

Sentiment Analysis of Customer Reviews to Determine Favorite Perfume Scents Using the Naive Bayes Method

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Abstract: This study is motivated by the large number of customer reviews regarding perfume fragrances that are still evaluated manually, making it difficult to objectively identify the most preferred fragrance. This study aims to develop a sentiment analysis system to classify customer reviews into positive, neutral, and negative sentiments using the Naïve Bayes method and to determine the favorite perfume fragrance. The study employed a quantitative approach using sentiment analysis. The population consisted of all customer reviews at the perfume store under study, while the sample comprised reviews containing information about fragrance and review content. The research instrument consisted of customer review data collected through online questionnaires and direct interactions. Data analysis involved preprocessing, TF-IDF weighting, an 80:20 training-testing split, Naïve Bayes classification, and evaluation using a confusion matrix, accuracy, precision, recall, and F1-score. The results showed that the model achieved 71.43% accuracy on 42 testing data, with 30 correctly classified instances. Of the 36 reviews, positive sentiment accounted for 58.33%. CHRISTIAN DIOR - SAUVAGE obtained the highest positive sentiment, with 7 of 10 reviews or 70.00%. The conclusion indicates that Naïve Bayes can effectively be applied to classify customer sentiment and support the identification of favorite perfume fragrances for store decision-making.

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Introduction

The development of the perfume industry is in line with increasing consumer attention to appearance, lifestyle, and self-expression. The diversity of brands and scent characteristics

makes consumers need information that can help them identify products that suit their preferences and needs. In this context, consumer experience with a product is a crucial source of information because it can provide insight into users' perceptions and assessments of the product they have used (Marcelino et al., 2025).

Customer reviews are a form of information that can directly describe consumer experiences. The content of reviews can reflect assessments of a product's quality, characteristics, and level of satisfaction, thus providing input for both consumers and businesses. Research on consumer reviews shows that the information contained in reviews can play a role in shaping consumer perceptions and decisions about a product (Siswati & Maupa, 2024; Zhu et al., 2024). Therefore, customer reviews not only serve as information for potential consumers but can also be used as a data source to understand customer preference trends.

Problems arise when the number of customer reviews increases, and all of this information is in unstructured text. Manual processing is time-consuming and can be ineffective when dealing with large amounts of data. Therefore, a computational approach is needed that can automatically process and group customer opinions based on their sentiment content. Previous research has shown that sentiment analysis can help overcome the problem of processing large volumes of product reviews, allowing for more efficient analysis of customer information (Gunawan et al., 2018; Hassolthine et al., 2025).

This problem was also found in the perfume store that was the subject of the study, which has two branches. Customer reviews obtained through online questionnaires and in-person interactions are still manually evaluated, so information regarding customer sentiment trends cannot be systematically identified. This condition results in the store lacking an adequate quantitative basis for identifying the scents that receive the most positive responses. Utilizing sentiment analysis can be an alternative to transform previously unstructured review data into more measurable and easily usable information in the product evaluation process (Chavan et al., 2025).

Sentiment analysis is an approach that can be used to identify and group opinions in text into specific sentiment categories. In product review analysis, this approach allows a collection of customer comments to be classified into positive, neutral, or negative sentiments, allowing for a more systematic understanding of consumer response tendencies (Sari et al., 2020; Zahirma & Rumini, 2025). One method that can be used is Naïve Bayes because it has a relatively simple and efficient classification process and has been applied to various studies on product review sentiment analysis (Astuti & Astuti, 2022; Zahirma & Rumini, 2025).

This research aims to develop a system capable of processing customer reviews, classifying positive, neutral, and negative sentiments using the Naïve Bayes method, and determining favorite perfume scents based on the highest number of positive sentiments. The analysis results are expected to provide more objective information for stores in understanding customer preference tendencies. Practically, this information can be used as a consideration in stock management, sales strategy development, and product development. The novelty of this research lies in the use of Naïve Bayes-based sentiment analysis on perfume store customer reviews to determine the scents that receive the most positive responses.

