

Sentiment Analysis on BNI mobile application review Using K- Nearest Neighbors Algorithm

Alfin Hilmy Nurmakhlufi¹⁾, Muhammad Rafi Haidar Arsyad ²⁾, Wahyu Sri Mulyani ³⁾,
Kristiawan Nugroho ^{4)*}

Fakultas Teknologi Informasi dan Industri, Universitas Stikubank^{1,2,3,4)}

alfinhilmy0039@mhs.unisbank.ac.id¹⁾ rafihaidar@edu.unisbank.ac.id²⁾ wahyusri0034@mhs.unisbank.ac.id³⁾,
kristiawan@edu.unisbank.ac.id⁴⁾

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Abstract— The banking industry is growing in Indonesia in serving the lives of the community. Initially, national banks built various branches throughout Indonesia, but with the increasing needs of community transactions, the queues at various banks are getting higher. As a solution to this problem, Bank Negara Indonesia (BNI) has introduced the BNI Mobile Banking application to facilitate customer transactions digitally. In addition, public opinion regarding bank services, especially on social media, is very important to improve services. This study aims to analyze the satisfaction of BNI Mobile application users, based on user review sentiments on the Google Play Store. The K-Nearest Neighbors method is used to classify reviews into positive, neutral, and negative sentiments. The dataset consists of 2,000 reviews collected between June 2022 and April 2024. After going through the preprocessing stage, the data was analyzed using KNN to determine the classification accuracy. The results showed that the KNN algorithm was able to achieve the best accuracy of 97%, with an average accuracy of 96.5%. This study provides important insights into the user experience of the BNI mobile application, highlighting features that users appreciate and areas that need improvement. Understanding user sentiment can guide developers in optimizing application functionality and improving customer satisfaction. Suggestions for further research include comparing the performance of several other algorithms, such as Naive Bayes and Support Vector Machine, to obtain more comprehensive results. Furthermore, expanding the dataset to include user feedback from multiple platforms can provide a more holistic view of user experience and preferences.

Keywords— *Sentiment, BNI Mobile, K-Nearest Neighbors, User Satisfaction, Mobile Banking*

INTRODUCTION

Information Technology (IT) has developed rapidly in various fields significantly, including the banking industry. By utilizing IT, challenges in service delivery can be mitigated, as seen in the adoption of BNI Mobile Banking. (Agarwal dkk. 2021) In this digital era, online banking services are essential for customers, offering them the convenience to conduct transactions anytime and anywhere via smartphones. (Altay, Ulas, dan Alyamac 2020) Despite these conveniences, not all customers are satisfied with their experience. Several users encounter difficulties when using the application, ranging from technical issues to usability concerns, which can negatively impact user satisfaction and loyalty. (Kherif dkk. 2021) These challenges emphasize the need for a deeper understanding of user experiences to improve service quality. (Tri Dewi Septiani, Prayogo Kuncoro, dan Subarkah 2023). The banking industry needs to conduct in-depth analysis based on customer opinions during their service by the bank. In general, various public comments are currently made through social media as an expression of their feelings during the service they receive from banks.

To address these issues, sentiment analysis becomes relevant. Analyzing user reviews can uncover insights into the specific challenges users face. (Almomany, Ayyad, dan Jarrah 2022) This research aims to apply sentiment analysis to classify user reviews of the BNI Mobile Banking application into positive, neutral, or negative categories. Sentiment analysis is essential as it provides a clearer understanding of users' feelings and experiences, enabling the identification of common problems and areas for improvement. (Indarti dkk. 2020) This process helps the bank focus on enhancing the user experience, addressing customer dissatisfaction, and ultimately improving service delivery. (Boateng, Otoo, dan Abaye 2020a) Data mining plays a crucial role in extracting useful information from vast amounts of data. (Assegie 2021) By utilizing statistics, machine learning, and AI techniques, important patterns and insights can be identified from user reviews, which would otherwise remain hidden. In this study, sentiment classification is applied using the K-Nearest Neighbors (KNN) algorithm on review data that has been pre-processed through a data cleaning stage. (Dwiki, Putra, dan Juanita 2021). Text mining further complements this process by analyzing unstructured text data, such as user reviews, and categorizing them based

*name of corresponding author



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on sentiment. (Wisnu, Afif, dan Ruldevyani 2020) This approach allows for the collection of high-quality information relevant to the issues users face, thus providing a more detailed understanding of user satisfaction or dissatisfaction with the BNI Mobile Banking application. (Isnain, Supriyanto, dan Kharisma 2021a)

The K-Nearest Neighbors (KNN) algorithm is an effective method for data classification due to its simplicity and intuitive approach. (Chen dkk. 2020) By classifying data points based on the majority of their nearest neighbors, KNN enables the accurate grouping of similar data, such as user reviews, into specific sentiment categories. The probability of two reviews being grouped together increases when they share similar characteristics, and decreases when they differ. (Wijati dkk. 2024). In this study, the KNN algorithm is applied to a dataset of user reviews from the BNI Mobile Banking application. (Zhang dan Li 2023) Through supervised machine learning, the reviews are classified as positive, neutral, or negative based on the analysis of the training data. The goal is to provide valuable insights into user satisfaction and highlight areas where the application can be improved. (Afdal dkk. 2022)

