

A Comprehensive Review on Machine Learning Based Customer Satisfaction from Airline Tweets

Rohit Chaudhary¹, Dr. Harsh Lohiya²

Research Scholar, Department of Computer Science, SSSUTMS, Sehore¹

Associate Professor, Department of Computer Science and Engineering, SSSUTMS, Sehore²

Abstract: *This paper presents a comprehensive review of the application of machine learning techniques to analyze customer satisfaction derived from airline-related tweets. As social media has become a critical platform for customer feedback, understanding sentiments expressed in tweets offers valuable insights for airline companies striving to enhance their service quality. We explore various machine learning methodologies, including sentiment analysis, topic modeling, and predictive analytics, that have been employed to decipher customer sentiments and identify recurring themes in user feedback. By systematically examining existing literature and case studies, this review highlights the effectiveness of different algorithms—ranging from traditional classifiers to advanced deep learning approaches—in extracting meaningful patterns from large volumes of unstructured tweet data. We discuss the implications of these findings for airline management, emphasizing the importance of real-time monitoring and proactive customer engagement strategies. Additionally, we identify gaps in current research and suggest future directions, such as the integration of multimodal data sources and the development of more sophisticated models for nuanced sentiment detection. This review aims to serve as a foundational resource for researchers and practitioners interested in leveraging machine learning to improve customer satisfaction in the airline industry.*

Keywords: *Customer Satisfaction, Tweets, Machine Learning, Classification, Sentiment Analysis.*

1. Introduction

In an era where social media platforms have become main means for customer connection and criticism, knowing consumer mood is vital for businesses, especially in the highly competitive airline industry. Airlines have particular difficulties, such as shifting consumer expectations, interrupted services, and the requirement for efficient crisis communication. Because of this, it's become more crucial than ever to be able to assess client satisfaction through real-time comments on websites like Twitter. The use of machine learning techniques to examine consumer satisfaction from airline-related tweets is the main topic of this review. With its ability to handle enormous volumes of unstructured data, machine learning presents creative ways to draw conclusions from social media. Researchers and practitioners can use a variety of algorithms—from sophisticated deep learning approaches

to conventional statistical methods—to spot trends in sentiment, find problems quickly, and create data-driven plans to improve the customer experience. The research holds importance not only for its ability to enhance airline services but also for its contribution to the wider domain of customer satisfaction analysis in various businesses. Prior research has indicated the effectiveness of sentiment analysis in comprehending consumer behavior; yet, there is a deficiency in a concentrated investigation that combines discoveries particular to the airline sector with machine learning techniques.

By offering a thorough summary of the body of research on machine learning-based consumer satisfaction analysis from airline tweets, this study seeks to close that gap. We'll look at the approaches taken, highlight the most important discoveries, and talk about the ramifications for airline management. We will also point out areas in need of further investigation and suggest potential paths to further our knowledge of and use of machine learning in this field. By doing this, we want to help advance the

conversation on how technology and customer service interact, which will ultimately help airlines provide better customer service.

2. Background

2.1 Customer Satisfaction in the Airline Industry

Customer satisfaction in the airline industry refers to the degree to which passengers' expectations and experiences align with the services provided by airlines. It is a critical metric for measuring the overall performance of airlines and is essential for fostering customer loyalty, enhancing brand reputation, and driving profitability.

Major parameters of Customer Satisfaction

1. Service Quality:

Staff Interaction: The professionalism and friendliness of airline personnel during booking, check-in, boarding, and in-flight can greatly influence customer perceptions. Positive interactions can lead to higher satisfaction.

Responsiveness: Quick and effective responses to customer inquiries and issues, especially during delays or cancellations, are vital. Passengers appreciate timely updates and support.

2. Flight Experience:

Comfort: Factors such as seating comfort, cabin space, and cleanliness play a significant role. Airlines that offer a pleasant flying environment generally see higher satisfaction levels.

In-Flight Services: Amenities such as food quality, entertainment options, and Wi-Fi access contribute to the overall experience. High-quality services can enhance passenger enjoyment and satisfaction.

