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Analyzing Consumer Behavior on Social Media Using Business Intelligence Tools: A Sentiment Analysis Case Study on U.S. Airlines

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August 2025

Abstract

The rapid expansion of social media platforms has generated vast datasets reflecting consumer behaviors, opinions, and preferences. This study investigates the integration of sentiment analysis with Business Intelligence (BI) tools to examine consumer behavior on social media, focusing on Twitter data related to U.S. airlines. By employing natural language processing (NLP) techniques, sentiments are categorized as positive, negative, or neutral to identify patterns in customer feedback. The methodology includes preprocessing a publicly available dataset, engineering additional features, and developing interactive Power BI dashboards to visualize insights. Results reveal a predominance of negative sentiments (63%),primarily driven by customer service issues and flight delays, with complaints peaking during early mornings and late evenings. These findings highlight operational and service-related challenges faced by airlines. Managerial implications suggest prioritizing customer service enhancements and optimizing resource allocation during high-complaint periods. This integrated framework bridges sentiment analysis and BI, providing actionable insights for improving customer experience and supporting strategic decision-making. Future research could explore multi-platform integration and real-time data processing to further enhance the framework's applicability.

1 Introduction

Social media platforms have become critical sources of consumer-generated content, offering real-time insights into behaviors, preferences, and opinions.With millions of users actively sharing feedback on platforms like Twitter, businesses can leverage this data to understand consumer perceptions and improve services.Sentiment analysis, a technique rooted in natural language processing, enables the classification of text into positive, negative, or neutral categories, providing a systematic approach to extracting actionable insights from consumer feedback.

The significance of this analysis is particularly evident in competitive industries such as aviation, where customer satisfaction directly influences brand reputation and loyalty. While sentiment analysis uncovers

patterns in consumer opinions, Business Intelligence (BI) tools like Power BI transform raw data into interactive visualizations, enabling data-driven decision-making. However, integrating these approaches into a cohesive framework remains underexplored, presenting an opportunity to enhance managerial strategies.

This study aims to analyze consumer behavior on social media using BI tools, with the following objectives: (1) classify sentiments expressed in airline-related tweets, (2) identify key drivers of negative feedback, and (3) visualize temporal and geographical trends to support strategic decisions. The research addresses the following questions: What are the dominant sentiments in consumer discussions about U.S. airlines? What factors contribute to negative sentiments? How can BI dashboards facilitate actionable managerial insights? By addressing these, the study seeks to bridge the gap between sentiment analysis and BI applications, contributing to improved customer experience management.

2 Literature Review

The rapid growth of social media platforms has created vast amounts of real-time data that reflect consumer opinions, preferences, and behaviors. Studies highlight that social media is not only a communication channel but also a valuable source for understanding customer experiences and brand perception through **sentiment analysis**. Sentiment analysis uses natural language processing (NLP) techniques to classify text into positive, negative, or neutral categories, and it has been widely applied to extract insights from consumer feedback (Liu, 2012).

Several works emphasize the role of sentiment analysis in generating actionable insights for businesses. For example, Rustam et al. (2020) applied machine learning models on Twitter data to classify U.S. airline customer sentiments, showing how consumer feedback on social media can directly inform service quality evaluation. Similarly, Barakat et al. (2021) used tweets to measure airport service quality, demonstrating the potential of user-generated data in the aviation sector. Beyond the airline industry, recent research stresses that consumer sentiment analysis provides valuable input for marketing campaigns, product development, and customer experience management (Hu et al., 2022).

In parallel, **Business Intelligence (BI)** tools have become critical for turning raw data into visual and managerial insights. BI platforms such as Power BI or Tableau allow organizations to design dashboards, monitor key performance indicators (KPIs), and make data-driven decisions. Gonçalves et al. (2023) demonstrated how Power BI dashboards can be used to support sales management, while Malawani et al. (2025) highlighted that BI contributes to organizational agility and competitive advantage. Integrating BI with social media analytics enables companies to not only process consumer feedback but also present it in a way that supports strategic decision-making (Niu et al., 2021).

2.1 Research Gap

Although there is extensive literature on sentiment analysis and the use of BI tools, **few studies combine both in an end-to-end framework** that transforms social media data into BI dashboards for managerial purposes. Most research focuses either on the technical side of sentiment classification or on the general benefits of BI, but **practical applications that connect consumer sentiment with BI dashboards remain limited**. Furthermore, issues such as real-time data processing, multi-platform integration, and explainability of sentiment models are still under-explored. This gap provides the basis for the present study, which aims to analyze consumer sentiment in social media using Power BI to deliver actionable insights.

