



# Text Classification of Indonesian Translated Hadith Using XGBoost Model and Chi-Square Feature Selection

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**Abstract**—Aside from the Holy Qur'an, Hadith is indeed a life guide that every Muslims in this world must follow. The technology for classifying texts and sentences, including categorizing hadiths, is evolving in tandem with the advancement of the times. The model used to perform classification has also been developed and optimized such as the use of the XGBoost algorithm which is more optimized than the previous tree algorithm. This can also make it easier for us as Muslims to study hadiths by categorizing them according to recommendations, prohibitions, and information. This study conducted text classification of Indonesian translations of hadith texts based on recommendations, prohibitions, and information using the XGBoost algorithm, TF-IDF for its feature extraction, and Chi-Square for its feature selection. In this study, experiments were carried out by changing the order of the preprocessing process for the stopword removal and stemming parts, performing the classification process with and without using chi-square as a feature selection, and adding parameter value during the modeling process with XGBoost and manage to get the final result of 75%, 75%, 74% and 74% for accuracy, precision, recall, and F1-Score.

**Keywords:** Text classification; Indonesian translated Hadith; XGboost; Feature selection; TF-IDF; Chi-Square

## 1. INTRODUCTION

As human beings, we need guidelines or rules to follow in order to live as decent people on this planet. According to Islam, in addition to following the instructions of the Qur'an, we are also expected to follow the Hadith. Hadith is referred to everything pertaining to the Prophet Muhammad SAW before and after his prophethood, including his deeds, words, and personality traits[1]. Hadith is one of the most important Islamic disciplines, because without studying hadith in accordance with the methodology properly and correctly, then someone will not be able to understand the hadith properly and correctly[2]. There are various principles in the Hadith that we might take to heart. These principles can be divided into three groups: the first group is recommendation, the second is prohibition, and the last group is information[3]. It is essential that we are able to recognize hadiths as well as their categories so that there are no inaccuracies when studying or reading hadith. So categorization is expected to make it efficient for us to read or study hadiths since it is important to be able to distinguish hadiths along with their categories[3].

Research on the classification of Indonesian translations of hadiths has been carried out by Ghiina Zain Nabilah in 2021 [3]. The classification used for that research was a multi-label classification with Chi-Square feature extraction and the K-Nearest Neighbor model with an accuracy of 88.29%. In this research, the researcher wanted to use the Chi-Square selection feature which had previously been proven effective to select features in the Indonesian translation hadith dataset but by using a different model which is the XGBoost model.

The classification model that will be used in this research is the XGBoost model which has previously been used for sentiment analysis research on Indonesian motorcycle taxi services by Sondang Tesalonika Simanjuntak in 2021[4] which obtains an accuracy value of 92%, using the Chi-Square extraction feature which was previously also used in Indonesian translation of hadiths topic classification research by Ghiina Zain Nabilah[3] for feature extraction in his research. By looking at the results of sentiment analysis research using XGBoost on Indonesian gojek services[4] and research on the topic classification of hadith translations using the KNN method[3], the XGBoost model is chosen as a model and Chi-Square as a feature selection because it has been proven effective and managed to get good results and optimal in previous studies. In this research, the researcher compared the accuracy of using and without using feature selection.

There is also another study about this topic from Z Maulana in 2021 [5] that the goal of that research is to be able to implement sea level prediction into an application using Cilacap's sea level data and the XGBoost algorithm contributing good results such as MSE = 0.03, RMSE = 0.005, and R2 = 0.87. Another study that use the XGBoost algorithm was conducted in 2020 by S. Lei, K. Xu, Y. Huang, and X. Sha [6] where they detect credit card fraud using XGBoost with hyperparameter and the results were promising, with an accuracy value of 0.976 and an AUC of 0.942. In these two kind of researches, the final results were evaluated using MSE, RMSE, R2, accuracy, and AUC values. This is different from this research which uses accuracy, precision, recall, and f1-score as the final value for evaluation.

Fahmi Hamzah in 2021[7] write about the use of Chi-Square for feature selection with a significance of 0.05, 0.1, and 0.15 which reduced approximately 91% of the features with the lowest confidence interval of 85% but did not make such a big difference to accuracy but by using feature selection Chi-Square, the time needed to train the model is faster than without feature selection. This is quite different compared to this study because this study does not apply a comparison of significance levels during the Chi-Square feature selection. H. Biyanesha Putra in 2020 [8] also used Chi-square as a feature selection to analyze customer satisfaction sentiments for online transportation. The results obtained from this study are quite good with 86% for accuracy on gojek data and 88% accuracy on Grab data.

