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# A Review: Challenges and Solutions of Customer Behavior Analysis in E-commerce using Machine Learning Approach

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**ABSTRACT:** In today's digital environment, firms can gain a competitive advantage by utilizing large amounts of data, which is abundant in many fields of operations. It provides important information to help businesses flourish by placing advertisements. The study looks into the use of machine learning algorithms to analyze e-commerce customer reviews, with a particular focus on classifying user suggestions based on textual comments. It solves the difficulty of analyzing vast amounts of unstructured data to determine overall customer sentiment.[1] This article provides a comprehensive review of sentiment analysis methodology and applications. The article reviews and compares several methodologies to understand their merits and limitations. Finally, we evaluate the challenges of customer behavior analysis in e-commerce to define future directions.

**KEYWORDS**: - customer sentiment, logistic regression, support vector machine, Naive Bayes

#### I. INTRODUCTION

Customer relationship management is a crucial aspect of marketing for all industries. Retaining loyal consumers in a saturated market is more cost-effective than acquiring new ones and solid clients can generate consistent revenue for a corporation. Sentiment is a feeling-driven attitude, idea, or assessment. Opinion mining, another name for sentiment analysis, is the study of people's feelings about particular things. From the standpoint of the user, individuals can publish their own material on a variety of social media platforms, including social media networks, forums, and blogs. An increasing number of people are using their mobile phones to search the internet for everything from a job to a product to a payment, an exam, an education, a business lead, or amusement, according to a recent survey. As a result, the business must understand the buying patterns of its clients. Predicting and preparing for consumer behavior in the context of online buying is the main objective of this study. Thus, a greater level of efficiency is achieved in the operation of the proposed Machine Learning framework. Various levels can be applied to examine the sentiment of a given input.

As seen in Figure 1, the sentiment of a particular input can be analyzed at multiple levels.



Figure 1: Various Levels of Sentiment Analysis





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**Document Level Analysis:** - This level evaluates whether the document's general opinion is reasonable, harmful, or neutral. Sentiment analysis can identify whether a reviewer has a positive, negative, or neutral perception of the subject. This process is sometimes referred to as "document-level sentiment classification." This level of analysis implies that each document expresses opinions about a specific thing (such as a product). This does not apply to documents comparing or contrasting multiple entities [2].

**Sentence Level Analysis:** - This task level evaluates sentences to determine if they convey a positive, negative, or neutral mood. The subjectivity categorization exam, which distinguishes between factual and subjective sentences, is analogous to this level of analysis [2].

**Aspect Level Analysis**: - The document and sentence range approaches do not provide fine-grained sentence analysis. They do not specify the exact expressions persons have towards an entity's properties or attributes.

The level sentiment analysis approach focuses on fine-grained analysis of review sentences. Aspect-level sentiment analysis focuses on opinion words stated towards specific features in a review sentence, rather than linguistic constructs like clauses, paragraphs, or documents. Opinion words express feelings about an entity's specific or general characteristic [2].

#### **II. LITERATURE SURVEY**

**Neetaben et al.** addresses how consumer behavior in retail marketing is analyzed using Machine Learning (ML) techniques to enable segmentation, prediction of buying behavior, and marketing strategy optimization, so improving customer engagement and satisfaction in e-commerce environments [3].

To forecast preferences in e-commerce, Nikhil Sanjay et al. suggests a new model combining consumer behavior analysis with powerful machine learning techniques. This method seeks to increase recommendation accuracy by tackling issues such data sparsity and changing user preferences for better consumer involvement [4].

**Deming Liu et. al.** proposed machine learning techniques including Random Forest, Gradient Boosting Decision Trees, and Extreme Gradient Boosting, the study examines consumer behavior in e-commerce and achieves 72 to 75 percent accuracy in forecasting purchase likelihood depending on click stream data [5].

**Md Abdullah et. al.** proposed machine learning technique to examine consumer behavior in e-commerce in order to forecast annual spending, customer turnover, and product on-time delivery. Important factors are purchase frequency, product categories, and average session length, thereby improving customer retention and income policies [6].

O. Alrusaini et.al. study about machine learning techniques, the research examines e-commerce customer evaluations to characterize emotions. Using textual feedback analysis, it shows how well models including support vector machines, logistic regression, and light gradient boosting machine grasp consumer behavior [1].

**Ijegwa David et al.** The study uses machine learning—more especially, the k-means clustering technique—to examine consumer behavior in e-commerce by means of personality trait identification and correlation with purchasing behavior, so enabling focused marketing strategies and improving customer satisfaction by means of customized campaigns [7].

**S. R. and B.D et. al.** The study addresses consumer behavior in e-commerce by use of machine learning methods including association rule mining and clustering employing which It underlines the need of data mining for precise forecasts and focused marketing plans depending on consumer demographics and buying patterns [8].

