

Sentiment Analysis and Topic Modeling for Public Perceptions of Air Travel: COVID Issues and Policy Amendments

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Abstract

Among many industries, air travel is impacted by the COVID pandemic. Airlines and airports rely on public sector information to enforce guidelines for ensuring health and safety of travelers. Such guidelines can be policy amendments or laws during the pandemic. In response to the inception of COVID preventive policies, travelers have exercised freedom of expression via the avenue of online reviews. This avenue facilitates voicing public concern while anonymizing / concealing user identity as needed. It is important to assess opinions on policy amendments to ensure transparency and openness, while also preserving confidentiality and ethics. Hence, this study leverages data science to analyze, with identity protection, the online reviews of airlines and airports since 2017, considering impacts of COVID issues and relevant policy amendments since 2020. Supervised learning with VADER sentiment analysis is deployed to predict changes in opinion from 2017 to date. Unsupervised learning with LDA topic modeling is employed to discover air travelers' major areas of concern before and after the pandemic. This study reveals that COVID policies have worsened public perceptions of air travel and aroused notable new concerns, affecting economics, environment and health.

Keywords: Anonymization, Coronavirus, Freedom of Expression, Global Policy, Online Reviews, Transparency

1. Introduction

The COVID pandemic continues to be a great disruptor to many industries, including air travel. In a global health crisis, people expect public sector organizations to provide information that can be used to create policies and laws to ensure the protection and safety of people across all industries and institutions. During the COVID pandemic, public health organizations, e.g. Centers for Disease Control and Prevention (CDC, 2022), and World Health Organization (WHO, 2022) enforced policies such as mask wearing, COVID testing and social distancing, to help prevent the spread of the virus (TSA, 2022). Doing so consequently changed the process of air travel. In an unprecedented situation such as a pandemic, it is important to rely on the public sector for guidance. It is equally important for people affected by these changes to freely express their own opinions on implementation of new policies to ensure transparency, maintaining anonymity as needed.

As travelers are poised to keep up with the latest COVID preventative guidelines, they must comply with the protective measures deemed appropriate by their location of departure, destination and air carrier. Consequently, while flying during the pandemic and its immediate aftermath, travelers have voiced their experiences online via reviews, anonymizing or concealing their own identity if needed. Our study therefore aims to explore the impact of COVID related policy amendments on the public perceptions of air travel, while protecting user identity and preserving ethical issues. We investigate how travelers' perceptions have changed since March 2020 and

comprehend the concerns that have increased and emerged ever since preventative measures have been executed via public sector information. In this process, we deploy publicly accessible sources to collect data (e.g. TripAdvisor), however, the user identities are not revealed in our work to protect their privacy.

2. Related Work

The significance of mass opinion is highlighted in numerous studies that cater to public policy, some of which pertain to work in our own research teams. This is surveyed in a recent paper addressing its importance in various environmental issues (Du et al., 2019). It is emphasized in smart governance through mining ordinances and their public reactions (Puri et al., 2022, Puri et al., 2018). It is discussed in work on sentiment analysis for partially labeled data (Gandhe et al., 2018). Additionally, it mentioned in some studies on policy related areas such as hydro-informatics (Pathak et al., 2020). It is a subject of research in work on air quality assessment (Du et al., 2016). Moreover, it is evident from work in infrastructure improvements relevant to social sciences (Wieczerek et al., 2022). While implementing policy amendments and laws during a health crisis, public opinion is a primary constraint (Treloar and Fraser, 2007). Needle and syringe programs have prevailed in the public sector in Australia to battle the opioid epidemic. Failure to consider public opinion in releasing information about these programs has led to instances of hasty political response, thereby evoking negative public reaction, and often causing chaos.

The COVID pandemic has resulted in rapidly evolving and sometimes, contradictory public policies (Sheluchin et al., 2020). The public health sector has put forth policies throughout the pandemic and then had a change of heart. For example, public health agencies in both the U.S. and Canada have revised guidance on the utility of masks. In 2020, a research study gauging public response to the mask usage reversal laws in Canada revealed that throughout the tumultuous changes in policy, It is noticed that Canadians have remained compliant with the guidelines of their country.