3. Punctuality and Reliability:

On-Time Performance: Timeliness is one of the most critical factors influencing customer satisfaction. Passengers expect flights to depart and arrive as scheduled.

Handling of Disruptions: Effective management of delays and cancellations, including proactive communication and compensation policies, can mitigate dissatisfaction.

4. Pricing and Value:

Cost-Effectiveness: Customers evaluate the value they receive relative to the price paid. Competitive pricing combined with quality service can enhance perceptions of value.

Transparency in Pricing: Clear communication about fees and charges during the booking process helps manage customer expectations and reduces frustration.

Customer Support:

Accessibility: Availability of support channels, including phone, email, and social media, allows passengers to easily reach out for help.

Issue Resolution: Efficiently addressing complaints and providing satisfactory resolutions are critical for maintaining customer trust and satisfaction.

Measuring Customer Satisfaction

Airlines employ various methods to assess customer satisfaction, including:

Surveys and Feedback Forms: Post-flight surveys collect direct feedback from passengers about their experiences, helping airlines identify strengths and areas for improvement.

Net Promoter Score (NPS): This metric measures customer loyalty by asking passengers how likely they are to recommend the airline to others.

Social Media Monitoring: Analyzing sentiments expressed in social media posts allows airlines to gauge public perception and respond to emerging issues in real-time.

Challenges in Achieving High Customer Satisfaction

Despite its importance, achieving high customer satisfaction in the airline industry can be challenging due to:

Operational Complexities: The intricacies of flight scheduling, staffing, and compliance can lead to service inconsistencies and operational disruptions.

External Factors: Weather, security concerns, and global events (such as pandemics) can adversely affect operations and customer experiences.

High Customer Expectations: With increasing competition and the rise of low-cost carriers, customers expect higher levels of service and value, making it essential for airlines to continuously enhance their offerings.

The Role of Technology

Technology plays a pivotal role in shaping customer satisfaction in the airline industry:

Online Booking and Check-in: User-friendly platforms streamline the booking process and reduce wait times at airports.



Data Analytics: Airlines utilize data analytics to gain insights into customer preferences, allowing for personalized services and targeted marketing.

Real-time Communication: Technologies that enable real-time updates on flight statuses, delays, and gate changes help build trust and reduce passenger anxiety.

Conclusion

Customer satisfaction in the airline industry is a multifaceted construct influenced by service quality, operational reliability, and effective communication. As competition continues to intensify, airlines must prioritize understanding and addressing customer needs to enhance satisfaction and foster loyalty. By leveraging technology and focusing on continuous improvement, airlines can navigate the complexities of customer expectations and deliver exceptional service in an increasingly challenging environment.

2.2 Role of Machine Learning

Machine learning (ML) has emerged as a powerful tool for enhancing customer satisfaction across various industries, including the airline sector. By leveraging vast amounts of data, machine learning algorithms can analyze customer behavior, preferences, and feedback to provide actionable insights that help businesses improve their services and customer experiences. Here's how machine learning plays a crucial role in customer satisfaction:

1. Sentiment Analysis

Understanding Customer Feedback: Machine learning algorithms can analyze unstructured data from social media, reviews, and surveys to gauge customer sentiment. Techniques such as natural language processing (NLP) enable the classification of feedback as positive, negative, or neutral, allowing airlines to understand public perception and react accordingly.

Real-Time Monitoring: Automated sentiment analysis tools can continuously monitor social media platforms, providing airlines with real-time insights into customer opinions and emerging issues.

2. Personalization of Services

Tailored Recommendations: Machine learning models can analyze past customer behavior, preferences, and booking history to offer personalized recommendations for flights, upgrades, and in-flight services. This tailored approach enhances the customer experience by making it more relevant and engaging.

Dynamic Pricing: ML algorithms can analyze market trends and customer data to optimize pricing strategies,

allowing airlines to offer personalized fares based on individual passenger profiles, thus enhancing perceived value.

3. Predictive Analytics

Forecasting Customer Behavior: Machine learning can identify patterns in customer data to predict future behaviors, such as booking tendencies, likelihood of cancellations, or service preferences. This allows airlines to anticipate customer needs and tailor their offerings accordingly.