3 Methodology

This research uses the Airline Sentiment dataset provided under the Social Media Data License (CC BY-NC-SA 4.0). The dataset is publicly available and includes more than 14,000 tweets about U.S. airlines The dataset, provided in CSV format, was imported into *Power BI* through Power Query. Only relevant attributes were selected for the analysis, including sentiment labels (positive, negative, neutral), reasons

for negative comments, airline names, tweet text, retweet counts, and temporal or location information such as creation date, user location, and timezone. Data preprocessing involved trimming and normalizing text fields, handling missing values by replacing null entries in the "negativereason" column with the label "Other," converting variables to appropriate data types, and removing records with missing airline names or sentiment labels. Additional features were engineered to enrich the dataset, such as extracting the date, hour, and weekday from the timestamp of each tweet, as well as creating a numeric sentiment score (positive = 1, neutral = 0, negative = –1). To reduce the effect of outliers, retweet counts above the 99th percentile were capped. The cleaned and enriched dataset was then loaded into *Power BI*, where interactive dashboards were developed to visualize key insights, including the distribution of sentiments across airlines, reasons for negative feedback, temporal sentiment trends, and geographical patterns of consumer opinions. This methodology ensured that unstructured social media data was transformed into a structured and reliable dataset, enabling meaningful analysis and the generation of actionable consumer insights through BI tools.

4 Results

The analysis of the Airline Sentiment dataset provides several insights into consumer behavior on social media.
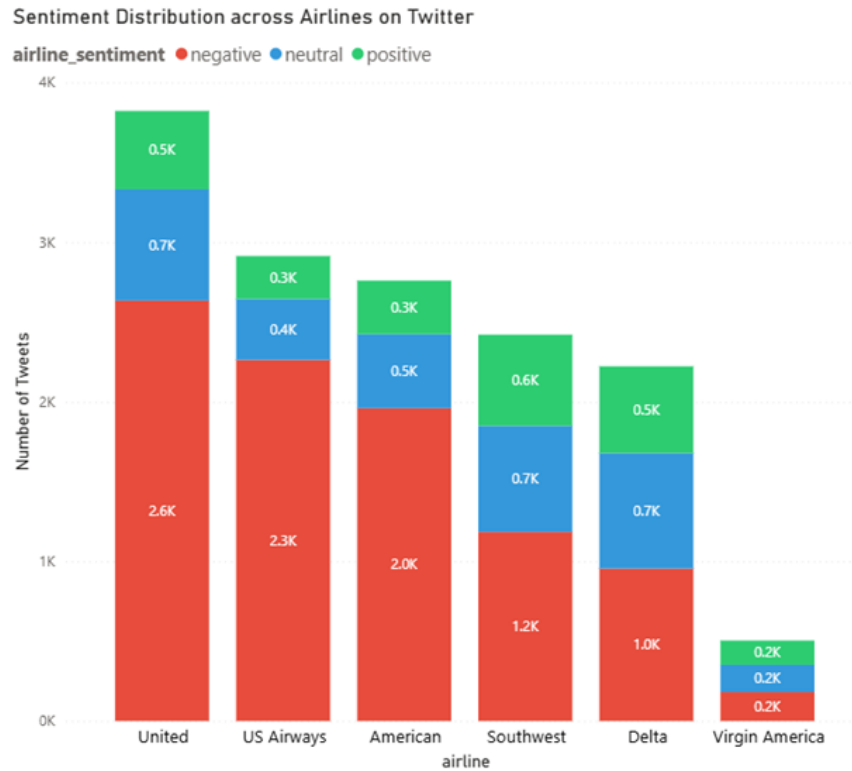

Figure 1: Distribution of consumer sentiment across airlines

First, the overall distribution of sentiments across airlines (Figure 1) shows a strong dominance of negative feedback. United, US Airways, and American Airlines receive the largest number of negative tweets, while Southwest and Delta show relatively fewer complaints. Virgin America has the smallest number of tweets overall, but still displays a mix of positive and negative sentiments.