LITERATURE REVIEW

The use of machine learning, particularly the K-Nearest Neighbors (KNN) method, in this research emphasizes the algorithm's suitability for classifying large datasets efficiently, especially those involving textual data like user reviews (Hastie, Tibshirani, & Friedman, 2009). By applying KNN to the BNI Mobile app's user reviews dataset, the study demonstrates how the algorithm can effectively group feedback into distinct sentiment categories based on the proximity of data points in the feature space (Uddin Dkk, 2022b). This approach not only enhances the accuracy of sentiment classification but also provides a scalable solution for handling continuous streams of user feedback, enabling BNI to make informed decisions based on real-time customer sentiment analysis. The successful implementation of such a system would enhance the bank's understanding of user satisfaction and guide decision-making to enhance customer experience (Ramos, Wang, & Dong, 2020).

Furthermore, customer satisfaction plays a pivotal role in determining the long-term success of mobile banking applications. The satisfaction level of users, as captured through their reviews, serves as an essential metric for banks to evaluate the performance of their mobile services. According to Anderson and Srinivasan (2003), customer satisfaction in online services is directly linked to customer loyalty and retention. This is especially important in the highly competitive financial technology sector, where user experience and service reliability can make or break a company's success. Incorporating sentiment analysis as a feedback mechanism allows banks to gauge customer satisfaction dynamically, providing actionable insights based on real-time feedback (Dahiya, Gupta, & Jain, 2021).

In recent years, sentiment analysis has emerged as a powerful tool to interpret and classify customer reviews in various industries, including mobile banking (Pang & Lee, 2008). The advancements in Natural Language Processing (NLP) and machine learning algorithms, such as Support Vector Machines (SVM) and KNN, have significantly improved the accuracy of sentiment analysis models (Zhang, Jin, & Zhou, 2020). These techniques can efficiently categorize large volumes of textual data into positive, negative, or neutral sentiments, enabling businesses to understand customer perceptions at scale. In mobile banking, where user feedback often centers on issues like app usability, transaction security, and customer support, sentiment analysis provides valuable insights for continuous improvement (Uddin et al., 2022b).

The significance of this study lies in its focus on optimizing the sentiment analysis process for mobile banking applications, with an emphasis on leveraging user reviews for actionable insights. By utilizing the KNN algorithm, the research highlights how supervised learning methods can improve the classification of sentiment in user feedback (Manning, Raghavan, & Schütze, 2008). As the volume of data continues to grow, the adoption of efficient data mining techniques becomes increasingly necessary to manage and analyze user-generated content. This research is a step towards building an automated system that banks can use to continually monitor and respond to customer sentiment, thereby improving user satisfaction and fostering customer loyalty (Wahyu Sholeha et al., 2022).

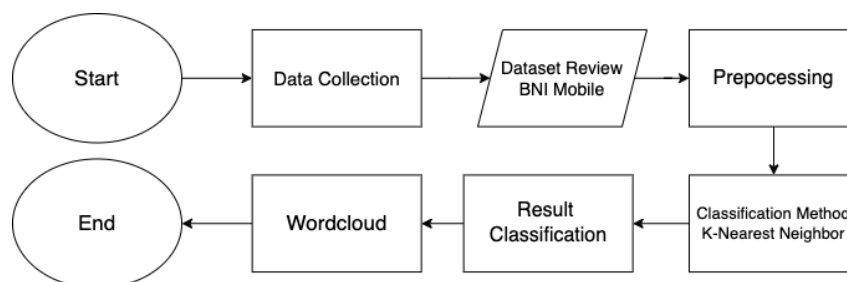


Fig. 1. KNN Research Flowchart

*name of corresponding author



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Dataset Review

This research uses reviews written by BNI Mobile Banking users on the Play Store as data. Review submission was conducted from June 6, 2022 to April 4, 2024, with a total of 2,000 reviews taken. Data retrieval is done using Python programming language through Data Scraping techniques.(Charbuty dan Abdulazeez 2021) This dataset contains reviews in Indonesian and is saved in CSV format. BNI Mobile Banking application user review data collected, as illustrated in Figure 2. (Rahayu dkk. 2022)

reviewId	userName	userImage	content	score	thumbsUpCount	reviewCreatedVersion	at
0	6c90dfa1-19e2-4b9d-ba80-d93bc7e268b6	Harry Sutarito	https://play.googleusercontent.com/ia/ACg8oc...	Sering error .dan membuat saya pusing, saat sed...	2	133	2024-03-30 21:23:39
1	d578c79c-39b9-4895-8859-1c205118333	Alyhd Alyhd	https://play.googleusercontent.com/ia/ACg8oc...	Saya setiap mau masuk ke aplikasi BNI mobile b...	1	215	2024-03-28 07:37:37
2	db0c475b-1d0-4e90-a89f-b79c4e9cbb9	Gia Me	https://play.googleusercontent.com/ia/ALVU...	Aplikasi yang merepotkan, ketika instal ulang ...	1	30	2024-04-10 12:41:27
3	8986eb5-35c7-45cb-894a-8b0623b924c	hendin narwandi	https://play.googleusercontent.com/ia/ACg8oc...	Dulu saya akan merekomendasikan aplikasi ini ...	1	12	2024-03-29 23:20:28
4	1d03d78c-d929-44fa-a3aa-b643e9a83007	Agung Saena	https://play.googleusercontent.com/ia/ALVU...	Heran tiap malam pasti aja kalau gak gangguan ...	1	2	2024-04-23 19:15:15