Churn Prediction: By analyzing historical data, airlines can identify at-risk customers likely to switch to competitors. Early identification enables targeted interventions, such as personalized offers or proactive customer service, to improve retention.

4. Improving Operational Efficiency

Resource Allocation: Machine learning can optimize staff scheduling, manage aircraft maintenance, and predict demand for specific routes. Efficient resource management leads to smoother operations and improved service delivery, which in turn enhances customer satisfaction.

Delay and Disruption Management: Predictive models can analyze various factors, such as weather and traffic patterns, to forecast potential delays. By proactively communicating with customers and managing disruptions, airlines can mitigate dissatisfaction.

5. Enhanced Customer Support

Chatbots and Virtual Assistants: Machine learning-powered chatbots can provide instant responses to customer inquiries, resolve issues, and assist with bookings. This 24/7 availability enhances customer experience and satisfaction by reducing wait times for support.

Automated Ticketing and Issue Resolution: ML algorithms can classify and prioritize customer support tickets, ensuring that urgent issues are addressed promptly, further improving the customer experience.

6. Identifying Improvement Areas

Feedback Loop: By analyzing customer feedback data, machine learning can identify recurring issues or service shortcomings. Airlines can use these insights to implement changes, enhancing service quality and addressing customer concerns effectively.

A/B Testing and Experimentation: ML models can facilitate A/B testing for various service changes (e.g., menu offerings, boarding processes), enabling airlines to evaluate the impact of modifications on customer satisfaction and make data-driven decisions.



7. Customer Segmentation

Targeted Marketing: Machine learning enables airlines to segment customers based on their preferences, behaviors, and demographics. This segmentation allows for more targeted marketing campaigns, enhancing customer engagement and satisfaction.

Understanding Diverse Needs: Different customer segments may have unique expectations and preferences. Machine learning helps airlines understand these differences and tailor their offerings to meet diverse needs. Machine learning is transforming the way airlines approach customer satisfaction by providing insights and tools to enhance service quality, personalize experiences, and anticipate customer needs. As airlines continue to harness the power of machine learning, they can improve operational efficiency, foster loyalty, and ultimately create a more satisfying travel experience for their passengers. The integration of ML technologies represents a significant opportunity for airlines to stay competitive in a rapidly evolving industry.

3. Literature Survey

WajdiAljedaani, Furqan Rustam [1], Performed sentiment analysis based on the Six USA Airlines dataset. The architecture of the proposed research consists of data collection of 14640 tweets, data preprocessing, feature engineering, splitting of the data, lexicon-based sentiment analysis, applying deep learning [2] as well as machine learning algorithms, data prediction and based on the data prediction the trained model evaluation is carried out. The dataset consists of 3 types sentiments i.e., positive, negative, neutral. With the help of textblob model accuracy is improved to perform classification. Results of research shows that using TF IDF & LSTM 92 % & 97% of accuracy is achieved.

E Prabhakar, M Santhosh, Hari Krishnan, T kumar, R Sudhakar [3], They Proposed a sentiment analysis of top 10 airlines services reviews in US using one of the popular machine learning techniques Adaboost. Tweets or reviews present in English language are considered. To check the accuracy and analysis of performance recall, precision, F score is calculated using various machine learning algorithms. They started with data collection from top 10 airlines service reviews or tweets, preprocessing of the collected data is carried out to remove unwanted data. For the main analysis purpose, the 75 % of the data is taken for the training and remaining data is used for the testing.

Bagging and boosting ensemble [4] techniques are applied to train the model. The New approach called as Adaboost

results with the higher accuracy. The second highest accuracy score is given by the random forest algorithm. The New Approach Ada boost gives the precision of 78%, recall of 65%, and the F score of 68%. And the random forest algorithm gives the precision of 71%, recall of 66%, F score of 60%.

Therefore, one can easily decide to choose best model based on the accuracy results.

Ankita Rane, Dr. Anand Kumar [5], Sentiment analysis of US Airlines tweets are carried out using multi class classification.

