

Comparison of Service and Ease of e-Commerce User Applications Using BERT

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Abstract—The development of e-commerce has transformed shopping patterns by harnessing the internet, enabling consumers to shop online. In Indonesia, e-commerce has experienced rapid growth, with numerous options such as Tokopedia, Shopee, and Lazada, leading to intense competition. Sentiment analysis using machine learning techniques has become crucial for understanding consumer views on these e-commerce services. This study analyzes user comments on Tokopedia, Shopee, and Lazada e-commerce platforms from Instagram social media, totaling 3600 data comments, using the Bidirectional Encoder Representations from Transformers (BERT) model with 10, 20, and 30 epochs, a batch size of 32, and several splitting data. Sentiment analysis utilizes 3 types of labels: positive, neutral, and negative. The final results of the study include the performance analysis of the BERT model, as well as comparisons for each predefined category, namely Promotions & Offers, and Services. The final results of the model indicate good performance, with accuracy rates of 95%, 97%, and 99%, respectively.

Keywords— BERT, Classification, e-Commerce, Sentiment Analysis

I. INTRODUCTION

The development of internet-utilizing e-commerce has facilitated online shopping, enabling people to fulfill their needs from the comfort of their homes. According to a survey by Katadata, 96% of internet users in Indonesia have utilized e-commerce services, contributing to rapid growth in this sector. E-commerce sales in Indonesia even reached \$20 billion USD in 2021[1][2].

In the era of rapidly growing e-commerce, business competition is getting tougher such as Tokopedia, Shopee, and Lazada, presenting a paradox of choice for the public because of the many options available such as varied promotions from each e-commerce and various kinds of services available such as a large selection of payment methods, and courier options that match user preferences[3][4][5]. Companies need to continuously update technology, pay attention to customer needs, and attract new customers with attractive services such as promos or discounts[6][7]. Social media, including Instagram, is effectively used by e-commerce companies to interact with users, with Instagram as a popular platform and utilized by e-commerce companies to present information and get feedback from users[8][9].

All suggestions, criticisms, opinions, and complaints that become comments on social media such as Instagram[10], can be used as sentiment data. This data reflects people's views on a company's services and is used in Sentiment Analysis using machine learning techniques in Natural Language Processing. Natural Language Processing (NLP) is a research and application field focused on how computers can understand and manipulate natural language text or speech to accomplish useful tasks. Researchers in NLP aim to understand how humans comprehend and use language to develop tools and techniques that allow computer systems to understand and manipulate natural languages effectively to achieve desired outcomes[11]. Sentiment Analysis is a classification process that

determines whether a positive, neutral, or negative emotions[12]. The research will evaluate Tokopedia, Shopee, and Lazada based on indicators of Promotion, Deals, and Customer Service. The evaluation uses data on related words such as "promo," "discount," "cashback," and "customer service," "return," "complaint," "disruption.", and this research aims to reveal people's views on popular e-commerce services in Indonesia in 2023 Quarter I to 2024 Quarter I, by assessing sentiment in comments, the research data was taken using scraping techniques on Instagram comments using the Python language, and the Google Colab tool as a Notebook to facilitate Python[13][14][15].

There are several techniques and algorithms to improve the accuracy of sentiment analysis, such as Bidirectional Encoder Representations from Transformers (BERT), Bidirectional Gated Recurrent Unit (BiGRU), and Generative Pre-trained Transformer (GPT). BiGRU and BERT, two models that operate bidirectionally like BERT, but BERT is superior in understanding word context due to its ability to see surrounding words simultaneously. The difference between BERT and GPT is their intended use: BERT is for natural language understanding and query processing, while GPT is used for generative text generation. BERT uses a bidirectional approach, allowing it to understand the context of sentences better, while GPT focuses on generating text from previous context. According to Mathew and Bindu's (2020) research, BERT has 94% accuracy compared to 72% for BiGRU in comparing movie review data from IMDb[16].

This research is based on previous studies conducted by Irawan and Puspita, who analyzed sentiment in e-commerce social media content on Instagram using Naive Bayes, achieving an accuracy of 88.73%. Their results provided insights into user responses regarding service quality and user convenience when using Shopee[8].

