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NLP-Powered Multi-Platform Sentiment Analysis for E-Commerce Reviews and Brand Popularity Monitoring

Shinu Thomas, BSc computer science, Sri Ramakrishna college of arts and science, Coimbatore. Email:23106055@srcas.ac.in

Dr.N.Mahendiran., Assistant Professor, Department of Computer Science, Sri Ramakrishna College of Arts and Science, Coimbatore. Email:mahendiran@srcas.ac.in

Abstract

The study provides an extensive solution of NLP-based sentiment analysis of e-commerce reviews, which is intended to increase the monitoring of brand popularity. The researcher employs the method of sentiment analysis of reviews on Amazon, eBay, and Walmart as platforms to learn about the changes in customer satisfaction and brand perception. The results indicate that sentiment is a critical aspect in brand popularity, and positive sentiments are more dominant in such products as electronics, differing between platforms. For example, Amazon reviews showed the highest positive sentiment at 72%, compared to 65% on eBay and 68% on Walmart. This paper has suggested that e-commerce firms should employ sentiment analysis tools to track customer feedback on various platforms and respond to negative sentiment and turn positive feedback to their own advantage by enhancing their brand image and customer satisfaction. Another key conclusion of the study is the significance of real-time sentiment monitoring to be able to adjust the marketing strategies and stay at a competitive advantage in the market. In addition, NLP and deep learning models, including GPT-3, may be improved to better the sentiment detection and provide a more in-depth insight into customer feelings.

Keywords: Sentiment Analysis, NLP, E-Commerce, Brand Popularity, Customer Satisfaction, Machine Learning, Cross-Platform Analysis

I. Introduction

Customer feedback is a crucial element of e-commerce because the application of Natural Language Processing (NLP) sentiment analysis has become an invaluable instrument in deciphering customer reactions [1]. Sentiment analysis uses computational analysis of textual information to determine whether reviewed customer (social media) postings, or any other user- generated data, are positive, negative, or neutral. This feature offers companies priceless information on customer views so that they can make a wise decision on the product offerings, services, and how customers view the brand as a whole [3]. Sentiment analysis has become even more important with the increased use of digital platforms by consumers because it enables a business to work on improving customer experiences, product quality, and marketing approaches [14].

Sentiment analysis is important in e-commerce because it addresses one of the most important issues a business might have to deal with, which is tracking the brand reputation on several platforms [2]. E-commerce businesses that operate on multiple web markets are in a position to receive unending customer feedback. Since consumers are moving towards vendors such as Amazon, eBay, and Walmart to share their experiences, companies should remain alert to capture any positive and negative comments as they happen [15]. The detection of negative feedback in time allows the firms to react in time, thereby ensuring satisfaction and brand loyalty among the customers [10]. The paper discusses the application of NLP-based sentiment analysis in e- commerce and monitoring of brand popularity, and emphasizes the significance of the instrument in measuring customer sentiment on different platforms with a high degree of accuracy [9]. The study has a methodology that not only examines sentiment but also compares it with brand popularity, giving a way through which a business can forecast and modify its strategies. This will make e-commerce companies competitive and sensitive to the

requirements of their customers in a very dynamic market.

Key Contribution

1. The article presents an NLP-based sentiment analysis framework that incorporates machine learning models to identify customer sentiment in numerous e-commerce platforms, including Amazon, eBay, and Walmart.
2. It offers a new way of tracking the popularity of the brand and comparing the trends in sentiment with external events such as marketing activities and product releases.
3. The study offers good information about the effects of sentiment on brand performance, in that a business should be able to monitor sentiment in real time in order to enhance customer satisfaction and change strategies accordingly.