Fig. 2. Mobile Banking Data Review Scraping Results

Preprocessing

The Preprocessing stage is carried out to tidy up the data obtained from the results of scraping (data collection) user reviews of the BNI Mobile application, which was initially unstructured, so the K-Nearest Neighbor method was used to facilitate the classification process. (Yang dkk. 2020)This study uses five stages in preprocessing review text, namely: Case Folding, Cleaning, Tokenizing, Stopwords Removal, Normalization.(Rival dkk. 2023)

Case Folding

Case Folding is the initial stage that converts data from uppercase to lowercase. Thus, BNI Mobile application review data that has been collected will be converted into lowercase letters as a whole.(Zhafran Muflih, Rizki Abdillah, dan Noor Hasan 2023).

No	Before Case Folding	After Case Folding
1	Aplikasi yang merepotkan, ketika instal ulang terlalu banyak data yg harus di isi dan sangat ribet, untuk developer BNI Mobile contohlah aplikasi dari Bank sebelah LIVIN MANDIRI, pengoperasian mudah, simpel dan cepat karena pada dasarnya data sudah ada di pusat jadi jika instal ulang sangat gampang aktivasianya yg memanfaatkan kecanggihan kemudahan teknologi terkini, tidak seperti BNI yang sangat ribet sekali ujung"? harus ke bank CS terdekat juga. Hadeeehhh.....	aplikasi yang merepotkan, ketika instal ulang terlalu banyak data yg harus di isi dan sangat ribet, untuk developer bni mobile contohlah aplikasi dari bank sebelah livin mandiri , pengoperasian mudah, simpel dan cepat karena pada dasarnya data sudah ada di pusat jadi jika instal ulang sangat gampang aktivasianya yg memanfaatkan kecanggihan kemudahan teknologi terkini, tidak seperti bni yang sangat ribet sekali ujung"? harus ke bank cs terdekat juga. hadeeehhh
2	Aplikasi Mobile Banking BNI sekarang kenapa sering perbaikan layanan ya? Mau masuk ke aplikasinya jadi gak bisa transaksi kalau lagi butuh. Update : Sejak sebelum lebaran aplikasinya error terus. Tak bisa digunakan untuk pembayaran dgn QRIS. Status yg muncul perbaikan layanan ? ,i?	aplikasi mobile banking bni sekarang kenapa sering perbaikan layanan ya? mau masuk ke aplikasinya jadi gak bisa transaksi kalau lagi butuh. update : sejak sebelum lebaran aplikasinya error terus. tak bisa digunakan untuk pembayaran dgn qris . status yg muncul perbaikan layanan ? ,i?

Cleaning

Data cleaning is a fundamental step in preparing datasets for machine learning tasks, especially in sentiment analysis. The process involves removing unnecessary elements such as punctuation, special characters, and other non-alphabetic symbols that could distort the meaning of text data. In the context of sentiment analysis for mobile banking applications, cleaning the dataset ensures that only relevant information, such as words and phrases that directly express user sentiment, is retained for further analysis (Gupta & Kumar, 2021). Without proper data cleaning, the presence of noise, such as URLs, usernames, and hashtags, could introduce errors into the model, leading to inaccurate predictions (Pratmanto Dkk, 2023). Cleaned data, therefore, plays a pivotal role in improving the accuracy and performance of machine learning algorithms, such as K-Nearest Neighbors (KNN)

*name of corresponding author



and Support Vector Machines (SVM), by focusing on the essential linguistic features needed for sentiment classification (Zhang Dkk, 2021).

No	Before Cleaning	After Cleaning
1	Selalu off line jika dini hari diatas jam 00.30 pasti off line...padahal sangat dibutuhkan. Tidak sekali dua kali tetapi selalu off line. BNI harusnya ngecek hal tersebut agar tidak mengecewakan pelanggan dan nasabahnya.	selalu off line jika dini hari diatas jam pasti off line padahal sangat dibutuhkan. tidak sekali dua kali tetapi selalu off line bni harusnya ngecek hal tersebut agar tidak mengecewakan pelanggan dan nasabahnya.
2	Ke tiga kali nya makin lemot Mau buka nunggu 60 detik SMP 30 detik baru kebuka menu utama Dr 2022 2023 2024 makin ?, Æ Seharusnya makin baik BUKAN MASALAH JARINGAN APA SINYAL YA ..SAYA INTERNET ULTIMATE...ini bukan karena jaringan EMG aplikasi BNI makin payah ...	Ke tiga kali nya makin lemot Mau buka nunggu detik smp detik baru kebuka menu utama dr makin Seharusnya makin baik bukan masalah jaringan apa sinyal ya saya internet ultimate ini bukan karena jaringan emg aplikasi bni makin payah

Tokenizing

Tokenization is a crucial preprocessing step in Natural Language Processing (NLP) and machine learning, as it converts unstructured text into a structured format that algorithms can process. By breaking down sentences into smaller word units, tokenization facilitates the extraction of features that can be used in subsequent tasks such as sentiment analysis (Jurafsky & Martin, 2023). This step is particularly important in sentiment analysis of customer reviews, where understanding individual words and their context is essential for determining whether a sentiment is positive, negative, or neutral (Manning, Raghavan, & Schütze, 2008). In the context of mobile banking applications, tokenization helps in efficiently analyzing user reviews by focusing on specific keywords and phrases that signal user satisfaction or dissatisfaction with features such as usability, security, and performance (Liu & Zhang, 2022).