Research Methods

This study used quantitative research with sentiment analysis to classify perfume customer reviews into three categories: positive, negative, and neutral. The classification method used was Naïve Bayes because it is easy to implement, has a fast computational process, and is quite good at text classification (Astuti & Astuti, 2022). The research process included preprocessing, TF-IDF weighting, training and testing data division, Naïve Bayes classification, and model evaluation. The classification results were then used to determine the favorite perfume scent based on the highest number of positive sentiments (Sari et al., 2020).

The research instrument consisted of customer review data obtained through online questionnaires and direct interactions at perfume stores. The data were analyzed through data cleaning, case folding, tokenizing, filtering or stopword removal, stemming, TF-IDF weighting, and data division into approximately 80% training and 20% testing. Classification was performed using Naïve Bayes with three sentiment classes, while model performance was evaluated using a Confusion Matrix through accuracy, precision, recall, and F1-score. The classification results were then grouped by scent, and the scent with the highest number of positive sentiments was determined as the favorite perfume scent (Marcelino et al., 2025).

The study population comprised all customer reviews of various perfume scents at the targeted store, obtained through questionnaires and direct customer feedback. The sample consisted of collected customer reviews containing information about the scent and the content of the reviews, which were then labeled positive, negative, or neutral. The manual calculation used six data points: two positive, two neutral, and two negative reviews, while the system implementation used all available training data.

The research procedure begins with the collection and labeling of review data, followed by preprocessing, which includes data cleaning, case folding, tokenizing, filtering, and stemming. The preprocessed data is weighted using TF-IDF, then divided into training and testing data with a proportion of approximately 80% and 20%. The training data is used to build a Naïve Bayes model and the testing data is used for testing. The results are then evaluated using a Confusion Matrix, accuracy, precision, recall, and F1-score. Next, the classification results are grouped by scent, and the scent with the most positive sentiment is determined as the favorite perfume scent.

Results and Discussion

System Requirements

1. Hardware Requirements

Hardware requirements refer to the physical components used to support the development, testing, and operation of a perfume review sentiment analysis application. The devices used must have adequate capabilities to ensure the proper operation of web-based applications, local servers, databases, and data processing.

In this study, a computer or laptop was used as the primary device for system development and testing. The device was used to run the program, manage the database, perform sentiment classification using the Naive Bayes method, and display the results via a web browser.

The hardware specifications used can be adjusted to suit the available devices, as long as they can consistently support the system's requirements. Generally, recommended devices include a minimum Intel Core i3 processor or equivalent, at least 4 GB of RAM, at least 128 GB of storage, and a monitor with sufficient resolution to support application development and testing activities.

In addition to the primary device, network connection support can be used when the application is accessed via a local network or the internet. However, during development using a local server, the application can still run without an internet connection as long as all required components are installed on the device.

2. Software Requirements

The software requirements describe the various applications and supporting components used during the development, operation, and testing of the perfume review sentiment analysis system. The software is needed to assist in program development, data management, local server provisioning, and sentiment classification using the Naive Bayes method.

In the application development process, Visual Studio Code is used to write and manage program code. The system is developed using PHP as the primary programming language, while HTML, CSS, and JavaScript are used to construct page structure, customize the interface, and support user interaction in web-based applications.

The application runs locally using XAMPP. This software provides Apache as a web server and MySQL/MariaDB as a database manager. The database is used to store various information required by the system, such as administrator data, perfume scent data, customer review data, training data, and sentiment classification results.

Additionally, web browsers like Google Chrome are used to access and test application functionality. Text processing support components are also used in the preprocessing stage, particularly to assist with the stemming process before data is classified using the Naive Bayes method. With this software support, the entire system development and testing process can be conducted in a single, integrated work environment.

System Implementation

System implementation is the stage of applying the design to a web-based application, encompassing processes, data management, interfaces, and sentiment analysis. The system consists of customer and administrator pages. Customers can enter data, select scents, and provide reviews, while administrators can manage scent data, training data, reviews, model evaluations, reports, and dashboards.

Customer reviews are processed through text processing stages and classified using the Naive Bayes method into positive, neutral, and negative sentiments. The classification results are used to observe the sentiment distribution of each scent and determine the favorite perfume scent based on the highest percentage of positive sentiment. The system implementation is displayed on the Customer Reviews page, Administrator Dashboard, Scent Categories, Training Data, Review Data, Model Evaluation, and Analysis Results Report.