**D. S. Garg et. al.** The study examines consumer behavior in e-commerce utilizing data analytics and machine learning to discover notable trends and patterns. It underscores the necessity for tailored product suggestions and strategic marketing to improve consumer happiness and maximize promotional initiatives [9].

**E.** Akisani et. al. The study utilizes machine learning for sentiment analysis of e-commerce product reviews to forecast consumer behavior. This study compares the Support Vector Machine and Naive Bayes algorithms, revealing that the Support Vector Machine attains a superior accuracy of 97% in sentiment categorization [10].





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**J. Panduro-Ramirez** et. al. The study utilizes machine learning methodologies to assess consumer behavior in ecommerce through the analysis of extensive transactional data, user interactions, and demographic information. It discerns patterns via grouping, classification, and predictive modeling to improve marketing strategies and client happiness [11].

Sr. No.	Author	Year	Method used	Data Set
1	O. Alrusaini and H. Beyari et. al	2024	The research employed five classification algorithms for sentiment analysis of e-commerce customer reviews: logistic regression, support vector machine, Naive Bayes, random forest, and light gradient boosting machine. Each algorithm was evaluated using performance criteria including accuracy, precision, recall, and F1 score [1].	The study examined consumer attitudes and recommendations based on textual comments using a dataset of women's clothes evaluations taken from online retailers.[1]
2	D. Liu, H. Huang et. al	2024	The paper utilizes machine learning models such as Random Forest (RF), Gradient Boosting Decision Trees (GBDT), and Extreme Gradient Boosting (XGBOOST) to predict customer purchasing behavior based on click stream data. Additionally, deep learning models like Recurrent Neural Networks (RNN) and Long Short-Term Memory (LSTM) are employed to forecast whether customers will make a purchase, with the LSTM model showing the highest prediction accuracy among the deep learning models.[5]	Both acquired from actual e-commerce consumers, the study included 33,040,175 records from the click file and 1,177,769 records from the buys file. Using machine learning and deep learning models for analysis, these datasets were utilized to forecast consumer purchase behavior depending on click stream data.[5]
3	A. Al Rahib et. al	2024	SVM for e-commerce customer churn and on-time delivery prediction. For customer churn, SVM was configured with kernel 'rbf' and random state, while for product on-time delivery, gamma, C, and random state. The Decision Tree method was used for regression and classification in customer churn and on-time product delivery prediction. Both datasets used decision tree parameters including criterion, max depth, and random state to categorize customer churn and on- time delivery [6].	The study used data pre- processing to improve dataset reliability and consistency. The researchers used the median value for columns with null or missing values to prepare the data for machine learning algorithm analysis[6].
4	E. Akisani Asogor	2024	Classify product reviews from e- commerce platforms using SVM and Naive Bayes. Support Vector Machine outperformed Naive Bayes in sentiment classification	The study trained and tested machine learning models using e-commerce product reviews for sentiment analysis. Support Vector Machine

#### Table -1: Literature Review Table





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			accuracy at 97% [10].	and Naive Bayes were used to compare their accuracy on the dataset to evaluate sentiment classification [10].
5	J. Panduro-Ramirez et. al	2024	uses clustering, classification, and predictive modeling to determine client types from large-scale transactional data, user interactions, and demographics. Through the application of these methodologies, the research intends to assess purchase trends and anticipate future behaviors of customers on e- commerce platforms to boost marketing efforts and improve customer satisfaction [11].	The study analyzes large- scale transactional data, user interactions, and demographic information to examine customer behavior on e-commerce platforms. Machine learning methods like clustering, classification, and predictive modeling are used to identify consumer behavior patterns, client types, purchase trends, and future behaviors [11].

#### **III. METHODOLOGY**

Sentiment analysis pulls features from user-posted thoughts, perspectives, sentiments, and opinions on social media platforms. The amount of data generated by social networking sites is massive; nevertheless, this data is unstructured and cannot provide significant information until it is examined. To make sense of this massive volume of data, we do sentiment analysis, which involves extracting and classifying features from it. Our methodology incorporates four essential steps: data collecting, processing, sentiment analysis, and data visualization.



Figure 2: Proposed Methodology

First, gather customer input data from surveys, social media, and customer reviews, among other sources. Create a model for training and testing data from the dataset and eliminate unnecessary information in the second and third steps of comparative sentiment analysis and data preprocessing. We then forecast the outcome.





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**IV. CONCLUSION** 

Over the past six years, this review study provides a thorough summary of research on Customer Behavior Analysis utilizing Machine Learning inside the e-commerce space. The rising relevance of recommendation systems in the fast expansion of e-commerce drives this study. This literature review's main goal is to give researchers a thorough awareness of the developing trends, difficulties, and solutions particular to Customer Behavior Analysis in e-commerce. Finally, our research emphasizes the need of ongoing innovation and research as well as offers a thorough knowledge of the present scene of customer behavior analysis in e-commerce. These future prospects will not only solve current problems but also provide new opportunities, hence guiding the following wave of e-commerce recommendation system developments.

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