No	Before Tokenizing	After Tokenizing
1	Fiturnya banyak, lengkap, mau buka tabungan, transfer, QRIS, top up, bisa semua. Karena fitur nya banyakk diawal memang perlu penyesuaian, tp overall bagus	“fiturnya”, “banyak”, “lengkap”, “mau”, “buka”, “tabungan”, “transfer”, “Qris”, “top up”, “bisa”, “semua”, “karena”, “fitur”, “nya”, “banyak”, “diawal”, “memang”, “perlu”, “penyesuaian”, “tp”, “overall”, “bagus”
2	sangat puas pake mobile bni banking biar saldo tinggal sedikit tapi masih bisa transaksi,cukup puas lah pake bni mobile	“sangat”, “puas”, “pake”, “mobile”, “bni”, “banking”, “biar”, “saldo”, “tinggal”, “sedikit”, “tapi”, “masih”, “bisa”, “transaksi”, “cukup”, “puas”, “lah”, “pake”, “bni”, “mobile”

4 Stopwords Removal

Stopwords Removal is a process where a list of specific words is used to filter review data so that information relevant to the research topic can be obtained. Usually, this process will remove connecting words such as "dan", "atau", "ke", and so on.(Munazhif, Yanris, dan Hasibuan 2023) In Python programming, the NLTK function will be used to perform the stopwords removal process on BNI Mobile review data. (Tsania dkk. 2023)

No	Before Stopwords	After Stopwords
1	sangat puas pake mobile bni banking biar saldo tinggal sedikit tapi masih bisa transaksi,cukup puas lah pake bni mobile	Sangat puas mobile bni biar saldo tinggal sedikit masih bisa transaksi cukup puas bni mobile

*name of corresponding author



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```
[ ] import nltk
nltk.download('stopwords')
from nltk.corpus import stopwords
# Make a list of Indonesian stopwords
stopwords = nltk.corpus.stopwords.words("indonesian")
# Extend the list with your own custom stopwords
my_stopwords = ['bni']
stopwords.extend(my_stopwords)
# Remove stopwords
df['content_token'] = df['content_token'].apply(lambda x: [item for item in x if item not in stopwords])
df.head(3)
```

```
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data] Package stopwords is already up-to-date!
```

	content	score	Year	Month	Day	sentiment	content_token
188	aplikasi selalu saja ngefreeze ketika ada upda...	1	2023	12	4	-1	[aplikasi, ngefreeze, update, aplikasinya, dib...
191	gimana ni, sudah di reinstall sudah yg torupda...	2	2023	12	6	-1	[gimana, ni, reinstall, yg, torupdate, webview...
190	kenapa selalu payah dibuka aplikasinya, dibila...	1	2023	12	15	-1	[payah, dibuka, aplikasinya, diblang, koneksi...

Fig. 3. Python Stopword Removal Using NLTK Function

TF IDF

At this stage, feature extraction is performed which begins by converting text to numbers using label encoding. Later, the TF-IDF method was applied as part of feature extraction, with the aim of giving weight to certain words. (Suyal dan Goyal 2022)The Tf-idf Vectorizer module is used to generate word vectors and assign word weights. The results of the IDF TF process can be seen in figure 4. (Rizki dkk. 2022)

```

Dokumen ke-662:
Kata: dijalankan, Skor TF-IDF: 0.4513
Kata: liapp, Skor TF-IDF: 0.4782
Kata: alert, Skor TF-IDF: 0.3652
Kata: dapat, Skor TF-IDF: 0.3404
Kata: tidak, Skor TF-IDF: 0.1827
Kata: muncul, Skor TF-IDF: 0.2924
Kata: kenapa, Skor TF-IDF: 0.1996
Kata: banking, Skor TF-IDF: 0.2238
Kata: mobile, Skor TF-IDF: 0.2133
Kata: aplikasi, Skor TF-IDF: 0.1724
Kata: saya, Skor TF-IDF: 0.1854

Dokumen ke-663:
Kata: sendiri, Skor TF-IDF: 0.5645
Kata: tiba, Skor TF-IDF: 0.6151
Kata: update, Skor TF-IDF: 0.4399
Kata: bni, Skor TF-IDF: 0.3308

Dokumen ke-664:
Kata: sih, Skor TF-IDF: 0.6011
Kata: gimana, Skor TF-IDF: 0.6052
Kata: apk, Skor TF-IDF: 0.5219

Dokumen ke-665:
Kata: kalimat, Skor TF-IDF: 0.3029
Kata: mutasi, Skor TF-IDF: 0.2858
Kata: terjadi, Skor TF-IDF: 0.2503
Kata: mobil, Skor TF-IDF: 0.2644
Kata: lain, Skor TF-IDF: 0.1878

```

Fig. 4. Results of TF IDF Data Review BNI Mobile

RESULTS AND DISCUSSION

3.1 Data Frame

After the BNI Mobile application review data is scraped using Python, the next step is to take the review column from the scraping results. Then, the review column is entered into a dataframe called "scrappeddata1" with three columns, namely "content", "score", and "Time". (Araaf, Nugroho, dan Setiadi 2023) The "content" column contains the content of user reviews, the "score" column contains user-given ratings on a scale of 1-5, and the "Time" column contains the date and time of the review in datetime format. (Ali dkk. 2020)These results can be seen in Figure 5.

