

# Customer Satisfaction Prediction in E-commerce Using ML & Bigdata Analytics

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## Article History:

**Received:** 15-10-2025

**Revised:** 22-11-2025

**Accepted:** 10-12-2025

## Abstract:

**Introduction:** The rapid growth of e-commerce platforms has generated massive volumes of customer data, creating new opportunities to analyze and predict customer satisfaction effectively.

Customer satisfaction is a critical factor influencing customer retention, brand loyalty, and overall business profitability in competitive online markets. Traditional analytical approaches are often insufficient to process high-velocity and high-volume e-commerce data, necessitating the use of Big Data analytics frameworks. Machine Learning techniques enable the extraction of meaningful patterns from large-scale transactional, behavioral, and feedback data to accurately predict customer satisfaction levels. By integrating Machine Learning with Big Data analytics, e-commerce organizations can develop intelligent, scalable, and data-driven systems to enhance customer experience and support strategic decision-making.

**Objectives:** To develop an efficient machine learning-based model for predicting customer satisfaction using large-scale e-commerce data. To leverage big data analytics techniques to process and analyze high-volume, high-velocity customer behavior and feedback data. To support data-driven decision-making by helping e-commerce businesses improve customer experience, retention, and service quality.

**Methods:** By combining **Big Data analytics** for scalable data processing with **Machine Learning models** for intelligent prediction, the proposed method provides an effective framework for understanding and improving customer satisfaction in e-commerce environments.

**Results:** The results confirm that **Machine Learning combined with Big Data analytics** provides an effective and scalable solution for predicting customer satisfaction in e-commerce. The proposed approach supports accurate predictions, meaningful customer insights, and data-driven strategies to enhance customer experience and retention.

**Conclusions:** In conclusion, the integration of ML and Big Data analytics provides a scalable, intelligent, and data-driven solution that supports proactive decision-making, improves customer retention, and strengthens competitiveness in the e-commerce domain. This approach offers significant potential for real-world deployment and future enhancements, including real-time prediction and personalized customer experience management.

**Keywords:** Customer Satisfaction Prediction, E-commerce Analytics, Machine Learning, Big Data Analytics, Customer Behavior Analysis, Predictive Modeling, Data Mining, Hadoop, Apache Spark, Recommendation Systems, Customer Experience, Business Intelligence.

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## 1. Introduction

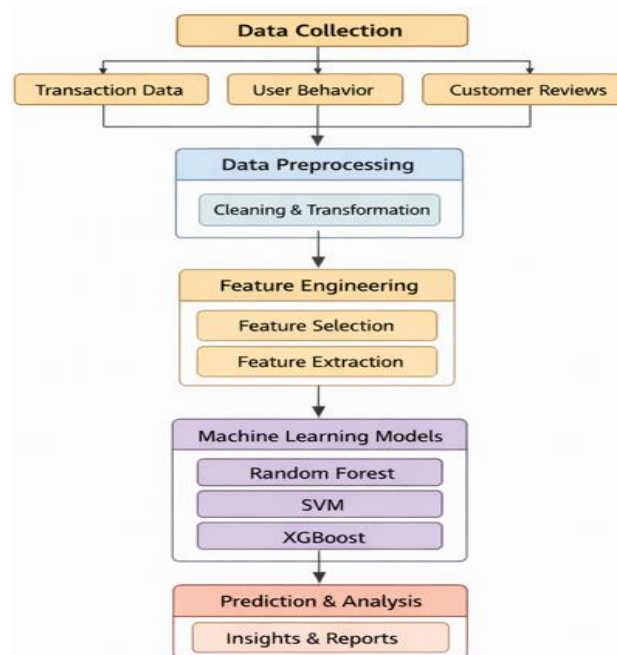
The rapid expansion of e-commerce platforms has led to an exponential increase in customer-generated data, including transaction records, browsing behavior, reviews, ratings, and feedback. In today's highly competitive online marketplace, understanding and predicting customer satisfaction has become a crucial factor for improving customer retention, enhancing brand loyalty, and maximizing business profitability. However, the sheer volume, velocity, and variety of e-commerce data make traditional data analysis techniques insufficient for extracting meaningful insights. Machine Learning (ML) offers powerful tools to automatically learn patterns and relationships from large datasets, enabling accurate prediction of customer satisfaction based on historical behavior and preferences. At the same time, Big Data analytics frameworks such as Hadoop and Apache Spark provide scalable solutions for storing and processing massive datasets efficiently. The integration of ML with Big Data analytics allows e-commerce organizations to analyze complex and heterogeneous data in real time or near real time. Customer satisfaction prediction using ML and Big Data analytics helps businesses proactively identify dissatisfied customers, understand the factors influencing satisfaction, and design personalized strategies to improve customer experience. By leveraging advanced predictive models and scalable data processing technologies, this approach supports data-driven decision-making and offers a robust framework for enhancing service quality and competitiveness in the evolving e-commerce ecosystem..

