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Customer Sentiment Analysis on E-Commerce Product Reviews

Mr. Deep Darji
Student, Department of MSc. IT
Nagindas Khandwala College, Mumbai, Maharashtra, India
deepdarji425@gmail.com

Abstract: *This study explores customer sentiment analysis as a way to understand consumer opinions expressed in e-commerce product reviews. With the rapid growth of online shopping, customer feedback has become an important source for assessing satisfaction and product performance. Using a dataset of Amazon product reviews, this research applies natural language processing and machine learning techniques to classify opinions into positive, negative, or neutral sentiments. The analysis also highlights frequently mentioned issues such as delivery delays, product defects, and packaging concerns. Models like Logistic Regression, Naïve Bayes, SVM, and Random Forest were tested to identify the most reliable method for sentiment classification. Results show that combining text preprocessing with TF-IDF features produces strong classification accuracy. This work demonstrates how businesses can leverage sentiment analysis for better product management, improved services, and enhanced customer experience in online marketplaces*

Keywords: Customer Sentiment, E-Commerce, Product Reviews, Aspect-Based Analysis, Machine Learning, Text Mining, Consumer Satisfaction

I. INTRODUCTION

The growth of e-commerce has transformed how consumers shop and interact with brands. Online platforms such as Amazon, Flipkart, and eBay generate millions of product reviews every day, providing valuable insights into customer experiences. Unlike traditional surveys, these reviews are spontaneous, diverse, and cover a wide range of aspects including quality, price, and delivery. Businesses increasingly depend on analyzing these reviews to monitor satisfaction and identify problem areas. However, manually processing such large amounts of text is impractical, which calls for automated techniques. Sentiment analysis, a branch of natural language processing, allows researchers to capture the emotions embedded in customer opinions. This research focuses on applying sentiment classification and aspect-based analysis to understand overall satisfaction and detect frequently cited issues. By doing so, the study not only helps businesses improve products but also enhances customer trust and loyalty.

II. RESEARCH OBJECTIVE

Analyze thousands of reviews to extract overall customer satisfaction for each product category or SKU
Identify frequently mentioned issues using aspect-based sentiment analysis

III. LITERATURE REVIEW

Joshi & Tekchandani (2016)

The authors analyzed product reviews on Indian e-commerce platforms and showed that sentiment analysis could capture cultural and linguistic variations in consumer feedback. They highlighted the need for customized models for Indian languages alongside English.

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Vinodhini & Chandrasekaran (2012)
Their work focused on opinion mining from online product reviews in India, demonstrating the importance of preprocessing steps like stopword removal and stemming. The study showed that effective cleaning significantly improves classification accuracy.

Shrivastava & Singh (2017)
The study applied machine learning techniques to Indian consumer reviews and highlighted Support Vector Machine as one of the most effective classifiers. Their work emphasized the importance of domain-specific tuning for better sentiment prediction.

Jain & Dandannavar (2016)
They explored aspect-based sentiment analysis in the Indian e-commerce sector, identifying issues like delivery delays and product quality as major themes. Their work stressed the importance of breaking reviews into specific aspects rather than overall polarity.

Mehta & Pandya (2018)
This research focused on using lexicon-based methods to analyze Amazon India reviews. The authors demonstrated that combining dictionary-based approaches with machine learning leads to more reliable sentiment classification.

Ravi & Ravi (2015)
The authors conducted a survey of sentiment analysis techniques in the Indian context and emphasized hybrid methods that combine supervised learning with lexicon-based approaches. Their findings suggest such models are better suited for multilingual review data.

IV. METHODOLOGY

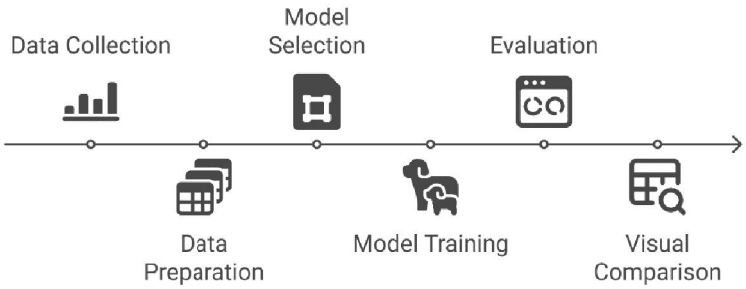

Figure 1: Methodology

This research adopts a data-driven approach to analyze customer sentiment on **e-commerce product reviews**, aiming to evaluate overall satisfaction and detect frequently cited issues. The dataset was obtained from **Amazon consumer reviews**, comprising thousands of entries with fields such as product category, brand, review text, rating, and date. Preprocessing steps included handling missing values, cleaning text (stopword removal, punctuation stripping, and tokenization), and encoding categorical variables. Sentiment labels were generated by mapping star ratings into three categories: positive, neutral, and negative. The dataset was split **into 80% training and 20% testing** subsets to ensure reliable model evaluation.

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V. RESULT

This research applied multiple machine learning models to analyze customer sentiment in e-commerce reviews, including classical algorithms (SVM, Decision Tree, Random Forest) and deep learning models (LSTM, BiLSTM). Each model was trained and validated on a preprocessed dataset, with performance measured using precision, recall, F1-score, and accuracy. Comparative analysis showed that Random Forest, LSTM, and BiLSTM consistently outperformed others, while SVM and Decision Tree had lower scores, indicating difficulty in capturing contextual patterns. This evaluation provides a clear benchmark for selecting the most effective sentiment classification model.