```
[ ] data = pd.DataFrame(np.array(result), columns=['review'])
data = data.join(pd.DataFrame(data.pop('review').tolist()))
scrappeddata1 = data[['content', 'score', 'at']]
sorteddata = scrappeddata1.sort_values(by='at', ascending=True) #Sort by Newest, change to True if you want to sort by Oldest.
sorteddata.head()
```

	content	score	at
188	aplikasi selalu saja ngefreeze ketika ada upda...	1	2023-12-04 02:49:35
191	Gimana ni, sudah di reinstall sudah yg torupda...	2	2023-12-06 00:17:00
190	Kenapa selalu payah dibuka aplikasinya, dibila...	1	2023-12-15 18:04:37
189	✓Sering kondisi 'sedang mengoptimalkan ...' s...	1	2024-01-21 16:38:27
43	Aneh baru instal, isi data, eh malah gak bisa ...	1	2024-02-06 09:12:22

Fig. 5. Data Frame 3 Columns : Content, Score, Time

For further visualization and grouping purposes, the "at" column will be separated into three new columns, namely "Year", "Month", and "Day". Then, these new columns will be added into the dataframe. You can see the result in figure 6. (Ramadhansyah, Asrofiq, dan Yunefri 2024)

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```
[ ] sorteddata['Year'] = sorteddata['at'].dt.year
sorteddata['Month'] = sorteddata['at'].dt.month
sorteddata['Day'] = sorteddata['at'].dt.day
sorteddata
```

	content	score	at	Year	Month	Day
188	aplikasi selalu saja ngefreeze ketika ada upda...	1	2023-12-04 02:49:35	2023	12	4
191	Gimana ni, sudah di reinstall sudah yg terUpda...	2	2023-12-06 00:17:00	2023	12	6
190	Kenapa selalu payah dibuka aplikasinya, dibila...	1	2023-12-15 18:04:37	2023	12	15
189	✓Sering kondisi 'sedang mengoptimalkan ...' s...	1	2024-01-21 16:38:27	2024	1	21
43	Aneh baru instal, isi data, eh malah gak bisa ...	1	2024-02-06 09:12:22	2024	2	6
...
53	hati" sama bni banking, saya pernah transaksi,...	1	2024-04-26 11:59:35	2024	4	26
69	Tolong dong bapak/ibu pimpinan,, tolong dong d...	1	2024-04-26 19:20:05	2024	4	26
131	Masih dengan masalah yang sama, transfer antar...	1	2024-04-27 01:37:43	2024	4	27
78	Ada kendala untuk Taplus muda, saya tidak bisa...	1	2024-04-27 06:49:31	2024	4	27
33	Tolong dong. Adakan fitur untuk pengaturan men...	5	2024-04-27 09:45:22	2024	4	27

199 rows x 6 columns

Fig. 6. Add year, month & day to the dataframe for visualization purposes.

The next step is to delete the "At" or "Time" column from the BNI Mobile application review data, making it possible to carry out further data processing. (Isnain, Supriyanto, dan Kharisma 2021b) You can see this step in figure 7.

```
[ ] df = sorteddata[['content', 'score', 'Year', 'Month', 'Day']]
df
```

	content	score	Year	Month	Day
188	aplikasi selalu saja ngefreeze ketika ada upda...	1	2023	12	4
191	Gimana ni, sudah di reinstall sudah yg terUpda...	2	2023	12	6
190	Kenapa selalu payah dibuka aplikasinya, dibila...	1	2023	12	15
189	✓Sering kondisi 'sedang mengoptimalkan ...' s...	1	2024	1	21
43	Aneh baru instal, isi data, eh malah gak bisa ...	1	2024	2	6
...
53	hati" sama bni banking, saya pernah transaksi,...	1	2024	4	26
69	Tolong dong bapak/ibu pimpinan,, tolong dong d...	1	2024	4	26
131	Masih dengan masalah yang sama, transfer antar...	1	2024	4	27
78	Ada kendala untuk Taplus muda, saya tidak bisa...	1	2024	4	27
33	Tolong dong. Adakan fitur untuk pengaturan men...	5	2024	4	27

199 rows x 5 columns

Fig. 7. Removal of the At or Time column.