N. B. Ufairah in 2021 [9] retrieved data from Twitter and built a sentiment analysis model by preprocessing, then using TF-IDF feature extraction, SMOTE, and the method classification of Support Vector Machine (SVM). The highest accuracy results obtained from this study were quite good, namely 87.63%. This research does not use SMOTE because the data used is already balanced and does not need to perform normalization in the process.

Research using TF-IDF as a feature extraction was also carried out by D. Vinoth and P. Prabhavathy in 2022 [10]. In this study, the author also uses Chi-Square and Information Gain as feature selection and gets the final accuracy of 0.947, precision of 0.952, and F-Score of 0.949 to detect and classify sarcasm on social media. Therefore, this study tries to combine the XGBoost classification method and Chi-Square feature selection for classification problems of Indonesian language hadith translations which in the preprocessing process also carry out TF-IDF feature extraction.

## 2. RESEARCH METHODOLOGY

The system built in this research is a text classification for categorizing Indonesian translated hadith using Extreme Gradient Boosting algorithm for it's model and and Chi-Square for it's feature selection. The flow of this model is illustrated in Figure 1.

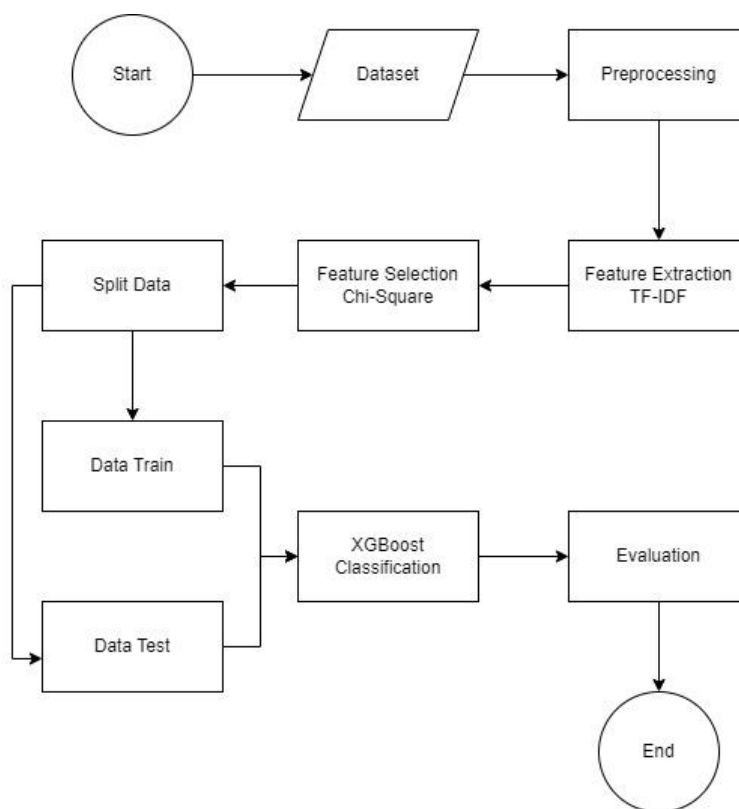


Figure 1. System Design Flow

### 2.1 Dataset

The data used in this research is an Indonesian translated hadith dataset. The data is obtained from Telkom University Dataverse which contains Indonesian translations of Bukhari's hadith in text form. The dataset has been labeled with prohibition, information, and recommendation classes that have been validated by hadith experts. The examples of the dataset that already has a label are shown in table 1.

Table 1. Data examples

Label	Sentence
Prohibition	“Janganlah kalian berdusta terhadapku (atas namaku), karena barangsiapa berduasta terhadapku dia akan masuk neraka.”
Information	“tidaklah beriman seorang dari kalian hingga aku lebih dicintainya daripada orang tuanya dan anaknya.”
Recommendation	“Barangsiapa berwudlu hendaklah mengeluarkan (air dari hidung), dan barangsiapa beristinja' dengan batu hendaklah dengan bilangan ganjil.”

