctuation has no special meaning in textual data [11]. After that is word filtering to remove words that do not significantly affect the review [19]. In this study, filtering was based on a dictionary compiled using the "literary" module. Next is the tokenizing process, which is cutting the text based on each constituent word used to calculate the frequency of occurrence of words and the process of weighting the words. The last step of text preprocessing is term weighting based on TF-IDF. The TF-IDF step is to calculate the term weight of the word occurrence and multiply it by the frequency of the document [11].

The third stage is to build a model and classification process using the Fuzzy Support Vector Machine (SVM). Calculating the accuracy of the classification model is helpful to evaluate the performance of the classification that has been done. The fourth stage is extracting word cloud information on negative reviews to provide recommendations for improvements companies need to overcome these problems.

3. RESULT AND DISCUSSION

3.1. Overview of Peduli Lindungi Application Reviews

The research begins by scrapping review data on the Google play site Peduli Lindungi application from July 1, 2021 to November 30, 2021. From the results of scrapping the data, there are 34.760 reviews. Figure 1 below shows the distribution of reviews.

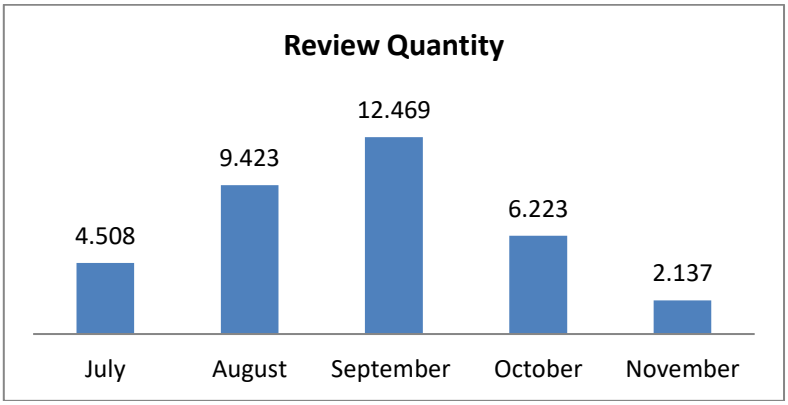

Figure 1. Peduli Lindungi application reviews distribution

From the results of the library Textblob test, it was found the number of fact reviews was 20.695 and opinion reviews 14.065. Also, it was found that the number of negative reviews was 4.501, and positive reviews were 9.564. So, this study only uses data from opinions because they want to know public opinion on the Peduli Lindungi application.

Based on Figure 1, the results of the data review show that it fluctuates every month. The trend in the first 3 months has increased. Peduli Lindungi app user reviews increased to 12.469 from July to September. It is estimated that this could be when the government starts a work program by urging the entire community to use the Peduli Lindungi application and launch a vaccination program to prevent the spread of the COVID-19 virus

[20]. However, in implementing the work program using the Peduli Lindungi application, some people have started to submit complaints through the comments column, such as late vaccine certificates, inappropriate Population Identification Numbers, GPS always active, etc. In addition, users also provide reviews to ask the government to improve the application immediately. The government responded that this was marked in October to November, the number of comments submitted by the public decreased, and the content of the reviews became thank you for fixing it, my vaccine certificate was issued, and so on.

3.2. Classification Analysis

With the Pareto Principle, the ratio of training and testing data is 80:20. However, it is possible in a study that does not only use comparisons with that value. This is because the total training data affects the accuracy value. The more training data, the better the accuracy of the model [21]. This is also reinforced by the research results conducted by [22] if the accuracy will increase when sharing data using a ratio of 80:20.

Based on the results in Table 1, it is known that the comparison of training data of 11.252 reviews and 2.813 reviews is testing data. This stage performs the division in determining the input for testing the FSVM algorithm. Data is split into training data and testing data. Testing data is used to predict the classification using the FSVM algorithm. This study implements the default penalty parameters based on Jupyter Notebook Software (C), namely C = 1, the RBF kernel, and type 2 as shown in Table 2. In a study by [23], the performance results can be measured as in Table 3.