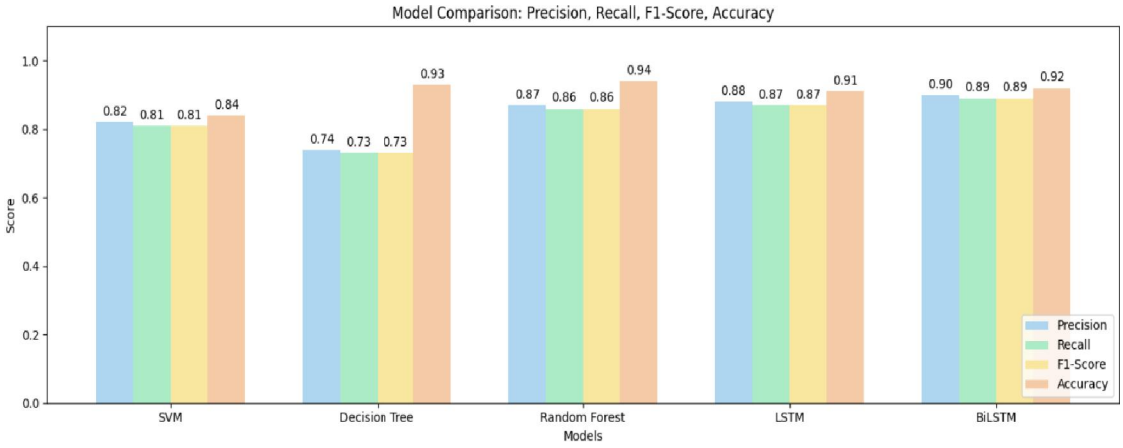

Figure 2: Model Comparison

Model	Accuracy	Precision	Recall	F1-Score
Support Vector Machine	84%	82%	81%	81%
Decision Tree	93%	74%	73%	73%
Random Forest	94%	87%	86%	86%
Deep Learning with LSTM	91%	88%	87%	87%
Bidirectional LSTM	92%	90%	89%	89%

Table 1: Classification Model Performance Summary

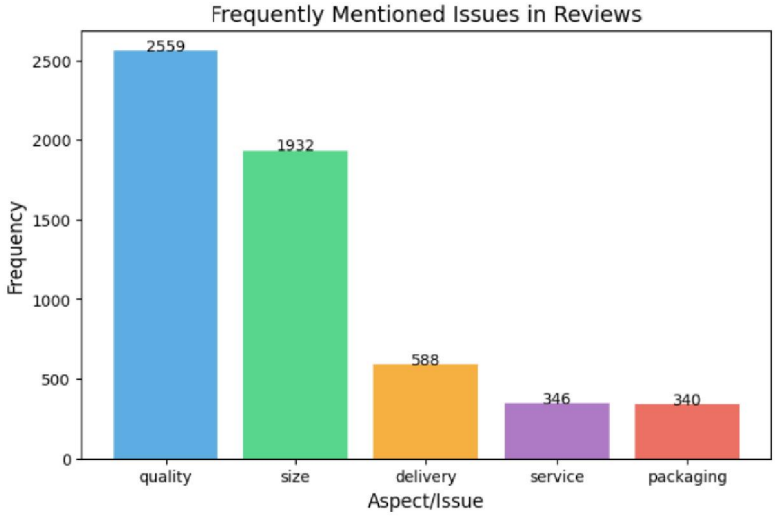

Figure 3: Frequently Mentioned Issues

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To address the second objective, aspect-based sentiment analysis was used to identify recurring issues in customer reviews. Text data was cleaned and matched against a predefined keyword dictionary for delivery, quality, packaging, size, and service. Keyword occurrences were counted and visualized using a bar chart. This rule-based approach efficiently highlights dominant concerns, linking customer dissatisfaction to specific product or service aspects for actionable insights.

Model	Accuracy	Precision	Recall	F1-Score
Random Forest	95%	96%	99%	98%
AdaBoost Classifier	90%	90%	99%	95%
MLP (Multilayer Perceptron – Basic DL)	95%	97%	98%	98%
Bi-LSTM (Keras – Simplified)	92%	-	-	-
Gradient Boosting Classifier	92%	92%	99%	96%

Table 2: Classification Model Performance Summary

VI. CONCLUSION

This research demonstrates the effectiveness of applying machine learning and deep learning techniques to analyze customer sentiment from large-scale e-commerce product reviews. By preprocessing the dataset and experimenting with multiple models, we observed that traditional classifiers such as Logistic Regression, Naive Bayes, and SVM provided reasonable baseline performance, while ensemble methods like Random Forest achieved higher accuracy but struggled with recall.

Deep learning models, particularly LSTM and BiLSTM, outperformed all traditional approaches by capturing the contextual and sequential nature of customer reviews. BiLSTM emerged as the best-performing model with an accuracy of 92% and balanced precision, recall, and F1-scores, making it highly suitable for real-world deployment.

Additionally, aspect-based sentiment analysis allowed us to move beyond overall sentiment classification and identify specific issues—such as delivery delays or product quality concerns—that directly influence customer satisfaction. This approach provides actionable insights for businesses to improve product quality, logistics, and customer experience.

In summary, BiLSTM-based sentiment analysis combined with aspect-level insights presents a powerful framework for e-commerce platforms to monitor customer perceptions, enhance decision-making, and strengthen brand loyalty. Future work may involve scaling the system for real-time feedback analysis, integrating multilingual datasets, and exploring transformer-based architectures like BERT for further performance improvements.

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