According to a recently published case study, Italian air travelers flying during the COVID pandemic have been increasingly more concerned about the compensations, cancellations than the coronavirus itself (Piccinelli et al., 2021). As per this analysis, travelers' feelings have been mixed and unpredictable. Many air travelers have become apprehensive with the irregularity of flights and have swarmed to online platforms to express their concerns.

3. Data

In order to gather traveler insights, data is generated from online reviews of airlines and airports from June 2017 until March 2022. The airlines being reviewed in our data are Delta Airlines, American Airlines and Southwest Airlines, which are the top three most flown airlines in the United States (Salas, 2022). Since this study only focuses on English-language data, airport reviews come from the United States, Canada and the United Kingdom. These reviews are obtained from TripAdvisor.com and AirlineEquality.com using a web-scraping tool built from the Selenium web driver library in python (Selenium, 2022). These websites are chosen because they both serve as focused platforms which allow travelers to connect and share travel related experiences through reviews and comments.

The total number of reviews obtained in this study is 17,145. There are 164 reviews from 2017; 577 from 2018; 5965 from 2019; 5437 from 2020; 4321 from 2021; and 681 from 2022. Figure 1 presents some snapshots from reviews on TripAdvisor.

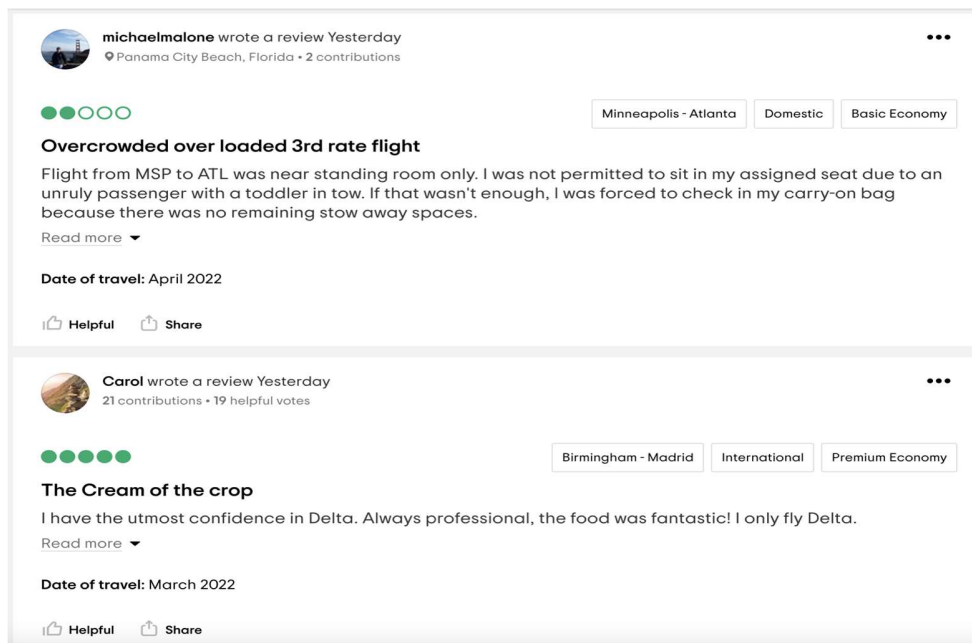


Figure 1: Sample reviews from TripAdvisor.com

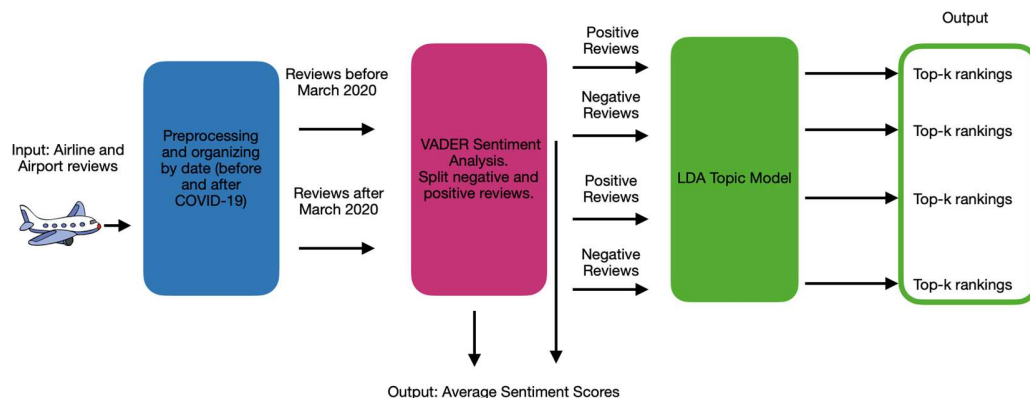


Figure 2: Proposed approach for the study

4. Methods

After data collection, the first step in our study is to organize the data into temporal categories. Using the “pandas” library in Python, reviews are categorized as: “before COVID” / “after COVID” and placed into respective csv files. For the purposes of this study, March 15, 2020 denotes the beginning of the pandemic period since it is the start date of the CDC implementing its policies.

The natural language toolkit (nltk) library of Python helps to preprocess text in our review data. In the preprocessing stage, non-character text such as punctuation, emojis and stop words are removed. This is because stop words do not contribute any significant meaning to the text as a whole in this context. While emojis and punctuations may at times convey sentiment, that is often expressed through the terms in the text itself, especially in online reviews on platforms such as TripAdvisor that tend to be somewhat more formal (as opposed to informal posts on Twitter and Facebook).

As a next step, suitable n-grams in the text are processed, i.e. clusters of n number of words that have a singular meaning when grouped together, such as “customer service” and “social distancing”. Thereafter, an analysis of the preprocessed data occurs. This entails two methods widely used in data science and linguistics studies, i.e. sentiment analysis, and topic modeling.