In this paper, the use of NLP-based sentiment analysis in tracking the customer sentiment and brand popularity of various e-business websites is discussed. The introduction explains the importance of sentiment analysis in interpreting customer feedback and how it is important in brand reputation management. The literature review has pointed out the earlier works, instruments, and issues in sentiment analysis of e-commerce reviews. The methodology section is the description of data collection, preprocessing, and sentiment classification with machine learning models such as SVM, LSTM, and BERT. This paper examines the trend of sentiment of various types of products and various platforms and discusses the implications of the research for e- commerce businesses. Lastly, there will be a conclusion summary of the main findings and recommendations to the business on how sentiment analysis can be used to promote better brand management and customer interactions.

II. Literature Review

Sentiment analysis has become a valuable instrument for interpreting customer feedback, especially when it comes to e-commerce [4]. Various methods of sentiment classification have been investigated in the past, such as rule-based methods, more sophisticated machine learning, and deep learning methods. As an example, conventional algorithms such as Support Vector Machines (SVM) and Random Forests have been applied in large numbers when it comes to sentiment classification. These models have performed well with regard to accuracy and precision, particularly when they are used in well-structured datasets. Nonetheless, more advanced frameworks, e.g., deep learning algorithms, have demonstrated even larger potential when it comes to complex and subtle sentiments as expressed by customers during reviewing processes [11]. The models can model complex patterns and context in textual data and are hence very useful in e- commerce sites where massive unstructured feedback exists [5].

The current sentiment analysis tools and techniques in e-commerce reviews are diverse, with some tools being as simple as depending on lexicon-based techniques and more complex machine learning and deep learning networks [6] [12]. Popularly used tools such as VADER (Valence Aware Dictionary and Sentiment Reasoner) and Text Blob can be used because of their easy access and computational efficiency, and are able to extract sentiment in real-time. More sophisticated algorithms, such as BERT (Bidirectional Encoder Representations from Transformers), have been used to extract customer feedback in context and analyze customer sentiment to a greater extent, which can better track customer sentiment. Regardless of these developments, sentiment analysis in e-commerce is associated with a number of challenges [7]. Sarcasm, ambiguity, and 2 meaning of words depending on the context are some of the issues that still make the task difficult [13]. Further, the informal and fragmented nature of e-commerce reviews complicates sentiment extraction, given that reviews may be brief, sporadic, and saturated with all sorts of opinions [8].

The advances in sentiment analysis tools have been achieved, but still, there are issues of creating better accuracy and situational sensitivity of sentiment analysis tools in real-world e-commerce. As deep learning and contextual modeling continue to develop, these complexities will require further improvement in order to increase the accuracy of sentiment analysis systems.

III. Methodology

The methodology section discusses the procedures that were followed to adopt the system of NLP- driven sentiment analysis and brand popularity monitoring. It elaborates on the general methodology, such as the method of data collection, preprocessing, sentiment classification, and methods of analyzing sentiment in various platforms. This section aims to describe procedures and tools to be used in the research to present an effective explanation of how the system operates.