Research by Rehana et al. showed that BERT performed better in the evaluation of Protein-Protein Interactions (PPI), with a precision of 85.17% compared to 83.34% for GPT[17]. Recent studies have also shown a high accuracy rate for BERT in sentiment analysis. For example, research by Kusuma and Yustanti found that BERT achieved 99% accuracy in sentiment analysis of customer reviews on the Ruang Guru application[18][19]. Similarly, research by Kusrnadi, et al. and Singh, et al. showed high accuracy results for BERT in sentiment analysis of the Genshin Impact game and the impact of coronavirus on social life[20][21]. This makes BERT one of the models that can be considered for use in this study.

II. METHODOLOGY

The methodology in this case study research uses sentiment analysis methods with the help of data scraping techniques, using Google Colab Notebook tools and Visual Studio Code with Python language. Data Scraping starts by using the Python language to scrape data. Followed by data pre-processing stages to modeling datasets using BERT with Google Colab tools. The data used in this research uses Instagram comment data from 3 e-Commerce accounts @tokopedia, @shopee_id, and @lazada_id, with a time span of March 2023 to February 2024.

The research method begins with scraping comment data from each e-commerce account. Next, the collected data undergoes preprocessing, which includes data cleaning, data labeling, and data splitting. This is followed by the modeling stage using BERT with 100 epochs. The final stage is analysis. Figure 1 shows the process of methodology of this research on flowchart.

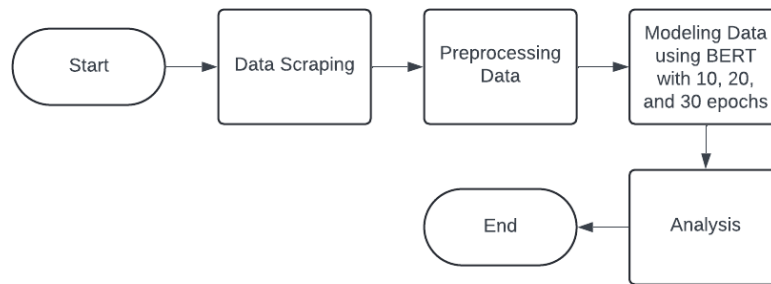


Figure 1. Research Methodology

A. Data Scraping

This research collects data from Instagram using scraping techniques. The data includes comments from three different Instagram accounts: @tokopedia, @shopee_id, and @lazada_id. The comments data from @tokopedia are presented in Table 1, from @shopee_id in Table 2, and from @lazada_id in Table 3. In total, collected comments up to 18000 comments.

Table 1. Preliminary Data Tokopedia

No	Comment
1	Sudah mendapatkan barang yang sudah masuk ke pembayaran, masukkan OTP CC, eh tiba-tiba barang tidak diproses dan CC sudah terkena charge pengembalian dana, maksudnya bagaimana ya, kayak menahan uang gitu sih.
2	Dibatalkan, ini tidak bagus, min. Notifikasinya tidak dimatikan saat toko orang tidak diikuti, itu mengganggu selama berjam-jam. Aplikasi yang ribet.
3	Yang dapat war hokinya kebangetan, mereka iri kalau dibilangin.
4	Bohong banget, ini suruh update aplikasi yang sudah terbaru tetapi saat check-out tidak ada permintaan untuk melakukan update.
5	Tokopedia dipekerjakan, gedungnya demo, sudah ada grup WhatsApp yang ramai di kantor Tokopedia, tinggal menunggu yang tepat untuk menghubungi pusat panggilan yang sulit terkendali oleh masalah pendanaan yang terhambat dan tidak pernah menyelesaikan masalah, Tokopedia tidak berfungsi dengan baik dan tidak bekerja.
..	
7037	beli ahhhh @jkt48.feni

Table 1 presented collected comments from @tokopedia Instagram posts using scraping techniques.

Table 2. Preliminary Data Shopee

No	Comment
1	Aplikasi MIN gangguan, kok ga dibuka ya?
2	Aplikasi terbaru di iOS tidak bisa dibuka, banyak bug-nya sudah saya coba delete dan install lagi, tetapi setelah beberapa saat tidak bisa lagi.
3	Nantikan acara tersebut.
4	Min, tolong baca DM. Top up saldo e-money belum diterima, ajukan pengembalian ditolak. Mengganggu sebagai warga. Tolong responnya, Terima kasih.
5	Tolong, ini menjadi Halo, Min. Pengembalian dana belum masuk aplikasi. Tertulis berhasil.
..	
6428	Wkwkwk emosi tp penasaran, semangat pejuang cocoki,

Table 2 presented collected comments from @shopee_id Instagram posts using scraping techniques.