Figure 2: Overall sentiment indicators showing proportions of positive, neutral, and negative tweets

The overall indicators (Figure 2) confirm this trend: out of more than 15,000 tweets, 63% are negative, 21% are neutral, and only 16% are positive. This suggests that consumer experiences with airlines on Twitter are largely framed by dissatisfaction and complaints.
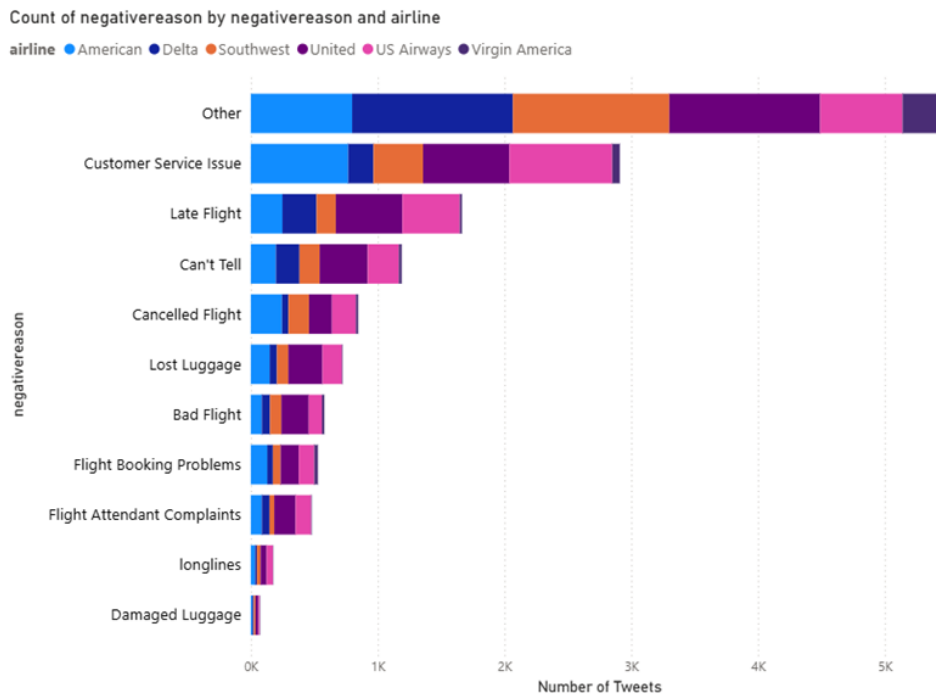

Figure 3: Main reasons for negative sentiment in consumer tweets

A closer look at the reasons for negative feedback (Figure 3) reveals that **customer service issues** and **late flights** are the most common sources of complaints, followed by cancellations and lost luggage. These findings highlight operational and service-related challenges as major drivers of negative consumer sentiment.
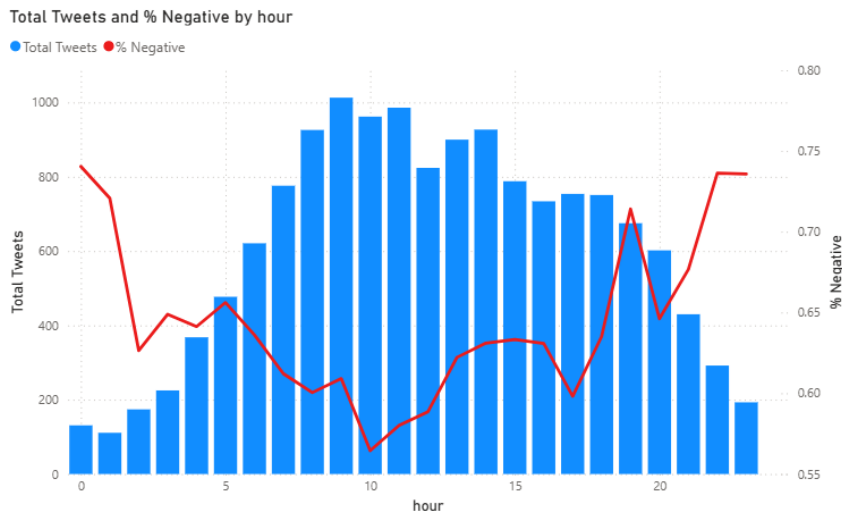