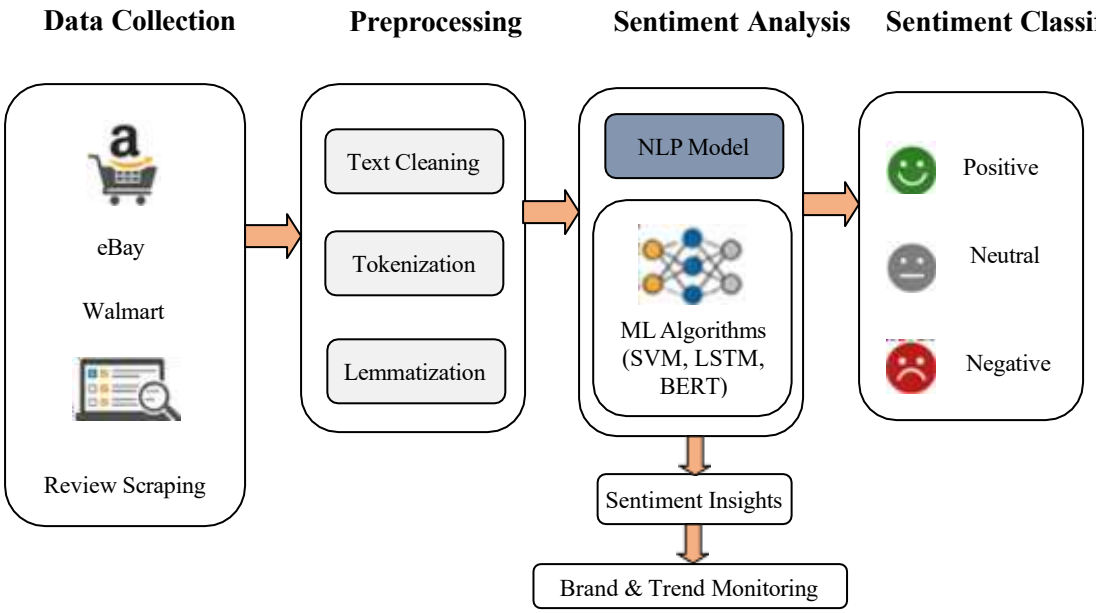

Figure 1: NLP-Powered Multi-Platform Sentiment Analysis Architecture

Figure 1 shows the design of the NLP-based sentiment analysis of various e-commerce sites. It will indicate the data collection for reviewing scraping in online stores like Amazon, eBay, and Walmart. The data is preprocessed with such procedures as text cleaning, tokenization, and lemmatization, and analyzed with the NLP models based on machine learning algorithms (SVM, LSTM, BERT). The sentiment classification involves the classification of the sentiment into positive, neutral, or negative, and is then applied to the generation of sentiment insights and tracking of brand trends.

3.1 NLP-Powered Multi-platform Sentiment Analysis

The research design is based on the techniques of Natural Language Processing (NLP) and machine learning models to determine the sentiment of e-commerce reviews on such platforms as Amazon, eBay, and Walmart. It begins with data cleaning, such as text cleaning, tokenizing, and lemmatizing the data to clean and standardize it. After the cleaning process, the text is sent to a sentiment classifier based on NLP that uses machine learning algorithms, including Support Vector Machines (SVM), Long Short-Term Memory (LSTM) networks, or Transformer-based models. These algorithms classify the sentiment into three groups, which include positive, neutral, and negative. The system gives useful information about the customers' sentiment, enabling businesses to track and enhance their brand perception on various platforms.

3.2 Data Collection in E-Commerce Reviews

Sentiment analysis data is gathered using the publicly available e-commerce review datasets, i.e., environments such as Amazon, eBay, and Walmart. Such data can be accessed via websites such as the Kaggle where one can find databases such as the Amazon Product Review Dataset, eBay Product Reviews and Walmart Review Dataset. These data sets contain a broad range of product types, which makes it possible to conduct sentiment analysis of various brands and markets. Through the reviews on Amazon, eBay, and Walmart, the analysis can capture the sentiment differences on the various e-commerce platforms, and it provides an insight into the variability of customer opinion variations on these

platforms.

Prior processing of the data comprises text cleaning, tokenization, and lemmatization. Text cleaning eliminates noise in the form of special characters, punctuation, and irrelevant words. To normalize the data, tokenization divides the text into smaller units, such as words or phrases, and lemmatization divides the words into their base forms. These preprocessing measures are to make sure that the data is correctly prepared to be classified into sentiments using NLP methodology.

3.3 Techniques of monitoring brand popularity

The brand popularity monitoring is based on the analysis of the trend of sentiment in the long run and its connection with such external variables as a marketing campaign, new product, or competitive activity. Through the analysis of the sentiment information obtained from the reviews on e-commerce platforms (Amazon, eBay, Walmart, etc.), the businesses will be able to determine changes in customer sentiment and how it might affect the popularity of a brand. The sentiment change over time is analyzed by time series analysis, and patterns or major events that have a great impact on customer sentiments are identified through trend analysis. The benefit of this strategy is that businesses would be able to know how the sentiment changes relate to brand performance and, therefore, make more informed decisions and change strategies to sustain or increase brand popularity.