Table 3. Preliminary Data Lazada

No	Comment
1	Tolong balas di pesan Messenger-nya pada hari Senin ya. Seluruhnya tertuju pada Lazada.
2	Wkwkwkwkwk, lucu banget! E-commerce saya beli celana bolong. Saya lakukan pengembalian dana, tapi ditolak. Gila, barangnya otomatis berubah menjadi status pesa diterima. Padahal, saat mengkomplain melalui customer service, jawabannya ngotot dan tidak mau ngasih solusi karena bla bla bla.
3	Bagaimana dengan sistem pembayaran Lazada ini? Harus diganti saja, ga ada uang gajian afilitor sampe ga cair insentif, benar-benar parah ga cair. Mengapa toko negeri dihapus?
4	Mohon dapatkah Anda menjelaskan kembali ini? Saya tidak mengerti maksud dari tersebut. Sangat keren. Mantap sekali mendengar lagunya.
5	KerenSangat kerennya, Aku merasa gemes.
..	
5931	Hallo ka promo big bos dadakan nih siapa cepat dia dapat Harga 5rb follower cuman 60rb saja , 10rb follower 100rb aja ,yo siapa cepat dia dapat khusus hari ini sampai - 00:00 untuk promonya siapa cepat dia dapat @ahhan_sosmed <

Table 3 presented collected comments from @lazada_id Instagram posts using scraping techniques.

B. Preprocessing Data

1) Cleaning Data

The data obtained from scraping will be cleaned first such as repetitive data and missing text data, but it is still not too clean so it still needs further stages such as case folding, stopwords, and stemming. The data has been cleaned from 18,000 comments to 1,200 comments per e-commerce comments. This was done to avoid repetitive comments and to ensure the accuracy of the analysis.

2) Data Labeling

Data labeling is done after data cleaning, case folding, stopwords, and stemming. Data labeling is divided into 3, namely positive, neutral, and negative[12].

3) Split Training, Test, and Validation Data

After the data is cleaned and labeled, the parameters for modeling must be set to 3, namely 80% training data, 20% validation data, and test data. After the training and validation data is complete, the test data is allocated 50% of the first result. The preprocessed comments are shows from scraped until labeled. @tokopedia comments are presented in Table 4, from @shopee_id in Table 5, and from @lazada_id in Table 6. Preprocessed comments are cleaned up, and labeled.

Table 4. Data After Pre-processed Tokopedia

Condition	Comment	Sentiment
Raw Comment	Sudah mendapatkan barang yang sudah masuk ke pembayaran, masukkan OTP CC, eh tiba-tiba barang tidak diproses dan CC sudah terkena charge pengembalian dana, maksudnya bagaimana ya, kayak menahan uang gitu sih.	-
Preprocessed Comment	barang masuk pembayaran masukkan otp cc eh tibatiba barang diproses cc terkena charge pengembalian dana maksudnya ya kayak menahan uang gitu sih	-
Labeled Comment	barang masuk pembayaran masukkan otp cc eh tibatiba barang diproses cc terkena charge pengembalian dana maksudnya ya kayak menahan uang gitu sih	negative

Table 4 presented raw collected comments, preprocessed, and labeled comments from @tokopedia Instagram posts.

Table 5. Data After Pre-processed Shopee

Condition	Comment	Sentiment
Raw Comment	Aplikasi MIN gangguan, kok ga kebuka ya?	-
Preprocessed Comment	aplikasi min gangguan ga kebuka ya	-
Labeled Comment	aplikasi min gangguan ga kebuka ya	negative

Table 5 presented raw collected comments, preprocessed, and labeled comments from @shopee_id Instagram posts.

Table 6. Data After Pre-processed Lazada

Condition	Comment	Sentiment
Raw Comment	Tolong balas di pesan Messenger-nya pada hari Senin ya. Seluruhnya tertuju pada Lazada	-
Preprocessed Comment	tolong balas pesan messengernya senin ya	-
Labeled Comment	tolong balas pesan messengernya senin ya	neutral

Table 6 presented raw collected comments, preprocessed, and labeled comments from @lazada_id Instagram posts.