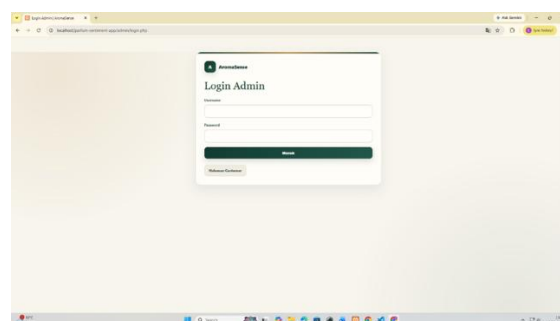


Figure 1. Login Page

The login page provides administrator access to the system. The administrator enters their registered username and password. The system then verifies the data. If correct, the administrator is redirected to the dashboard; if incorrect, the system displays a login failure message.

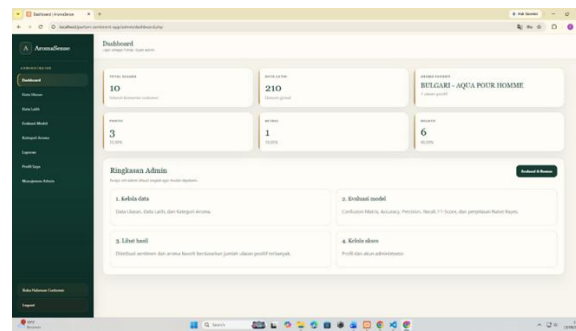


Figure 2. Dashboard page

The Dashboard page is the main page after successfully logging in. It displays a summary of the number of reviews, training data, the distribution of positive, neutral, and negative sentiment, and the fragrance scents with the highest level of interest. The dashboard also displays a fragrance ranking based on the percentage of positive sentiment and the most recent reviews, allowing administrators to quickly monitor analysis results.

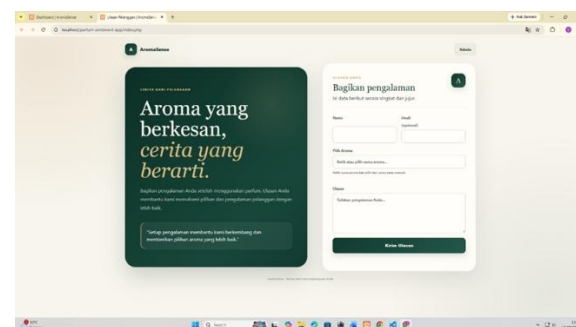
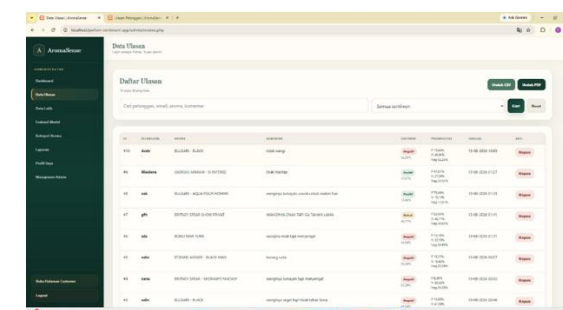


Figure 3. Review Page

The Customer Reviews page allows customers to share their opinions about perfume scents by providing their name, optional email address, selecting a scent, and writing a review. The submitted data is then preprocessed and classified using Naive Bayes to determine whether the sentiment is positive, negative, or neutral. It is then stored in a database for analysis of each fragrance.



The screenshot shows a table of customer reviews. The table has columns for 'No', 'Nama', 'Email', 'Aroma', 'Review', 'Sentiment', 'Tanggal', and 'Aksi'. The data is as follows:

No	Nama	Email	Aroma	Review	Sentiment	Tanggal	Aksi
1	Andi	andi@gmail.com	Rose	Sangat bagus, wanginya enak.	Positif	2024-03-10 10:00	Detail
2	Budi	budi@gmail.com	Vanilla	Wanginya manis, cocok untuk sehari-hari.	Positif	2024-03-10 11:00	Detail
3	Cici	cici@gmail.com	Lavender	Wanginya segar, bikin tenang.	Positif	2024-03-10 12:00	Detail
4	Dani	dani@gmail.com	Sandalwood	Wanginya mewah, cocok untuk acara formal.	Positif	2024-03-10 13:00	Detail
5	Eva	eva@gmail.com	Ylang-ylang	Wanginya manis, bikin bahagia.	Positif	2024-03-10 14:00	Detail
6	Fani	fani@gmail.com	Geranium	Wanginya segar, bikin semangat.	Positif	2024-03-10 15:00	Detail
7	Gina	gina@gmail.com	Stanger	Wanginya unik, bikin penasaran.	Positif	2024-03-10 16:00	Detail
8	Hani	hani@gmail.com	Stanger	Wanginya unik, bikin penasaran.	Positif	2024-03-10 17:00	Detail
9	Iani	iani@gmail.com	Stanger	Wanginya unik, bikin penasaran.	Positif	2024-03-10 18:00	Detail
10	Jani	jani@gmail.com	Stanger	Wanginya unik, bikin penasaran.	Positif	2024-03-10 19:00	Detail

Figure 4. Review Data Page

The Review Data page allows administrators to view customer reviews, including their identities, fragrance scents, comments, and positive, negative, or neutral sentiment classifications. This data is used to monitor incoming reviews, compile analytical summaries,

and determine customer interest in each fragrance.

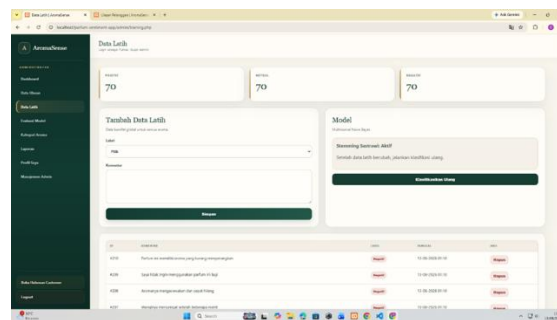


Figure 5. Training Data Page

The Training Data page is used by administrators to manage reviews that have been labeled positive, negative, or neutral as a basis for building a Naïve Bayes model. This data is used by the system to recognize word patterns within each sentiment category and can be reclassified if changes occur to the dataset.

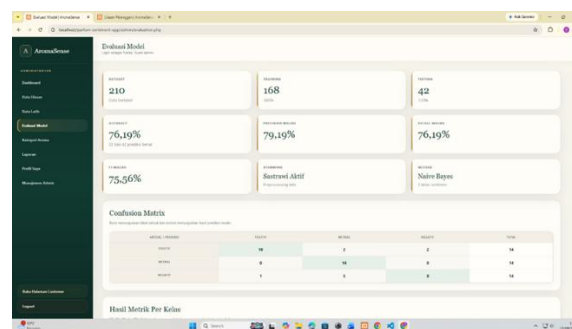


Figure 6. Model Evaluation Page

The Model Evaluation page is used to measure the performance of the Naïve Bayes method, splitting 80% of the training data and 20% of the testing data. Classification results are compared to actual labels and evaluated using a confusion matrix, accuracy, precision, recall, and F1-score to determine the model's ability to classify positive, negative, and neutral sentiments.

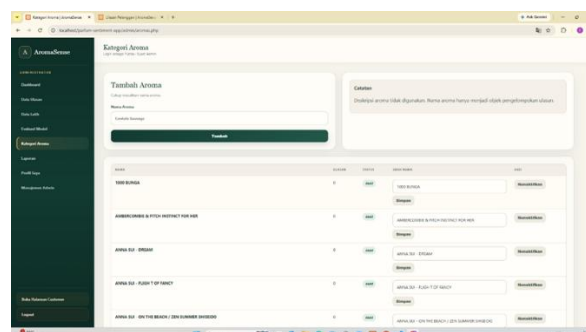


Figure 7. Aroma Category Page

The Scent Categories page is used by administrators to manage the list of available perfume scents. Scent data is used to identify customer preferences when leaving reviews and

to group sentiment results and display customer ratings for each scent.