### 2.2 Preprocessing

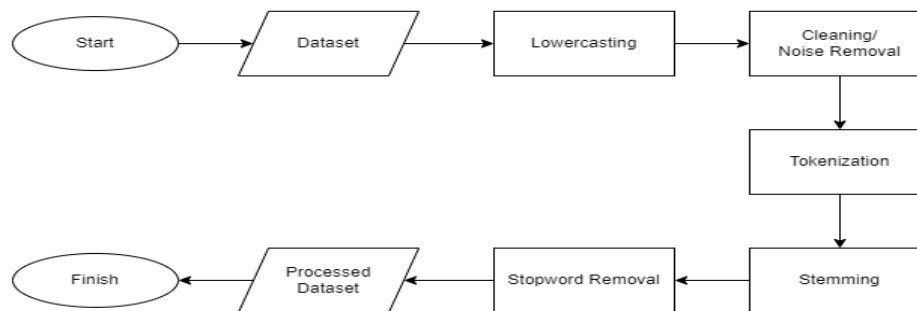


Figure 2. Preprocessing Stages

Data preparation or preprocessing usually a mandatory step. It converts previous useless data into new data that makes it easier to go ahead with the process[11]. The scheme of the preprocessing carried out in this study is shown in Figure 2. In this research, the preprocessing process used is Lowercasing, Cleaning/Noise Removal, Tokenization, Stopword Removal, and Stemming.

Lowercasing or also known as case folding is a process to standardize the writing format, which initially varies between uppercase and lowercase letters to become entirely lowercase. With lowecasting, you can also get more efficient features with the same format[12].

Cleaning or also known as noise removal is a process to remove parts that are not needed or considered disturbing in text analytics[13].

Tokenization is a process for splitting text in a sentence into pieces of words or tokens which will facilitate the process of analytic text[12].

Stemming is a step to remove the inflection of a word[12], this process removes the prefix or end of a word so that the word becomes its basic form[13].

Stopwords are words/features that have no meaning/relationship (irrelevant) with the main subject[14]. Stopword removal is a step to remove features that have no meaning and have no impact on the text analytics process[12].

After going through several preprocessing stages, the final result of the clean text can be seen in table 2.

Table 2. Preprocessing result

Text	Preprocessed Text
“tidaklah beriman seorang dari kalian hingga aku lebih dicintainya daripada orang tuanya dan anaknya.”	“iman orang cinta orang tua anak”

### 2.3 Feature Extraction using TF-IDF

After preprocessing the data, then feature extraction is carried out where in this study the feature extraction used is TF-IDF (Term Frequency – Inverse Document Frequency). In this process the data will be converted into a numeric form with a word weight process that aims to calculate the weight of each word that will be used as a feature[15]. In this process, the calculation of term frequency (TF) and inverse document frequency (IDF) is carried out using the equation as in number 1.

$$W_{t,d} = tf_{t,d} \times idf_t = tf_{t,d} \times \log \frac{N}{df_t} \tag{1}$$

### 2.4 Feature Selection using Chi-Square

After the data has gone through the previous process, feature selection using Chi-square will be carried out In this stage. The Chi-Square method is one of the feature selection methods available in the filter method. Chi-Square evaluates a term's independence from its category and attempts to eliminate confounding and irrelevant factors before it is classified. Chi-Square as a feature selection checks for independence and estimates the dependence of a class on the feature[16]. Reduction of features that are confounding or irrelevant which will interfere with the classification process is carried out using the equation as in number 2 and number 3.

$$e_{ij} = \frac{O_i \cdot O_j}{N} \tag{2}$$

$$\chi^2 = \sum_{i=1}^n \frac{(O_{ij} - e_{ij})^2}{e_{ij}} \tag{3}$$

### 2.5 XGBoost

The After the matrix-shaped data has passed feature selection, the data can be classified using a model, and in this study, the model used is the XGBoost algorithm model. XGBoost, which stands for Extreme Gradient Boosting, is a scalable tree boosting system that can be used for various functions such as classification, regression, and ranking[17].