The supervised learning method of sentiment analysis is useful in this work because it helps to gauge the opinions of the travelers, thus enabling the prediction of future reactions on similar policies, and hence guiding decision-making by leveraging transparency and openness. In order to perform sentiment analysis,

VADER: Valence Aware Dictionary and Sentiment Reasoner (Hutto and Gilbert, 2014) is used which is included in Python’s nltk library. This provides a numerical sentiment score to each review, -1 being the most negative a review can be and +1 being the most positive a review can be. The average sentiment score is calculated for reviews before and after COVID in order to ensure that the change in public opinion of air travel is observable.

Furthermore, in order to extract and highlight the major areas of concern expressed by various air travelers, the unsupervised learning method of topic modeling is useful. We harness LDA: Latent Dirichlet Allocation (Blei et al., 2003) for this purpose. LDA topic modeling uses statistical methods to group related words in a document together to create “topics” discussed in the document. We consider four different categories of reviews, separated based on sentiment score. These are: positive reviews before COVID, negative reviews before COVID, positive reviews after COVID and negative reviews after COVID.

A coherence score is calculated to determine how many topics should be generated for each review category to provide the most coherent and readable information. This topic modeling thereby helps to rank topics of interest based on the most significant to least significant ones that arouse concern among air travelers. It is yet another means to comprehend their reactions, to support future decision-making while shaping public sector policies, incorporating user involvement via transparency.

Based on this discussion, the algorithm proposed in this study for sentiment analysis and topic modeling is outlined next as a pseudocode in Algorithm 1. This is implemented into our program and is used to conduct

experiments, with a summary of the results presented in the following section.

Algorithm 1: Sentiment Analysis, Topic Modeling for Reviews

```

READ Review_Data
FOREACH review
IF review date is after "3-15-2020"
THEN Add review to After_Covid
ELSE Add review to Before_Covid

FOREACH review in After_Covid
COMPUTE Avg_Sent_Score
IF Avg_Sent_Score > 0.7
THEN Add review to Pos_After_Covid
ELSE Add review to Neg_After_Covid
FOREACH review in Before_Covid
COMPUTE Avg_Sent_Score
IF Avg_Sent_Score > 0.7
THEN Add review to Pos_Before_Covid
ELSE Add review to Neg_Before_Covid
OUTPUT Avg_Sent_Scores

SET categories: Pos_After_Covid, Neg_After_Covid, Pos_Before_Covid, Neg_Before_Covid
FOREACH category
COMPUTE topic model using LDA
SET value of k
OUTPUT top-k rankings
  
```

5. Results

The sentiment analysis reveals that ever since COVID policies have been in place through organizations such as the CDC and the WHO, public perceptions of air travel have become increasingly more negative. The results also indicate that this negative shift in public opinion is greater in airline reviews than airport reviews. Figures 3 and 4 present a summary of the sentiment analysis outcomes.