The sentiment column is added into the df dataframe with the following rule: if the score value is 1 or 2, then the sentiment is considered negative with the code -1; If the score is 3, the sentiment is considered neutral with code 0; And if the score is 4 or 5, the sentiment is considered positive with code 1. (Hatem 2022) After adding the sentiment column, the results can be seen as illustrated in figure 8. (Isnain, Supriyanto, dan Kharisma 2021c)

```
[ ] sentimen = []
for index, row in df.iterrows():
    if row['score'] > 3 :
        sentimen.append(1)
    elif row['score'] == 3:
        sentimen.append(0)
    else:
        sentimen.append(-1)
df['sentiment'] = sentimen
df.head()
```

	content	score	Year	Month	Day	sentiment
188	aplikasi selalu saja ngefreeze ketika ada upda...	1	2023	12	4	-1
191	Gimana ni, sudah di reinstall sudah yg terUpda...	2	2023	12	6	-1
190	Kenapa selalu payah dibuka aplikasinya, dibila...	1	2023	12	15	-1
189	✓Sering kondisi 'sedang mengoptimalkan ...' s...	1	2024	1	21	-1
43	Aneh baru instal, isi data, eh malah gak bisa ...	1	2024	2	6	-1

Fig. 8. Add a Sentiment Column

Next we will visualize the distribution of sentiment using sns plot on BNI Mobile review data with planning -1 as a negative sentiment value, 0 as a neutral value and 1 as a positive sentiment value Seen in figure 9, negative sentiment dominates or occupies the highest position. (Uddin dkk. 2022b) Followed by positive sentiment and neutral sentiment.1.

*name of corresponding author



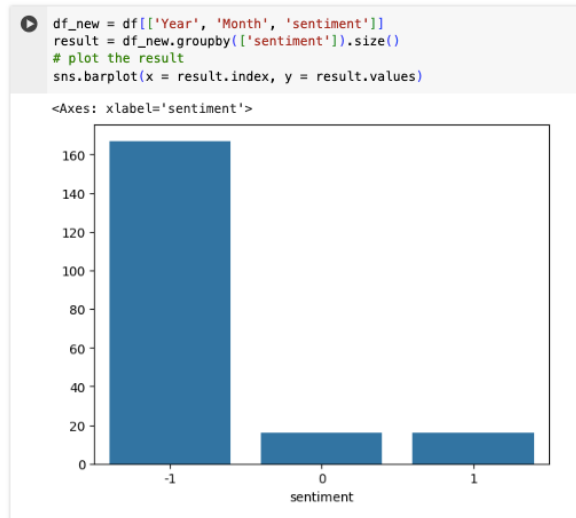


Fig. 9. Sentiment Distribution Using SNS Plot

Furthermore, visualization of the sentiment of BNI Mobile review data was carried out in the form of a Pie Chart, on the existing Pie Chart got information that the negative sentiment value shown at -1 (red color) got 83.9%, then for the neutral value shown at 0 (gray) got 8%, and finally the positive sentiment value shown with 1 (green color) got an 8% value, can be seen in Figure 10.(Boateng, Otoo, dan Abaye 2020b)

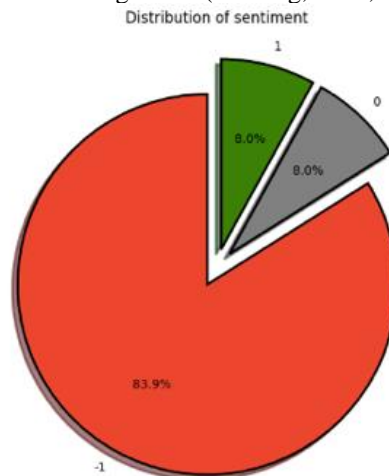


Fig. 10. Sentiment Visualization Data Review BNI Mobile Piechart Form.

Classification

Classification is the process of systematic grouping of data based on predetermined rules and criteria. In this context, classification involves grouping new data or objects based on observed variables, with the aim of predicting classes or categories of objects that are not yet known.(Masturoh dkk. 2023)

Classification is a data mining technique that focuses on the attributes of a predefined data group. Thus, new data classification is done by modifying confidential data and utilizing the results to generate classification rules. (Samad, TAZE, dan Kürsad UÇAR 2024) These rules are then applied to the new data for the subsequent classification process.(Chittam dkk. 2021) Classifier aims to correctly group unknown data using the K-Nearest Neighbor algorithm. This algorithm classifies new objects based on the learning data closest to them. The K-Nearest Neighbor algorithm is easy to implement and consists of several steps, one of which calculates Euclidean distances using the formula 1. (Wijaya, Saputra, dan Irwiensyah 2024)

$$d(x_i x_j) = \sqrt{\sum_{r=1}^n (a_r(x_i) - a_r(x_j))^2} \quad (1)$$

Formula 1. Euclidean Distance Method

*name of corresponding author



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Classification K-Nearest Neighbours

The classification in this study uses the K Nearest Neighbor method with a choice feature on BNI Mobile review data. The selection of features in the classification is expected to be more efficient by reducing the amount of data analyzed by identifying features that will then be processed based on machine learning modeling by means of classification that has been generated from the training process.(Shamrat dkk. 2021) So it will generate appropriate review data and generate valuable information. (Choi 2020)The BNI Mobile application review dataset used was 2000 reviews. For sentiment results, the Best KNN accuracy can be seen in figure 11.