XGBoost is an optimized algorithm from Gradient Boosting which has a more accurate result and 10 times faster execution time[18]. This method is one of the ensemble methods where this method works by combining predictions from several models into one. This is done by taking each predictor sequentially and modeling it based on the residual error from the previous model. The first process when entering a dataset is to create an initial model using the original data. Initial predictions and error/residual scores are then obtained from the initial model using the equation as in number 4 and number 5.

$$h_0(x) = \text{mean}(Y) \tag{4}$$

$$\hat{Y} = Y - h_0(x) \tag{5}$$

Where  $h_0(x)$  is the initial prediction of the first model and  $\hat{Y}$  is the residual error of the first model. The second model is then built using the residual error from the first model to get the prediction results for the second model. then, the third model is built using the residual error from the first and second models, and predictions from the third model will be obtained. This process runs repeatedly according to the number of n in the specified n\_estimator. the resulting predictions are cumulative predictions from the predictions of each previous model. The equation used in the XGBoost algorithm as in number 6 and number 7.

$$\bar{y}_i = \sum_{k=1}^K f_k(x_i) \tag{6}$$

$$L^{(t)} = \sum_{i=1}^n l(y_i \bar{y}_i^{(t-1)} + f_t(x_i)) \tag{7}$$

The training data will be exemplified as  $x_i$  with  $y_i$  label. The algorithm will use the number of K as a predictor of the output  $\bar{y}_i$  in equation number 5 where  $f_k$  shows the structure of the tree with a continuous score in each leaf. The score of each tree will be minimized by its object function by means of equation in number 6 where  $l$  is a differentiable convex loss function used to measure the difference  $y_i$  and  $\bar{y}_i^{(t)}$ [4].

### 2.5 Evaluation

In this research, the evaluation phase was carried out using a confusion matrix. Confusion Matrix measure the performances by comparing the predictive with the actual data [19]. Confusion Matrix has four representations of the result. There are TP which stands as True Positive, FP which stands as False Positive, TN which stands as True Negative, and FN which stands as False Negative. Based on the representative above, the equation of performances are described in number 8, number 9, number 10 and number 11.

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} \tag{8}$$

$$\text{Recall} = \frac{TP}{TP+FN} \tag{9}$$

$$\text{Precision} = \frac{TP}{TP+FP} \tag{10}$$

$$F1 = 2 \times \frac{(\text{Precision} \times \text{Recall})}{(\text{Precision} + \text{Recall})} \tag{11}$$

## 3. RESULT AND DISCUSSION

The Indonesian Hadith translation dataset is divided into three categories, namely recommendations, prohibitions, and information, several testing scenarios are tried which are useful to see the effect of the experiment on the final result of the translated hadith dataset and whether it can be better. The first test scenario is to change the sequence of the preprocessing process for the stopword removal and stemming sections, to see if the stopword is removed before stemming, the accuracy can be better or vice versa. The second test scenario is to carry out the classification process without using the chi-square selection feature. This scenario is to show how good feature selection is in increasing the performance of this dataset with the XGBoost algorithm. The third test scenario is to use hyperparameters during the modeling process with XGBoost. This scenario is to see how good the effect is on the final accuracy by using hyperparameters for the XGBoost algorithm. The experiments carried out in this study are shown below in table 3.

**Table 3.** Experiment scenario

Label	Sentence
Scenario 1	Change the sequence of the preprocessing process for the stopword removal and stemming sections
Scenario 2	Carry out the classification process without using the chi-square selection feature
Scenario3	Adding parameter value during the modeling process with XGBoost

### 3.1 Scenario 1: Change the sequence of the preprocessing process for the stopword removal and stemming sections

In the first experiment scenario, an exchange of preprocessing was carried out to find out whether the exchanged preprocessing process had an effect on the final result of the model. For this experiment, preprocessing was carried out twice, the first is as shown in figure 3, and the second is as shown in figure 4.