C. Modeling Data

The BERT model, designed to analyze two-way texts in depth, takes into account the surrounding context. This allows flexibility in customizing the model for different tasks without major changes in its structure. The BERT model works by first entering input, in this case a dataset in the form of text that has been processed at the preprocessing stage, then BERT will perform embedding and encoder which is tasked with converting the dataset into numbers so that the model can understand the relationship of each related word, and after the embedding and encoder process has been completed, the layer will function to process the information that has been learned in the previous stage, and softmax functions as a probability output, namely positive, neutral, and negative[11][22].

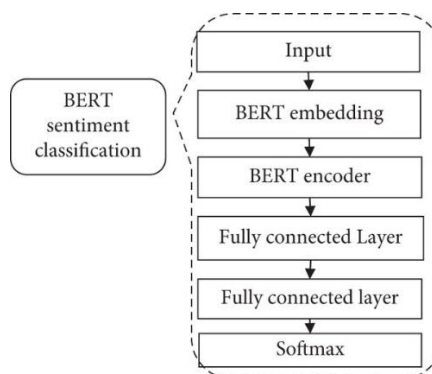


Figure 2. BERT Flowchart

Figure 2 shows the process how BERT works from end-to-end for sentiment classification task.

D. Analysis

After performing the data modeling process, the next process is to analyze the results of the data modeling. The purpose of doing data analysis is to be able to understand the

data by visualizing the data so that it is easy to understand. The results of the data analysis include the accuracy of the previous data modeling and categorizing the dataset into two categories: Promotion and Offers, and Services. The predefined keywords for these categories are "promo", "diskon", "kupon", "gratis ongkir", "ongkir", "harga", "cashback", "potongan", "hemat", "bonus", "flash sale", "hadiah" for the Promotion and Offers category, and "dm," "customer service", "cs", "retur", "error", "eror", "transaksi", "saldo", "komplen", "masalah", "gangguan" for the Services category.

III. RESULT AND DISCUSSION

A. Pre-processing and Labeling

Based on the results of preprocessing the dataset and labeling the research dataset that has been done, the results of sentiment analysis of each e-commerce presented on Table 7.

Table 7. Label Sentiment Distribution

e-Commerce	Positive	Neutral	Negative
Tokopedia	510 (42.6%)	414 (34.6%)	276 (22.8%)
Shopee	433 (36%)	595 (49.6%)	172 (14.3%)
Lazada	567 (47.3%)	492 (41%)	140 (11.7%)

Table 7 shows of distribution each label on each e-commerce comments. Labels have three categories which is Positive, Neutral, and Negative. These labels indicate the sentiment of each comment.

B. Modeling

1) Setting the Model

When modeling using BERT, the first step is to set up hyperparameters and tokens such as [CLS] and [SEP] tokens that function to separate each word and understand the context in order to produce classification output that matches the label.

The BERT model deeply analyzes two-way texts by considering the surrounding context, allowing flexibility for various tasks without major structural changes. It starts by processing input text through embedding and encoding, converting the text into numerical data. This enables the model to understand word relationships. After embedding and encoding, the model processes the information and uses a softmax layer to output probabilities for positive, neutral, or negative sentiments. Figure 3 shows how tokenizing process on BERT works.

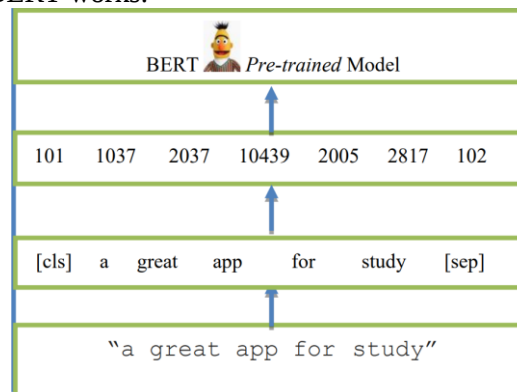


Figure 3. Tokenizing Process on BERT

In Figure 3, BERT will convert the comment data into vectors, followed by tokenizing the data so that BERT can understand the context of each comment.

2) Train the Model

The model was trained with 5 epochs, and a batch size of 32. These parameters were used according to the original BERT paper [18].

C. Analysis

After modeling, the next step is to analyze the results of accuracy evaluation, keyword filtering to display the required data, and classification reports. Table 8, Table 9, and Table 10 shows an accuracy chart of BERT modeling results based on 3600 datasets that have been cleaned. Table 8 are presented Tokopedia comments, Table 9 are presented Shopee comments, and Table 10 are presented Lazada comments with several epochs, and data splitted.