Table 1. Split ratio

Data	Percentage	Total
Training data	80%	11.252
Testing data	20%	2.813
Total	100%	14.065

Table 2. Fuzzy SVM parameter

No	Parameter	Range
1	Kernel	RBF
2	C	1
3	Type	2

Table 3. Result FSVM

Metrics	Result
Accuracy	0.7792392463562033
Predictions	2192 reviews from 2813 reviews

Based on Table 3, it can be seen that the classification performance or accuracy of FSVM with Peduli Lindungi review data performs quite well. Based on Table 3, it is known that the accuracy of the FSVM model is 77%; 2.192 reviews are correctly predicted from a total of 2.813 reviews. These results can occur because the selected parameters affect the accuracy of the FSVM [7]. This can happen because it could be the influence of one of the parameters used, namely the penalty parameter C whose value is small enough so it weakens the effect of the fuzzy membership function [24]. Based on the research by [24], the classification results can be measured using the metrics G-means (GM), SE (sensitivity), and SP (specificity) from FSVM. The results of performance FSVM are shown in Table 4.

Table 4. Model Performance Evaluation

Metrics	Result
GM	0.6648847452234958
SE	0.8585690515806988
SP	0.5148936170212766

Based on Table 4, G-mean results show the number 0.66. These results can be used to evaluate the model for shows a comprehensive classification performance especially with imbalanced data [25]. In the results, based on [24], the SE value indicates a positive class accuracy, while the SP is a negative class classification accuracy, and the overall performance using (1).

$$GM = \sqrt{SE} \times \sqrt{SP} \quad (1)$$

3.3. Word Cloud Representation

The results of the classification of positive and negative sentiment classes from the Peduli Lindungi application review data will be visualized. Visualization aims to extract information that users of the Peduli Lindungi application most often discuss. This review yields essential information. A word association search was conducted at multiple frequencies to strengthen the information obtained. The following is a visualization in the form of a diagram of the frequency of occurrence of words, word clouds, and word associations for the Peduli Lindung application.

Figure 2, Figure 3, Figure 4, and Figure 5 are visualizations of words that many reviews appear between positive and negative sentiments. In the first picture, the words #application, #good, and #mantap are examples of words with positive meanings from user reviews. Then, for the second, #application, #difficulty, and #vaccine result from negative user reviews. So, based on the negative sentiment of Wordcloud, it can be helpful as an evaluation material for the Indonesian Government to improve the application so that this policy can follow its objectives. Table 5 shows suggestions for improving recommendations written by researchers based on Google Play and government policies.