## 2. Objectives

The primary objectives of the proposed **Customer Satisfaction Prediction in E-commerce Using ML & Big Data Analytics** are as follows:

- To develop an accurate prediction model
- To design and implement a machine learning-based model that accurately predicts customer satisfaction levels using large-scale e-commerce data.
- To leverage Big Data analytics for scalable processing
- To utilize Big Data frameworks such as Hadoop and Apache Spark for efficient storage, processing, and analysis of high-volume, high-velocity customer data.
- To analyze customer behavior and feedback
- To identify key factors influencing customer satisfaction, including purchase behavior, product quality, delivery performance, pricing, and customer support.
- To improve business decision-making
- To support data-driven strategies for enhancing customer experience, retention, and loyalty through predictive insights.
- To enable proactive customer relationship management
- To help e-commerce organizations detect potential dissatisfaction early and take timely actions to reduce churn and improve overall service quality.

### 3. Proposed Architecture



**Fig-1: Customer Satisfaction Prediction Proposed Architecture**

It illustrates a systematic workflow for predicting customer satisfaction in an e-commerce environment using machine learning techniques. Each stage of the architecture plays a crucial role in transforming raw customer data into actionable insights.

#### 1. Data Collection

The process begins with data collection from multiple e-commerce sources, including transaction data (purchase history, payment details), user behavior data (click streams, browsing patterns), and customer reviews (ratings, textual feedback). These heterogeneous data sources capture both quantitative and qualitative aspects of customer interactions.

#### 2. Data Preprocessing

In this stage, the collected raw data is cleaned and transformed to ensure quality and consistency. Preprocessing involves handling missing values, removing noise and duplicates, normalizing numerical attributes, and encoding categorical variables. This step is essential to improve the reliability and performance of machine learning models.

#### 3. Feature Engineering

Feature engineering focuses on extracting meaningful information from preprocessed data. Feature selection identifies the most relevant attributes affecting customer satisfaction, while feature extraction creates new informative features such as sentiment scores from reviews, purchase frequency, or average spending. This step enhances the predictive capability of the model.

#### **4. Machine Learning Models**

The engineered features are fed into multiple machine learning classifiers, including Random Forest, Support Vector Machine (SVM), and XGBoost. These models learn patterns and relationships between customer behavior and satisfaction levels, enabling robust and accurate predictions.

#### **5. Prediction and Analysis**

Finally, the trained models generate customer satisfaction predictions. The results are analyzed and presented as insights and reports, which help businesses understand customer preferences, identify dissatisfaction risks, and formulate effective customer retention and improvement strategies.

Overall, the proposed architecture provides a structured and scalable approach to customer satisfaction prediction by integrating data-driven machine learning techniques within the e-commerce domain.