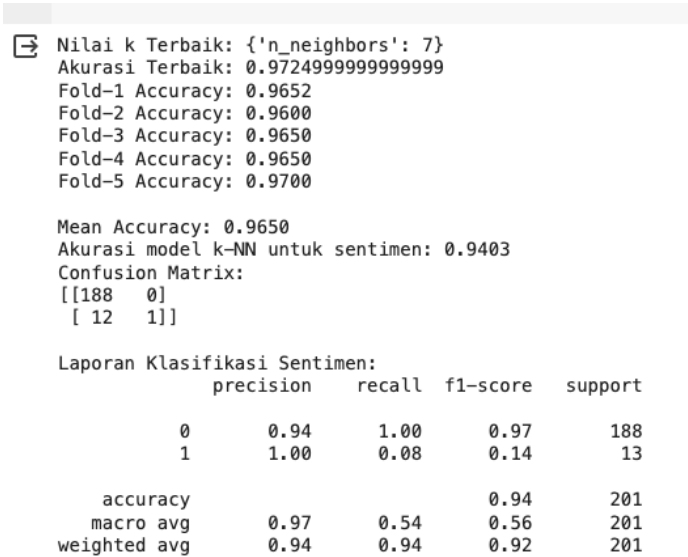


Fig. 11. Best Accuracy Value, Mean Accuracy, KNN Model Accuracy Sentiment

Based on the results of experiments using the K-Nearest Neighbors method produced the K Neighbors Value with the best accuracy with a value of 0.9724999999999999 / 97%. With an average value (Mean Accuracy) on BNI Mobile review data of 0.9650. (Al Dujaili, Ebrahimi-Moghadam, dan Fatlawi 2021) Then for the KNN Model Accuracy value Sentiment get 0.9403. The Precision Sentiment Classification Report with a value of 0.94, a Recall Value of 1.00, an F1 Score of 0.97, and Support of 188. For KNN Graph can be seen in figure 12.(Zarandah, Mohd Daud, dan Abu-Naser 2023)

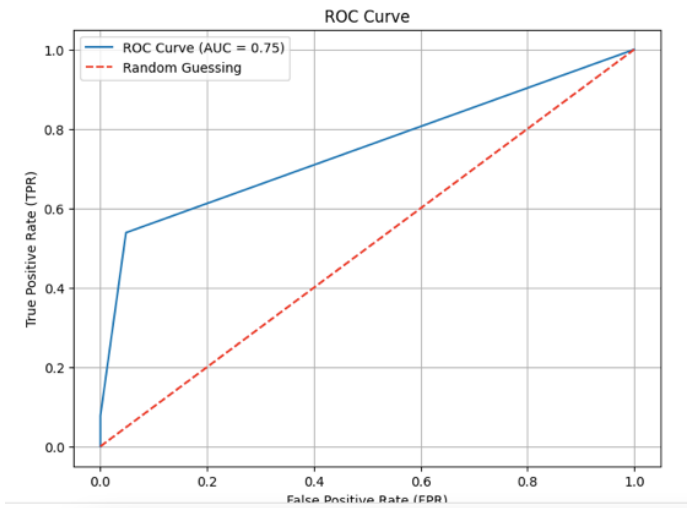


Fig. 12. KNN Sentiment Graph BNI Mobile Review Data

Furthermore, the wordcloud function is used in BNI Mobile's review data to produce image visualizations from written text. (Singgalen 2023)Wordcloud can be used as a tool in text analysis. Words in the text are depicted in a visualization, with the font size depending on the frequency with which the word appears in the text. In synthesis, the largest word in wordcloud is the word that appears most often in the data. This Wordcloud will be divided into three categories: Positive, Negative, and Neutral.(Vishwakarma dan Kesswani 2023)

*name of corresponding author



Wordcloud Positive Sentiment Filtering only positive sentiment on BNI Mobile application review data can be seen in figure 13. Wordcloud Positive Sentiment contains useful information including: "Transaksi", "Banking", "Fitur", "Aplikasi", "Notifikasi", "Bank", "Transfer", "Kartu".



Fig. 13. Wordcloud Positive Sentiment Data Review BNI Mobile Application

Furthermore, this negative sentiment wordcloud will filter words containing negative reviews of the BNI Mobile application can be seen in figure 14. Wordcloud Negative Sentiment contains relevant information including: "Error", "Susah", "Kode", "Login", "Masuk", "Transaksi", "Jaringan", "Buka".



Fig. 14. Wordcloud Negative Sentiment Data Review BNI Mobile Application

Next will experiment with bringing up Wordcloud Neutral sentiment, on this wordcloud contains positive and negative sentences in BNI Mobile review data can be seen in figure 15. Wordcloud Sentiment Neutral contains valuable information including: "Bank", "Login", "Transaksi", "Bagus", "Qris", "Aplikasi", "Tolong", "Update", "Sinyal", "Buka", "Scan", "Wifi", "Baik".



Fig. 15. Wordcloud Neutral Sentiment on BNI Mobile Application Review Data

Based on the BNI Mobile review data experiment with the KNN classification method, it produced a Plot Review with the highest average review at rating 1 with a value of 62.9%, then for rating 2 getting 13.3%, rating 3 getting 9.5%, rating 4 as much as 5.2% and rating 5 as much as 9.1% which can be seen in figure 16.