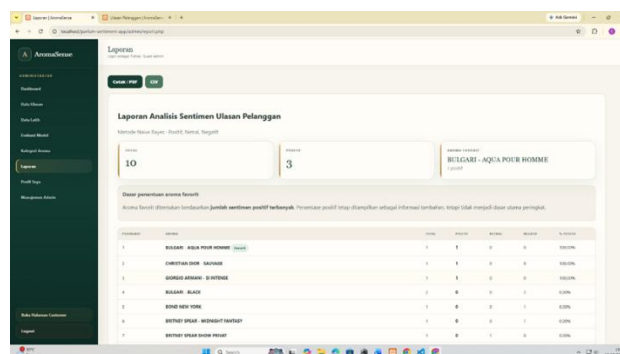


Figure 8. Analysis Results Report Page

The Analysis Results Report page presents a summary of the number of positive, negative, and neutral sentiments for each fragrance, as well as a comparison between them. This page helps administrators identify the scents with the highest positive responses, which can be used to determine favorite fragrances based on customer sentiment.

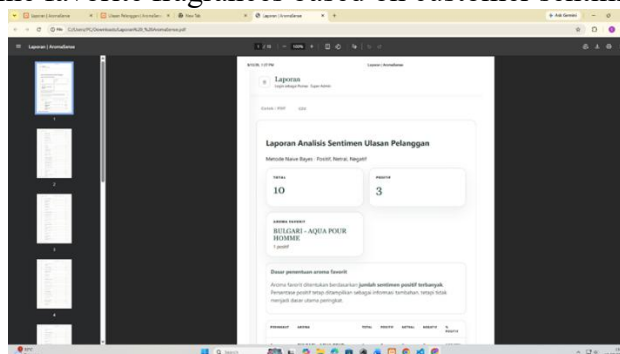


Figure 9. PDF Report

The PDF report presents the sentiment analysis results in a document that can be saved or printed. Information displayed includes total reviews, the number of positive sentiments, favorite fragrance scents, the basis for their selection, and a scent ranking. Favorite scents are determined by the highest number of positive sentiments, while the sentiment percentage is used as additional information to compare each scent.

System Testing

1. Black Box Testing

Table 1 Black Box Testing

No.	Tested Features	Testing Scenario	Expected results	Status
1	Administrator Login	Enter the correct username and password	The system accepts the login and displays the dashboard page.	Succeed
2	Administrator Login	Entering an incorrect username or password	The system rejects the login and displays an error message.	Succeed

3	Customer Reviews	Fill in all the review data correctly then press the submit button.	Review data is stored and processed by the system	Succeed
4	Customer Reviews	Submitting a review with required data missing	The system rejects the shipment and asks the customer to complete the data.	Succeed
5	Sentiment Classification	Customer successfully submitted a review	The system processes reviews and generates a positive, negative, or neutral sentiment.	Succeed
6	Review Data	Administrator opens review data page	The system displays customer review data along with sentiment classification results.	Succeed
7	Training Data	Administrator opens and manages training data	The system displays and saves changes to training data.	Succeed
8	Model Evaluation	The administrator runs the model evaluation process.	The system displays the confusion matrix as well as the accuracy, precision, recall, and F1-score values.	Succeed
9	Aroma Category	Administrator manages aroma category data	The system can display and store managed aroma data.	Succeed
10	Analysis Results Report	Administrator opens the report page	The system displays a summary of sentiment and perfume scent ratings.	Succeed
11	Determining Favorite Aroma	The system compares the number of positive sentiments for each scent.	The system displays the scent with the highest number of positive sentiments as the favorite scent.	Succeed
12	PDF Report	Administrator selects print or PDF function	The system generates analysis results reports in PDF format.	Succeed

Based on the results of black box testing, all key features of the application functioned as planned. Administrator login, customer review submission, sentiment classification, review and training data management, model evaluation, and report presentation were all successfully executed. Therefore, the application was deemed capable of performing its core functions according to system requirements.