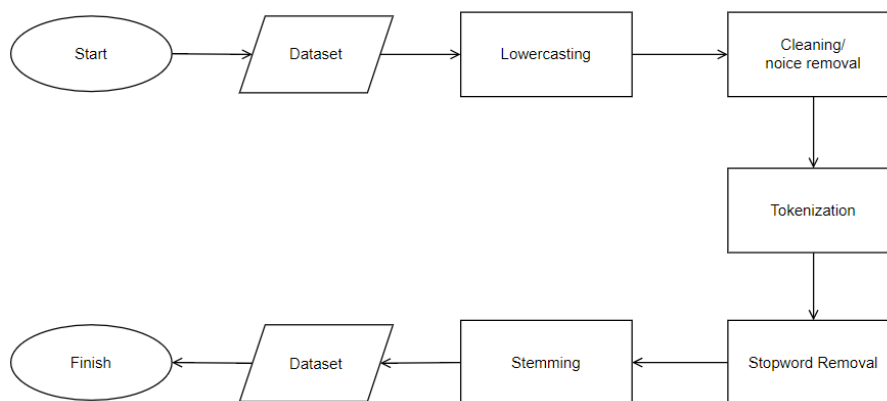


Figure 3. Preprocessing flow stemakhir

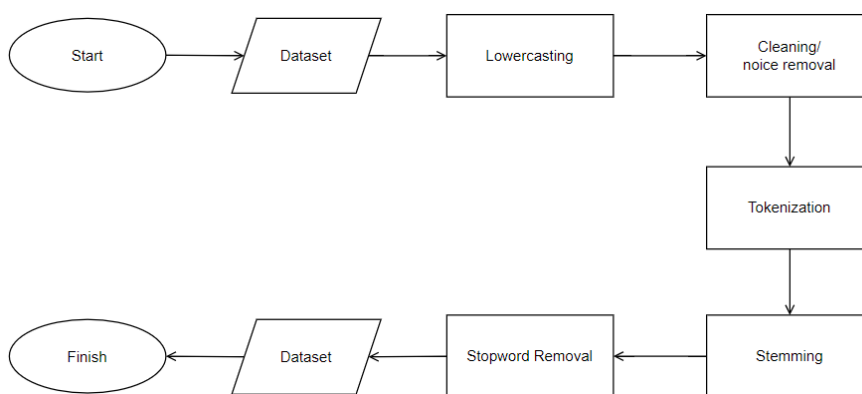


Figure 3. Preprocessing flow stemdulu

The difference between the two processes is the exchange of sequences in the stemming and stopwords removal processes. The results of the data that have been cleaned by the process in the first figure will be named the *stem akhir*, and the results of the data that have been cleaned by the process in the second figure will be named the *stem dulu*. The two datasets were then selected for each feature with Chi-Square for feature selection and modeled with the XGBoost algorithm without parameters. The results of this scenario are shown in table 4.

Table 4. The Effect of Changing the Preprocessing Process Flow

Label	Accuracy	Precision	Recall	F1-Score
<i>Stem Akhir</i>	74%	71%	70%	70%
<i>Stem Dulu</i>	<b>76%</b>	<b>73%</b>	<b>73%</b>	<b>72%</b>

From the experiments performed above, the results shown in the table above show that swapping the preprocessing process can affect the final results of the model, although not significantly. It gets 3% higher for the recall score, and for the accuracy, precision, and F1-score, it gets a 2% higher value by using *Stem dulu* where the data is preprocessed with stemming followed by stopwords removal. So it can be concluded that swapping the order of the preprocessing process by doing stemming first before doing stopwords removal can have better results for the Indonesian translated Hadith dataset using the XGBoost algorithm and Chi-Square feature selection.

This can happen because in the stemming process, there is a process where the words will be de-affixed so that the word will be returned to their original form[13], and in the stopwords removal process, there is a removal of words that are considered stopwords or not important[12]. So by returning the word to its original form followed by removing stopwords, it can make the set of words that will be modeled will have a cleaner result.

### 3.2 Scenario 2: Carry out the classification process without using the chi-square selection feature

In the second experiment scenario, the flow was tested without using the Chi-square feature selection. This experiment was conducted to see how far the use of chi-square feature selection affects the final results of the model. This experiment uses the Indonesian translated hadith dataset, where the preprocessing process is done before stopwords removal. Data is analyzed using the XGBoost algorithm without parameters. The results of the experiment can be seen in table 5.

**Table 5.** The effect of Chi-Square

Label	Accuracy	Precision	Recall	F1-Score
Using Chi-Square	<b>76%</b>	<b>73%</b>	<b>73%</b>	<b>72%</b>
Not using Chi-square	74%	72%	71%	71%

From the table above, it is shown that the use of chi-square feature selection is proven to influence data processing by using the XGBoost algorithm as a model with the Indonesian translated hadith dataset, although the changes given are not very significant. The accuracy value increased by 2% from 74% and 71% to 76% and 73% for accuracy and recall score, and by 1% from 72% and 71% to 73% and 72% for precision and F1-score. This proved the statement in study [3] that the use of Chi-Square as a feature selection is efficient enough to reduce unimportant features on the Hadith dataset in Indonesian translation. This can happen because the chi-square feature selection allows only the most influential features to be selected for the next process. This leads to better model results because features with low influence have been discarded during the feature selection process.