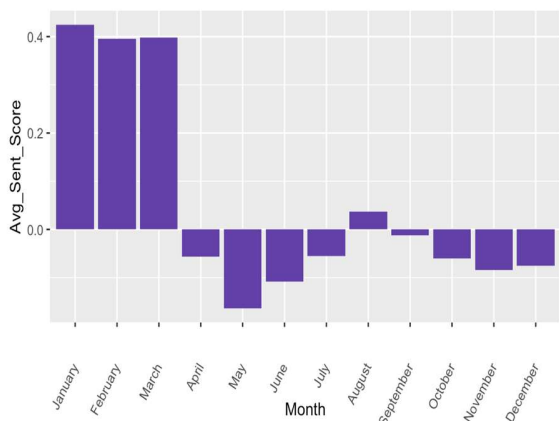


Figure 3: Change in Average Sentiment Scores over all the 12 months in 2020

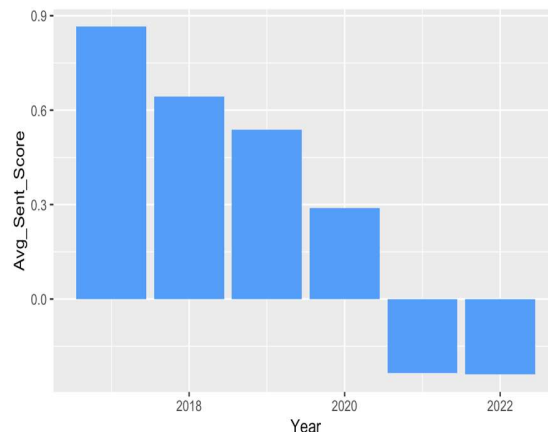


Figure 4: Change in Average Sentiment Scores all across the years 2017-2022

According to the topic models generated, air travelers' greatest areas of concern before the pandemic are: waiting time, customer service quality, and unexpected changes (e.g. flight rescheduling / seat alterations). After the pandemic, all these concerns persist. New concerns emerging are: mask mandates enforced unprofessionally by airline and airport staff, COVID guidelines poorly followed in airports, and COVID related measures being lackluster on airplanes. Accordingly, considering the value of $k=30$, Figures 5 to 8 synopsize the topic modeling results. Other such results are obtained for different k values.

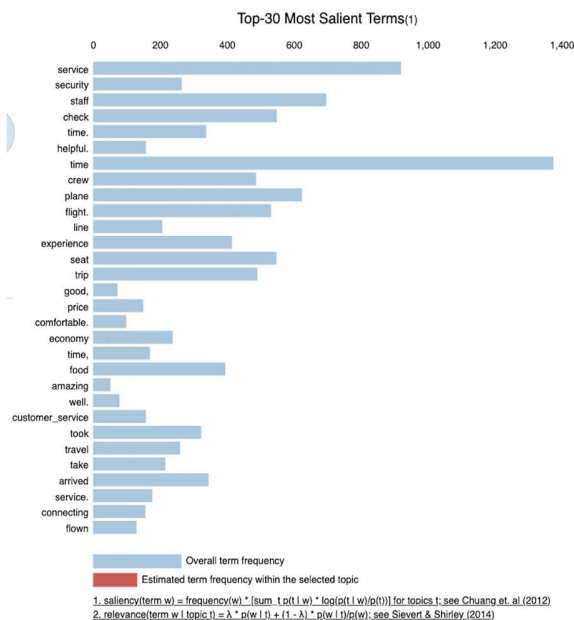


Figure 5: Top-k rankings of topic modeling for positive reviews before March 2020