*name of corresponding author



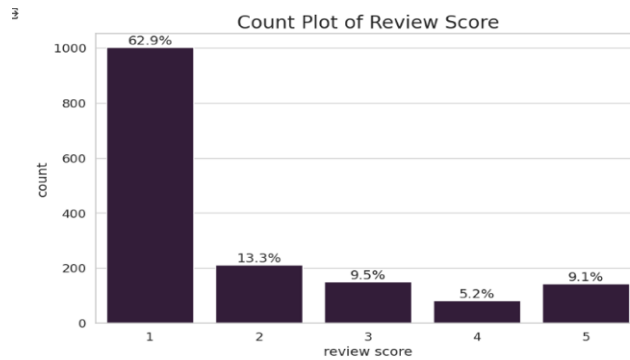


Fig. 16. Results Count Plot Of Review Score BNI Mobile

Furthermore, labeling the review data with the criteria "Positive, Negative, & Neutral" on the BNI Mobile application using the python programming language, for the results of the Count Plot Of Review Score, the BNI Mobile Application Review Data that has been processed gets the most negative reviews of 76.2%, then for neutral sentiment data review as much as 9.5% and positive sentiment as much as 14.3% can be seen in figure 17.

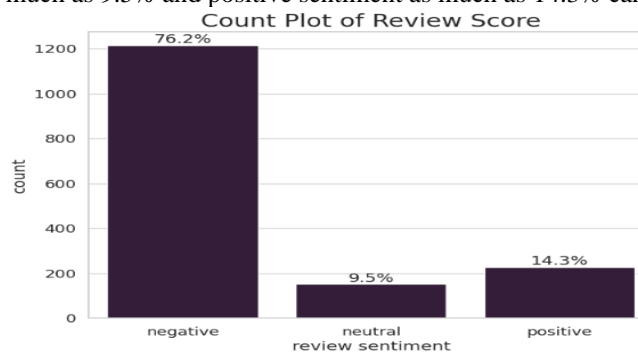


Fig. 17. Results of KNN Sentiment Labeling in the Form of Count Plot Of Review Score

RESULT AND DISCUSSION

Research on the analysis of user satisfaction with the BNI Mobile application using the K-Nearest Neighbour method provides a comprehensive understanding of user or customer satisfaction levels with the BNI Mobile application. The findings reveal significant insights into the performance of the sentiment classification model and user perceptions of the application. The K-Nearest Neighbours method demonstrated high accuracy in classifying user sentiments, with the best K Neighbours value achieving an accuracy of 97.25%. The Mean Accuracy value of the BNI Mobile review data stands at 96.50%, while the Accuracy of the KNN Sentiment Model is 94.03%. These high accuracy values underscore the effectiveness of the KNN method in classifying user sentiments for the BNI Mobile application.

The Sentiment Classification Report further supports the model's performance, with a Precision value of 0.94, a Recall value of 1.00, an F1 Score of 0.97, and Support of 188. These metrics indicate excellent classification performance, with perfect recall suggesting the model's ability to identify all relevant positive instances. Analysis of sentiment distribution revealed concerning trends. The KNN classification resulted in a Review Plot where the highest average review rating was 1, accounting for 62.9% of reviews. Further sentiment labeling experiments showed that negative reviews dominated with 76.2%, followed by neutral sentiment at 9.5%, and positive sentiment at 14.3%. This distribution highlights areas requiring urgent attention and improvement in the BNI Mobile application.

The Wordcloud analysis provided valuable insights into specific aspects of the application that influence user experience. The Positive sentiment Wordcloud featured words such as "Transaksi," "Banking," "Fitur," "Aplikasi," "Notifikasi," "Bank," "Transfer," and "Kartu," indicating aspects appreciated by users. Conversely, the Negative sentiment Wordcloud highlighted issues with words like "Error," "Susah," "Kode," "Login," "Masuk," "Transaksi," "Jaringan," and "Buka," pointing to areas needing improvement. The Neutral sentiment Wordcloud contained a mix of positive and negative aspects, reflecting the complexity of user experiences. These findings offer a nuanced view of user sentiments towards the BNI Mobile application. The prevalence of negative sentiments and low ratings indicates a significant gap between user expectations and the current performance of the application. However, the presence of positive sentiments and keywords in the Wordcloud analysis suggests that certain aspects of the application are appreciated by users.

*name of corresponding author



This research provides crucial information for BNI to enhance the quality of its mobile banking services. The insights gained from this sentiment analysis can guide targeted improvements in the application, focusing on areas that are major sources of user dissatisfaction while maintaining and enhancing features that users appreciate.

CONCLUSIONS

This research effectively utilized the K-Nearest Neighbors (KNN) method to analyze user sentiments regarding the BNI Mobile application, achieving a high accuracy rate of 97.25%. A dataset of 2,000 reviews was collected through data scraping using Python, revealing a significant dominance of negative sentiments and low ratings, which highlights an urgent need for application improvements. The effectiveness of the KNN method is underscored by its high classification accuracy, while Wordcloud analysis provided insights into specific factors affecting user experience.

The study produced visualizations, including Scatter Plot K-Nearest Neighbor and Wordclouds for various sentiments, offering an intuitive representation of sentiment distribution and key themes in user feedback. These findings lay a strong foundation for BNI to implement data-driven enhancements to their mobile application, focusing on areas causing user dissatisfaction while preserving appreciated features, thus potentially improving user satisfaction and retention.

Future research could explore comparative sentiment analysis using methods like Naïve Bayes, Support Vector Machine, or Random Forest to benchmark against KNN, as well as employing advanced Natural Language Processing techniques such as NLTK to enhance data preprocessing and analysis. This study serves as a valuable reference for researchers and educators interested in user satisfaction analysis within mobile banking services, providing actionable insights for future improvements.

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*name of corresponding author



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