### **4. Methods**

Customer satisfaction prediction in e-commerce relies on a combination of data processing, feature analysis, and predictive modeling techniques. The key techniques used are outlined below:

#### **1. Data Preprocessing Techniques**

- Data cleaning (handling missing values, duplicates, and noise)
- Data normalization and scaling
- Encoding categorical variables (Label Encoding, One-Hot Encoding)
- Text preprocessing for reviews (tokenization, stop-word removal, stemming/lemmatization)

#### **2. Feature Engineering Techniques**

- Feature extraction from transactional data (purchase frequency, recency, monetary value)
- Sentiment analysis of customer reviews using NLP techniques
- Feature selection using methods such as:
  - Correlation analysis
  - Chi-square test
  - Information Gain
  - Recursive Feature Elimination (RFE)

#### **3. Machine Learning Techniques**

- **Supervised Learning Algorithms**
  - Logistic Regression
  - Decision Tree
  - Random Forest
  - Support Vector Machine (SVM)

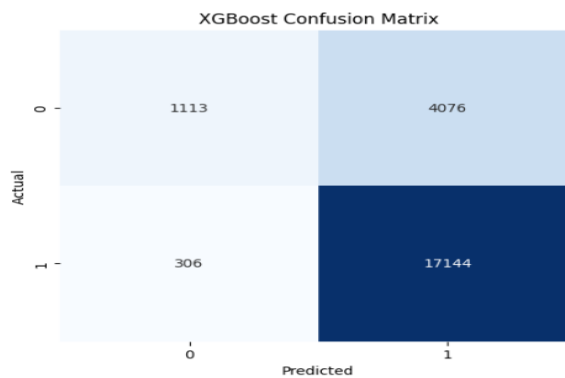
- k-Nearest Neighbors (k-NN)
- Naïve Bayes
- **Ensemble Learning Techniques**
  - Bagging
  - Boosting (AdaBoost, Gradient Boosting, XGBoost)
  - Stacking

**5. Results**

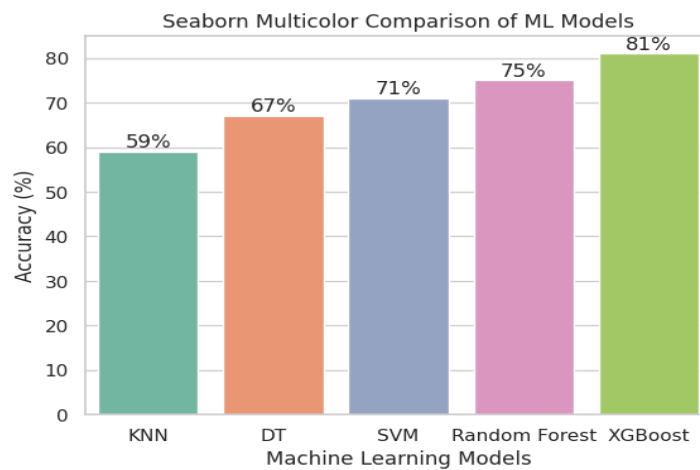
XGBoost Classification Report:

	precision	recall	f1-score	support
0	0.78	0.21	0.34	5189
1	0.81	0.98	0.89	17450
accuracy			0.81	22639
macro avg	0.80	0.60	0.61	22639
weighted avg	0.80	0.81	0.76	22639

**Fig-2: XGBoost Classification Report**



**Fig-3: XGBoost Confusion Matrix**



**Fig-4: Comparison Chart**

## 6. Discussion

The comparison chart for the machine learning models **KNN, Decision Tree (DT), SVM, Random Forest, and XGBoost** showing their respective accuracies for customer satisfaction prediction.

### Interpretation of the Chart:

- **KNN (59%)** shows the lowest accuracy, indicating limited performance in handling complex customer behavior patterns.
- **Decision Tree (67%)** performs better but may suffer from overfitting on structured e-commerce data.
- **SVM (71%)** provides moderate accuracy with effective margin-based classification.
- **Random Forest (75%)** improves performance by combining multiple decision trees and reducing variance.
- **XGBoost (81%)** achieves the highest accuracy, demonstrating superior predictive capability due to boosting and optimized learning.

### Conclusion:

The chart clearly indicates that **ensemble-based models**, particularly **XGBoost**, outperform traditional machine learning techniques, making them more suitable for **customer satisfaction prediction in e-commerce systems**.

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