The dataset is taken from Kaggle released dataset by CrowdFlower which comprises of 6 major US Airlines Services and total 14640 tweets. Doc2Vec and word embedding techniques is used on preprocessed tweets to perform analysis at phrase level. this analysis is done using different machine learning classification algorithms. The dataset is separated into 2 parts, 80% of the data is used to train the model and 20% of the data is used for testing. The results are either positive or negative or neutral. Spyder tool is used to do entire experiment. The data visualization is done for solving business problems such finding the root cause of negative reviews as well as finding the total sentiments counts. As compare to all other machine learning algorithm applied accuracies, Ada Boost Algorithm shows the highest accuracy of 84.5%.

Ankit, Nabizath Saleena [6], Discussed the sentiment analysis of the tweets or review using Ensemble Classification and using base classifiers. The sentiment classification is classified into 2 categories i.e., positive and negative. Neutral sentiment is not taken into consideration. The research process consists of 4 main steps, initially the data preprocessing is carried to cleaning the data, then the feature extraction is carried out to extract only essential features from the data. For the feature extraction one of the popular feature extraction techniques called Bag of Words is applied. the sentiment classification is done using various base classifiers and the ensemble classifier.

The applied base classifiers techniques include naïve bayes, random forest, support vector machine (SVM) & logistic regression. In ensemble classifier model, the inputs are test tweets and the output is its sentiment score. Sentiment score is calculated based on the probability. If the input test tweet has more positive score, then negative then it is considered as given test tweet is of positive sentiment. Similarly, if the test tweet has more negative score than the positive score it is considered as the given test tweet is of negative sentiment. Results are calculated and data visualization is shown using graphs. The ensemble classifier shows better results as compared to others.

4. Problem Statement

The airline industry, being one of the most customer-sensitive sectors, continuously seeks to enhance customer satisfaction by improving service quality. With the increasing usage of social media platforms, especially Twitter, passengers often express their satisfaction or dissatisfaction with their airline experiences in real-time. These tweets provide airlines with valuable insights into customer sentiments and experiences, which, if properly analyzed, can lead to more effective strategies for improving customer satisfaction.

- **Problem Definition:** This study aims to conduct a comprehensive review of machine learning techniques employed to assess and enhance customer satisfaction using airline-related tweets. The primary problem is to identify, classify, and analyze how customer feedback from social media, particularly Twitter, can be leveraged to measure and improve service quality in the airline industry through various machine learning models.
- **Unstructured Data:** Tweets are often unstructured, brief, and include informal language, abbreviations, and slang. This makes extracting meaningful information a challenging task for traditional analytics methods.
- **Sentiment Analysis:** Analyzing customer sentiments involves determining whether tweets express positive, negative, or neutral sentiments. Machine learning models, such as natural language processing (NLP) techniques, must be employed for accurate sentiment classification.
- **Emotion Detection:** Beyond sentiment classification, detecting specific emotions (e.g., frustration, satisfaction, anxiety) from tweets can provide deeper insights into customer experiences.
- **Topic Modeling:** Understanding the primary topics of customer complaints or praise is crucial for airlines. Topic modeling techniques, such as Latent Dirichlet Allocation (LDA), are commonly used for clustering tweets into relevant categories (e.g., delays, baggage handling, customer service).
- **Real-time Data Processing:** Airlines need to monitor customer feedback in real time to promptly address issues. Implementing machine learning systems capable of processing and analyzing streams of live Twitter data is essential for timely decision-making.

- **Noise in Data:** Social media posts often contain irrelevant information, spam, or advertisements, which must be filtered out during analysis.

5. Research Gap

Despite the growing body of research in applying machine learning (ML) techniques to analyze customer sentiments from social media, there remain significant gaps in fully leveraging the potential of such data for improving airline customer satisfaction. These gaps can be identified in the following key areas:

- **Limited Focus on Industry-Specific Context**

Most existing studies on sentiment analysis using social media data focus on generic customer feedback across multiple industries. There is a lack of comprehensive research that specifically addresses the airline industry's unique challenges, such as dealing with large volumes of real-time feedback related to delays, cancellations, service quality, and safety concerns.