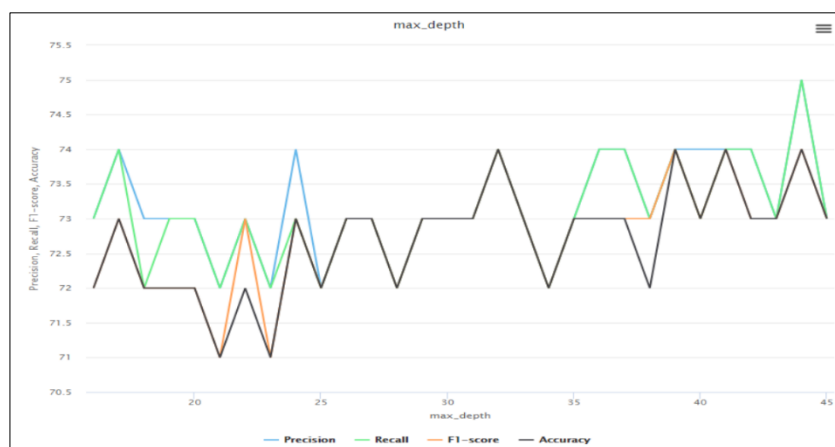
### 3.3 Scenario 3: Adding parameter value during the modeling process with XGBoost

In the third experiment scenario, a test was conducted on the flow with a model that uses parameters. This test was conducted to see how influential the addition of parameters from the XGBoost algorithm would be. The parameter's value added in this evaluation is max\_depth. In this testing process, the dataset used is the Indonesian translated hadith with preprocessing process where stemming is done first before stopword removal and Chi-square for the feature selection. The results of the experiments are shown in table 6.

**Table 6.** The effect of hyperparameter

Label	Accuracy	Precision	Recall	F1-Score
Using Hyperparameter	<b>75%</b>	<b>75%</b>	<b>74%</b>	<b>74%</b>
Not using Hyperparameter	<b>76%</b>	73%	73%	72%

The table above shows that the addition of parameters to the XGBoost algorithm is proven to achieve better results than without the addition of parameters. In this experiment, the max\_depth parameter is used which is a parameter to limit the growth or depth of the tree[19]. To get the optimal max\_depth value, experiments were carried out as shown in figure 4.



**Figure 4.** Performance of max\_depth Parameter Towards the Final Score

Based on the experimental results in Figure 4, the highest graphical value is achieved by using max\_depth = 44 with 75% accuracy, 75% precision, 74% recall, and 74% F1-score. Paper [20] compares the parameters used in the XGBoost algorithm for several datasets, and for one of the dataset, the author uses the value of max\_depth = 9 using randomsearch. It can be concluded that the value of adding parameter values affects the performance of the model.

### 3.4 Discussion

Based on the results obtained, the author can prove the statement in paper [21] which discusses the use of Chi-square as a feature selection proven to improve the performance of the model, and also the statement in paper [22] which inputting different parameters for the XGBoost algorithm can make an improvement for the final result of the model.

## 4. CONCLUSION

Based on the experiments and scenarios that have been carried out, the writer has built a system that can classify Indonesian translated hadith in text form with the XGBoost algorithm and Chi-square for feature selection, by

conducting three experiments. The first experiment is by swapping the preprocessing sequence into two sections, the first by performing stopword removal before stemming and the second by performing stemming before stopword removal. Then in the second experiment, the model was executed without using Chi-square as feature selection. And in the third experiment, parameters were added during modeling to see how influential the addition of parameters was on the final model results. The results that the writer gets from conducting various experiments are that changes in the preprocessing flow are quite influential for model performance, with a path that uses stemming before stopword removal obtaining better results even though it is not too significant. Then the use of Chi-square as feature selection is also proven to have an effect on the final results of the model because the function of feature selection is to reduce features that are not particularly relevant and make the set of words cleaner to be processed. Then the addition of parameters has also proven to perform better performance for the final results of the model in this paper, by finding the optimal value and changing the max\_depth value to 44 can make the final results of the model change although not significantly and manage to get the final result of 75%, 75%, 74% and 74% for accuracy, precision, recall, and F1-Score. In this research, the dataset used is a dataset of Indonesian translated hadith in which there are many absorption words from Arabic. The suggestion that can be given by the writer is to examine words that may have a major influence when doing preprocessing, especially before stemming because it is a concern that after doing the stemming process, the words may change their meaning due to the reduction of affixes.

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