2. Classification Results Testing Using Confusion Matrix

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=====
PENGUJIAN MODEL NAIVE BAYES
=====

Total Data      : 210
Data Training   : 168
Data Testing    : 42

Training Positif : 56
Training Netral  : 56
Training Negatif : 56

=== CONFUSION MATRIX ===

                Prediksi
            Pos  Net  Neg
Aktual Positif  12   1   1
Aktual Netral   3   8   3
Aktual Negatif  2   2  10

=== ACCURACY ===

Prediksi Benar : 30
Total Testing   : 42
Accuracy         : 71.43%

```

Figure 10. Confusion Matrix and Accuracy

Table 2 Confusion Matrix

Current Class	Positive Prediction	Neutral Prediction	Negative Prediction
Positive	12	1	1
Neutral	3	8	3
Negative	2	2	10

Based on Table 2, the model successfully classified 12 positive, 8 neutral, and 10 negative data sets correctly out of 42 test data sets. There were 12 misclassified data sets in several sentiment classes.

The accuracy value is calculated based on the number of correct predictions compared to the entire testing data. Correct predictions were obtained from the main diagonal, namely $12 + 8 + 10 = 30$ data, while the total testing data was 42 data. Thus, the accuracy value obtained was $(30/42) \times 100\% = 71.43\%$. These results indicate that the Naïve Bayes method was able to classify most of the testing data correctly, although there were still some prediction errors.

Sentiment Analysis Results

1. Sentiment Classification Results

Table 3 Distribution of Sentiment Classification Results

No.	Sentiment	Number of Reviews	Percentage
1	Positive	21	58.33%
2	Neutral	8	22.22%
3	Negative	7	19.44%
	Total	36	100%

Based on Table 3, positive sentiment was the most common category, with 21 reviews (58.33%), followed by neutral sentiment with 8 reviews (22.22%), and negative sentiment with 7 reviews (19.44%). This indicates that customer reviews of the perfume's scent tend to be generally positive.

The favorite perfume scent was determined by comparing the number of positive sentiments for each scent. The scent with the highest number of positive sentiments was determined as the customer's favorite.

2. Determining Your Favorite Perfume Scent

Table 4 Ranking of Five Aromas Based on Sentiment Results

Ranking	Perfume Aroma	Total Reviews	Positive Sentiment	% Positive
1	CHRISTIAN DIOR - SAUVAGE	10	7	70.00%
2	BULGARI - AQUA POUR HOMME	8	5	62.50%
3	GIORGIO ARMANI - SI INTENSE	7	4	57.14%
4	YSL LIBRE	6	3	50.00%
5	BRITNEY SPEAR - MIDNIGHT FANTASY	5	2	40.00%

Based on Table 4, CHRISTIAN DIOR - SAUVAGE received the highest positive sentiment, namely 7 out of 10 reviews or 70.00%, thus being designated as the favorite perfume scent. The next ranking is BULGARI - AQUA POUR HOMME with 5 positive sentiments, GIORGIO ARMANI - SI INTENSE with 4, YSL LIBRE with 3, and BRITNEY SPEAR - MIDNIGHT FANTASY with 2 positive sentiments.

These results demonstrate that sentiment classification using Naive Bayes can be used to identify which perfume scents garner the most positive responses. This information can be used to assess customer interest trends in available perfume scents.

Conclusion and Recommendation

Based on the research results, the Naïve Bayes-based customer review sentiment analysis system successfully classified reviews into three categories, namely positive, neutral, and negative, and determined the favorite perfume scent based on the dominance of positive sentiment. The test results showed that the model achieved an accuracy of 71.43% from 42 test data, with 30 data successfully classified correctly. In all 36 reviews, positive sentiment was the largest category at 58.33%, followed by neutral 22.22% and negative 19.44%. Based on the number of positive sentiments, CHRISTIAN DIOR - SAUVAGE was the favorite perfume scent with 7 positive reviews out of 10 reviews or 70.00%. Practically, this system can help shop owners obtain information about customer preference tendencies more measurably, so that it can support decision-making in stock management, sales strategies, and product development.

This study still faces limitations in the relatively limited amount of data, so the classification results do not fully represent all customer preferences, and the accuracy level still shows prediction errors. Furthermore, the determination of favorite scents is based solely on the number of positive sentiments without considering other aspects such as satisfaction intensity, purchase frequency, or customer characteristics. Future research is recommended to use a larger and more diverse data set, optimize preprocessing and feature weighting, and compare Naïve Bayes with other classification methods to obtain a more accurate model. Future research can also consider analyzing customer aspects or characteristics to make the results of the scent preference analysis more in-depth and representative.

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