Figure 4: Main reasons for negative sentiment in consumer tweets

Temporal analysis also provides important insights. As shown in Figure 4, the total number of tweets increases throughout the day, peaking between 9:00 and 11:00. Negative sentiment is most prevalent in early mornings and late evenings, suggesting that passengers are more likely to express frustration during off-peak travel hours. A similar pattern can be observed in the comparison of positive and negative sentiment percentages by hour (not shown), where positive tweets rise during late mornings and afternoons, while negative tweets dominate early mornings and nights.

weekday	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
Friday	7	10	16	12	27	56	90	97	111	103	92	96	65	94	91	80	82	71	88	62	58	43	33	16	1500
Monday	38	32	39	56	95	119	149	164	173	189	219	245	203	201	166	148	125	90	125	121	136	86	67	46	3032
Saturday	7	7	29	20	30	40	43	64	70	72	78	84	116	110	103	92	64	92	96	107	80	84	49	20	1557
Sunday	27	17	22	31	46	90	92	116	130	97	108	100	197	229	273	225	209	277	225	175	152	92	84	65	3079
Thursday	5	4	22	19	45	27	51	117	93	81	82	92	62	62	81	68	87	61	64	78	69	56	25	25	1376
Tuesday	32	27	37	65	95	97	121	147	248	379	311	295	105	116	122	96	82	90	86	72	60	35	19	15	2752
Wednesday	15	14	9	22	30	48	75	71	101	92	72	74	76	88	91	79	85	73	67	60	47	34	15	6	1344
Total	131	111	174	225	368	477	621	776	926	1013	962	986	824	900	927	788	734	754	751	675	602	430	292	193	14640

Figure 5: Weekly and hourly distribution of consumer sentiment on Twitter

Finally, the weekly and hourly distribution of tweets (Figure 5) shows that consumer engagement is highest on Mondays and Tuesdays, with activity concentrated in morning working hours. Sundays also record a high volume of tweets, reflecting significant consumer interaction at the beginning and end of the week.

Overall, the results demonstrate that social media analytics combined with BI dashboards can reveal not only the **intensity of consumer dissatisfaction**, but also the **specific causes** and **temporal patterns** of negative sentiment. These findings provide actionable insights for airlines seeking to improve service quality and customer experience.

5   Discussion and Managerial Implications

The findings of this study reveal that negative sentiment dominates consumer discussions about U.S. airlines on Twitter, with United, American, and US Airways receiving the highest proportion of complaints. One possible explanation is the size of their customer base: larger airlines naturally attract more feedback, which may increase the number of negative comments. Another contributing factor may be operational issues such as frequent delays, cancellations, or perceived weaknesses in customer service. These patterns are consistent with previous studies that emphasized how customer service quality and service disruptions are central drivers of consumer dissatisfaction (Rustam et al., 2020; Barakat et al., 2021).

From a managerial perspective, the analysis provides clear implications. Airlines experiencing high levels of negative sentiment should prioritize improving customer service, for example by strengthening online support channels and providing faster responses to complaints. Addressing operational challenges, particularly delays and cancellations, is also crucial, since these emerged as the most frequent reasons for dissatisfaction. The temporal analysis further suggests that airlines could allocate additional resources to customer support during early morning and late evening hours, when negative sentiment peaks.

These results not only align with earlier research on the importance of sentiment analysis for understanding consumer behavior (Liu, 2012; Hu et al., 2022), but also reinforce the role of BI dashboards in supporting data-driven decision-making (Gonçalves et al., 2023; Malawani et al., 2025). Unlike prior studies that treated sentiment analysis and BI separately, this research demonstrates the value of combining the two approaches in a practical framework. By integrating social media analytics with BI visualization, airlines can both monitor consumer opinions in real time and convert them into actionable insights, thereby bridging the gap highlighted in the literature

6   Conclusion

This study demonstrates the effectiveness of combining sentiment analysis with BI tools to analyze consumer behavior on social media, revealing a predominance of negative sentiments in U.S. airline discussions driven by customer service and operational issues. The integrated framework offers actionable insights for improving customer experience and supporting strategic decision-making. Future research could explore real-time multi-platform analysis and advanced NLP models to enhance accuracy. Practically, businesses should adopt similar approaches to leverage social media data for competitive advantage.

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Appendix

The complete project implementation, along with related documentation, is available in the GitHub repository below:

`https://github.com/Zohreh004/Management-of-Information-Systems-Implementation-Project`