Table 8. Accuracy Table on Tokopedia

Splitting Data	10 Epochs	20 Epochs	30 Epochs	Average
90/10	99.2%	98.5%	99.7%	99.13%
80/20	97.6%	99.4%	99.3%	98.7%
70/30	98.3%	99.3%	99.4%	99%
60/40	98%	97.5%	99.4%	98.3%

Table 8 shows accuracy after modeling with several epochs and splitting data, in this case, Tokopedia shows 90/10 splitting data is best for modeling on BERT.

Table 9. Accuracy Table on Shopee

Splitting Data	10 Epochs	20 Epochs	30 Epochs	Average
90/10	97.4%	99.4%	99%	98.6%
80/20	93.4%	99.4%	99.5%	97.4%
70/30	97.6%	98.9%	99.3%	98.6%
60/40	99.1%	98.6%	99.2%	98.9%

Table 9 shows accuracy after modeling with several epochs and splitting data, in this case, Shopee shows 60/40 splitting data is best for modeling on BERT.

Table 10. Accuracy Table on Lazada

Splitting Data	10 Epochs	20 Epochs	30 Epochs	Average
90/10	98.7%	99.4%	99%	99.03%
80/20	95.9%	98.6%	98.7%	97.7%
70/30	99.5%	99.6%	99.5%	99.5%
60/40	99.4%	97.3%	99.4%	98.7%

Table 10 shows accuracy after modeling with several epochs and splitting data, in this case, Tokopedia shows 70/30 splitting data is best for modeling on BERT.

Based on the modeling results above, the accuracy of using the BERT model is very good, from 3 dataset cases, a stable accuracy of 95% to 99% is obtained. Then, the next stage is filtering the dataset, here researchers divide into 2 categories, namely Promotions and Offers with keywords ("promo", "diskon", "kupon", "gratis ongkir", "ongkir", "harga", "cashback", "potongan", "hemat", "bonus", "flash sale", "hadiah"), and Service with keywords ("dm", "customer service", "cs", "retur", "error", "eror", "transaksi", "saldo", "komplen", "masalah", "gangguan", "pembayaran").

Then, researchers also divided the dataset into 2 datasets for each category, the contents of the dataset contain several records that have been filtered using the keywords specified above, and shows on Table 11 for Promotion and Offer Category, and Table 12 for Service Category.

Table 11. Distribution of Sentiment Labels per Promotion and Offer Category

e-Commerce	Positive	Neutral	Negative
Tokopedia	48.3%	35.6%	16.1%
Shopee	41.2%	47.5%	11.2%
Lazada	55.1%	32.7%	12.2%

Table 11 shows of distribution of sentiment labels per promotion and offer category and filtered comments using the specified keywords.

Table 12. Distribution of Sentiment Labels per Service Category

e-Commerce	Positive	Neutral	Negative
Tokopedia	12.8%	52.6%	34.6%
Shopee	20.3%	72.9%	6.8%
Lazada	17.2%	62.6%	20.2%

Table 12 shows of distribution of sentiment labels per promotion and offer category and filtered comments using the specified keywords.

After conducting accuracy analysis and filtering comments based on the categories established above, the researcher will then perform an analysis using a word cloud to see which words appear frequently. Word cloud shows on Figure 4 for each label from all e-commerce comments.



Figure 4. Word Cloud

Figure 4 presented all frequently showed comments on word cloud, and separated by each label for each word cloud.

IV. CONCLUSION

Based on the results of the research conducted by researchers, it can be concluded that the BERT model produces very good accuracy, with a dataset of 3600 data. The accuracy produced by the BERT model is stable ranging from 95% to 99%.

The BERT model shows good performance, and after researchers divide the dataset into 2 categories that have been explained in the results stage, namely the Promotions and Offers and Services categories, there are differences where Lazada has the largest positive sentiment of 55.1%, Shopee has the most sentiment in neutral sentiments, which are 47.5% and Tokopedia has the most sentiment in negative sentiments, which are 16.1%. And for the Service category, Shopee has the most sentiment in positive sentiment at 20.3%, and Shopee still has the most sentiment for neutral sentiment, which is 72.9% and Tokopedia has the most negative sentiment, which are 34.6%

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