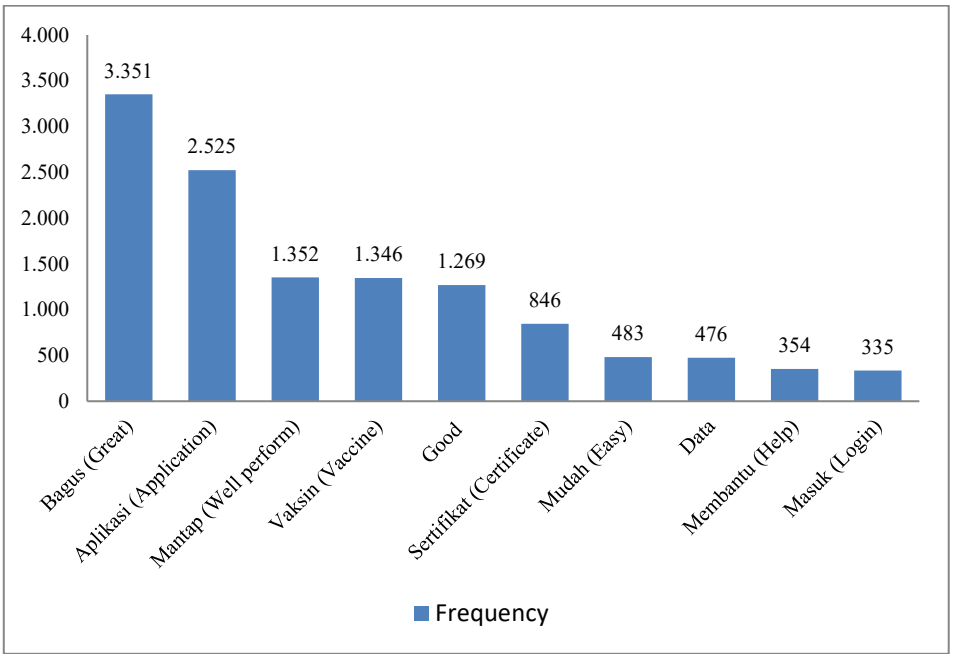

Figure 2. Top 10 word frequency of positive review

Figure 3. Word cloud of positive review

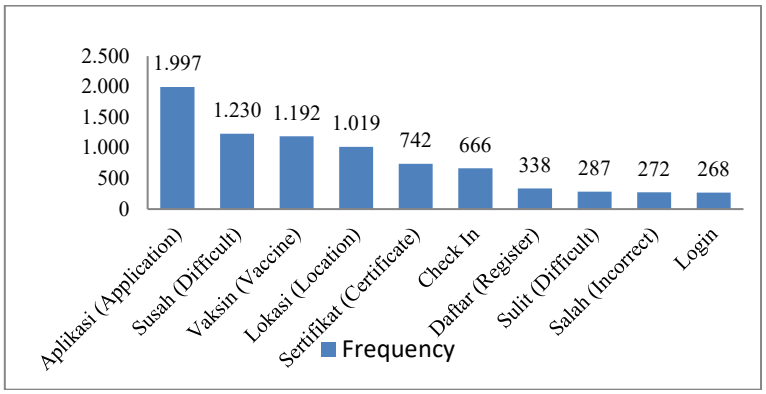

Figure 4. Top 10 word frequency of negative review

Figure 5. Word cloud of negative review

Table 5. Improvement recommendation

Factor	Problem Statement	Improvement Recommendation
Application	Not compatible with various devices	Describe compatible devices in the Terms and Conditions of Use of the Cares Protect application according to the API (Application Programming Interface) level (example: android device) [26]
	Complicated features	Provide tour guides for new users and Helpdesk or FAQ features [26]
Vaccination	Vaccination features that are difficult to understand.	Developers create application usage instructions [27]
Location	The Peduli Lindungi application, by default, accesses the user's location 24 hours a day, which causes battery waste and interferes with user privacy.	Grants the user full rights regarding the enable location permission when using the Cares Protect app [27]
Certificate	Vaccine certificates that are not real-time	Integrate vaccine site input into real-time system
Check-in	Failed to check-in due to network not being connected	Making offline check-in feature
Registration	Personal data does not match	Ensuring users to use NIK and password to register
Login	Personal data is always lost when the user want to login	Login innovation only by using NIK or fingerprint [27]

4. Conclusion

The results of this study provide information related to public sentiment toward the Peduli Lindungi application. The results show that Peduli Lindungi users often discuss applications, vaccines, services, certificates, data, locations, etc. The word association in the negative sentiment class indicates performance complaints related to applications, vaccines, certificates, locations, check-ins, registers, and service complaints. Therefore, the results of this study are expected to focus on improving the Peduli Lindungi application to enhance application performance. This proposal is based on Google Play and government policies for public use. Based on the analysis of the results, the Fuzzy Support Vector Machine model can perform classification by producing an accuracy value of 77%. The model can correctly predict about 2.192 review data from 2.813 review data overall.

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