IV. Results

4.1 Analysis of Sentiment Trends in E-Commerce Reviews

The sentiment analysis showed that there were some significant trends in different product categories. The electronics category (smartphones, technology devices, etc.) was the least negatively rated, which was among the most satisfied customers with the performance and functionality of the products. Clothing and accessories, on the contrary, demonstrated both positive and negative feedback, suggesting that customer experience tended to be more inconsistent in this group. The variation of the sentiment was more pronounced in fashion items, especially, probably because of the fit, quality, and preferences in styles. The trends indicate that the type of product makes a considerable impact on the overall feeling, as well as tech products tend to receive more consistent positive feedback than fashion or clothes products, which tend to be exposed to individual preferences and expectations.

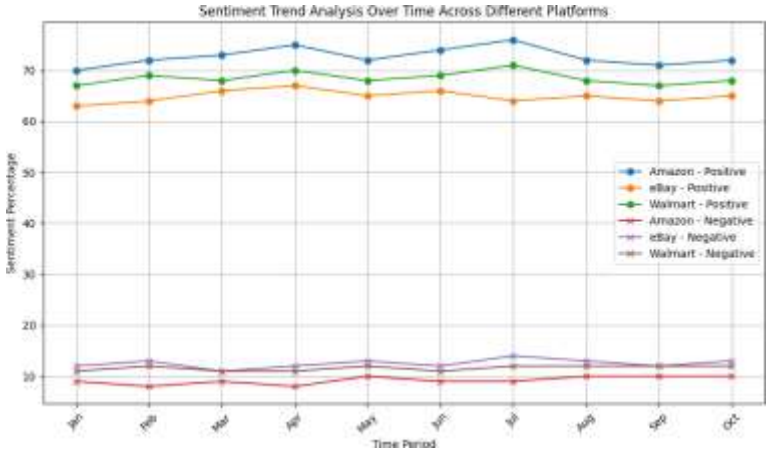

Figure 2: Sentiment Trend Analysis Over Time Across Different Platforms

Figure 2 explains the sentiment distribution (positive and negative) of e-commerce reviews over the period of the products of several platforms, including Amazon, eBay, and Walmart. It monitors the changes of sentiments within a 10-month period, presenting the change of customer satisfaction across platforms. The tendencies indicate the swings of sentiment which can be caused by the changes in the product, marketing policy, or other external factors. The overall favorable sentiment towards Amazon is comparatively high compared to eBay and Walmart, and the negative sentiment difference in

respective websites. The presented analysis is a helpful source of information on customer sentiment dynamics and brand perception in various e-commerce channels.

4.2 Comparison of Sentiment between the Various Platforms

Sentiment analysis across platforms showed that there were dissimilarities in customer satisfaction depending on the platform on which the reviews were posted. As an example, the reviews by Amazon generally had a higher number of positive than those by eBay, which might be explained by different aspects like quality of products, prices, and customer service among the platforms. Amazon has established a good reputation through its simple shopping and reliable customer relationships, and more positive feedback is likely to be created. Conversely, eBay, having an auction-based format and a broader range of products, receives a more mixed reaction as there should be fluctuation in the reputation of the sellers and the description of the products. This brings to the fore the need to have platform-based customer satisfaction management strategies.

Table 1: Sentiment Comparison Across Different E-Commerce Platforms

Platform	Positive Sentiment (%)	Neutral Sentiment (%)	Negative Sentiment (%)
Amazon	72%	18%	10%
eBay	65%	22%	13%
Walmart	68%	20%	12%

In Table 1, the sentiment distribution among three leading e-commerce sites, including Amazon, eBay, and Walmart, is listed. It presents the proportion of favorable, neutral, and unfavorable customer feedback on each platform. Amazon has the highest proportion of positive sentiment at 72%, followed by Walmart at 68% and eBay at 65%. Neutral sentiments are relatively similar across the platforms, with Amazon at 18%, eBay at 22%, and Walmart at 20%. Negative sentiment is highest on eBay at 13%, compared to 12% on Walmart and 10% on Amazon. Such differences may support the disparity in customer satisfaction in platforms and may be affected by some factors, including product quality, customer service, and user experience.