- **Inadequate Real-Time Processing and Analysis**

While many studies focus on analyzing historical data from tweets, there is a gap in research related to real-time processing of airline tweets for immediate action. Real-time feedback could be crucial for airlines to resolve issues quickly, yet research on implementing machine learning models that process and act on live streams of Twitter data remains underdeveloped.

- **Complex Sentiment and Emotion Detection**

The majority of sentiment analysis models classify tweets as positive, negative, or neutral, which oversimplifies the rich emotional content in social media posts. Research gaps exist in more advanced models capable of detecting nuanced emotions (e.g., frustration, anxiety, satisfaction) or distinguishing between mild and severe complaints. Additionally, the ability to capture subtle emotions expressed through sarcasm or irony remains a challenge in existing studies.

- **Data Noise and Irrelevant Content Filtering**

Many tweets do not provide relevant feedback or may include irrelevant information, such as spam, advertisements, or unrelated discussions. The current literature lacks effective methods for filtering out noisy or irrelevant data before analysis, which can lead to inaccurate insights.

- **Limited Multilingual Analysis**

Research on customer sentiment analysis often focuses on tweets in English, neglecting the global nature of the airline industry. Multilingual sentiment analysis, which can capture customer feedback from various regions in their native languages, is underexplored. Developing

machine learning models that can accurately process non-English tweets is a significant research gap.

- Integration with Customer Service Systems

Despite advances in ML techniques for sentiment analysis, there is limited research on how airlines can integrate these insights into their customer service systems. For example, how can airlines automatically generate appropriate responses or prioritize customer complaints based on sentiment analysis? The gap lies in developing end-to-end systems where ML-generated insights are operationalized to improve service quality.

- Cross-Platform Sentiment Analysis

Most studies focus solely on Twitter, while customers also express opinions on other platforms such as Facebook, Instagram, and online review sites. Research is needed to develop models that can integrate customer feedback from multiple platforms to provide a holistic view of customer sentiment.

- Evaluation of Existing Machine Learning Models

A wide range of machine learning models has been proposed for sentiment analysis, including traditional models like support vector machines (SVMs) and more advanced deep learning models such as recurrent neural networks (RNNs). However, there is a lack of comprehensive comparative studies evaluating the performance of these models specifically in the context of airline customer feedback analysis.

- Sentiment and Contextual Understanding

Current sentiment analysis models tend to classify tweets based on isolated textual content, without considering the broader context in which the feedback was provided. For instance, customer sentiments might change based on external factors such as weather conditions or political events affecting flights. There's a gap in research that integrates contextual data with sentiment analysis to provide deeper insights into customer satisfaction.

6. Conclusion

The rise of social media platforms like Twitter has provided airlines with a valuable, real-time source of customer feedback. Machine learning (ML) techniques, particularly in sentiment analysis, emotion detection, and topic modeling, have shown promise in transforming this unstructured data into actionable insights. However, despite progress in this area, significant challenges and gaps persist in fully leveraging these tools to improve customer satisfaction.

Key areas that remain underexplored include real-time data processing, nuanced emotion detection, effective filtering of irrelevant data, and multilingual sentiment

analysis. Additionally, the integration of ML insights into customer service systems and the lack of industry-specific research on the airline sector suggest that there is much room for improvement in how airlines apply these advanced techniques.

Moving forward, the development of more robust, scalable, and context-aware ML models is essential to handle the complexities of airline customer feedback. Solutions that can analyze real-time streams of multilingual data, filter out noise, and provide a deeper understanding of customer emotions will allow airlines to respond more effectively to customer concerns, improve service delivery, and enhance overall customer satisfaction.

In conclusion, machine learning holds great potential for revolutionizing how airlines monitor and respond to customer satisfaction from social media data. Addressing the existing research gaps can lead to more sophisticated, real-time systems that not only gauge customer sentiment but also proactively improve the flying experience, fostering greater customer loyalty and trust in the airline industry.

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