4.3 Relationship between sentiment and brand popularity.

It was observed that there was a clear relationship between sentiment and brand popularity, whereby most brands with a positive sentiment had higher measures of brand popularity. The brands experienced greater volume of sales as well as increased positive mentions on social media. On the contrary, the brands that had negative feedback constantly lost their customer loyalty and popularity. Negative sentiment used to be frequently related to such problems as product failures, ineffective service, or unfulfilled expectations. The connection implies that sentiment analysis can be a good indicator of the brand's performance, and the positive sentiments can result in further brand development, whereas the negative sentiments can potentially make it less successful over the long term.

V. Discussion

The results of this paper highlight the importance of sentiment monitoring to e-commerce companies as the key to ensuring a good brand image. Through actual sentiment analysis, the brands are able to monitor the sentiment change of customers in real time, enabling the company to notice the dissatisfaction at an early stage and act before problems occur. This initiative will help companies to address any negative comments early enough, enhance their customer experience, and protect their image on a variety of platforms such as Amazon, eBay, and Walmart. In addition, the constant observance of the sentiment trends may assist the businesses to remain sensitive to the shift in customer preferences, maximize product suggestions, and improve the company's marketing approaches. Finally, sentiment analysis can be used as a tool to improve brand perception, customer loyalty, and sustain long-term success in the competitive e-commerce settings.

Although sentiment analysis is an important tool of study, there exist limitations to this study. Reliance on textual reviews

is one of the significant weaknesses, as it might be insufficient to determine customer emotions and experiences. Reviews posted on e-commerce sites are rather brief and informal, and may not be able to reflect subtle or complicated emotions: sarcasm or irony, which sentiment analysis models may not be able to identify. Besides, written reviews might fail to capture visual or multimodal information that could provide more detailed information about customer sentiments. The next step in research might be to investigate how multimodal sentiment analysis (the analysis of the text and a picture or a video) may be combined to learn better learn the emotions of the customers in various settings. Also, using more powerful NLP models, including GPT-3, may contribute to an even greater level of accuracy and detail of sentiment analysis, enabling companies to understand customer opinions better and make better-informed decisions.

VI. Conclusion

This study offers an end-to-end method to the NLP-based sentiment analysis of the e-commerce review, which proves to be essential to gauge the customer sentiment and its direct influence on the brand popularity. The major results of the findings are that positive sentiment mostly appears in the product category like electronics, whereas the product category like clothing and accessories is characterized by a larger range of sentiment, where both positive and negative feedback are observed. The sentiment distribution across platforms also varies, with Amazon reviews generally being more positive (72%) compared to eBay (65%) and Walmart (68%). These observations provide a basis to note that analyzing sentiment on what to do on various platforms is important because customer satisfaction is directly proportional to brand popularity and sales. It is advisable that E-commerce ventures invest in sentiment analysis tools that can be used to track customer feedback on the different platforms. With targeted responses to negative sentiments and positive feedback, businesses would be able to raise customer satisfaction and build a stronger brand image. Moreover, live sentiment analysis will enable companies to check the emerging trends, predict customer demands, and remain competitive in the dynamic e-commerce market. Implementation of NLP-driven sentiment analysis is essential to brand monitoring because it will help businesses to understand customer perceptions correctly and modify strategies based on that. Sentiment analysis is a tool that provides the business with insights into the experiences of customers and allows it to react to the concerns beforehand and exploit the positive feedback. Since sentiment is a direct influence on brand loyalty and popularity, the use of these methodologies is necessary to retain a competitive advantage and long-term success in the e-commerce market.

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