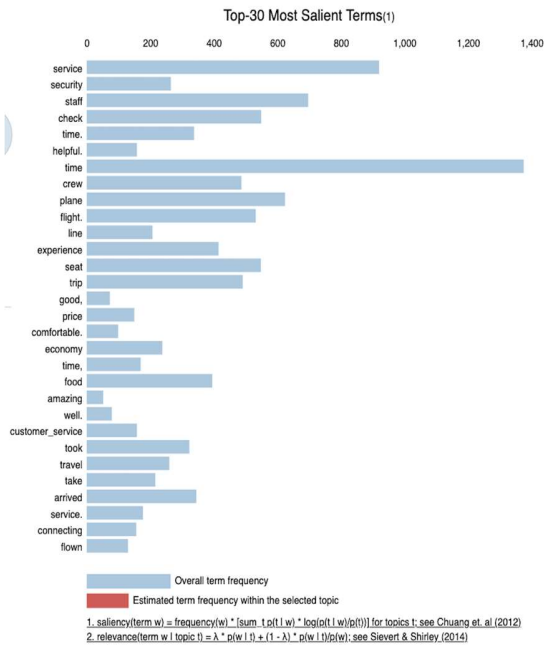


Figure 6: Top-k rankings of topic modeling for positive reviews after March 2020

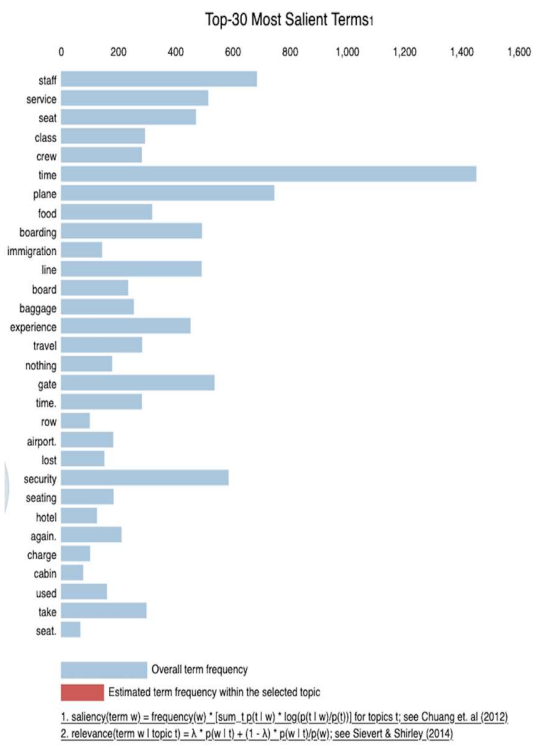


Figure 7: Top-k rankings of topic modeling for negative reviews before March 2020

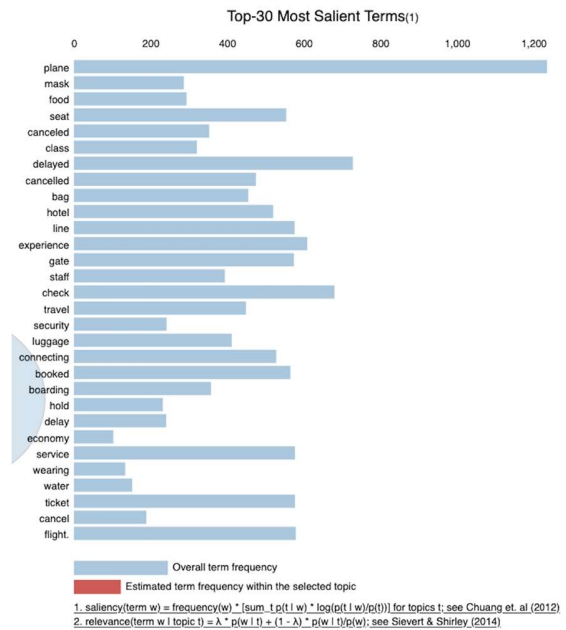


Figure 8: Top-k rankings of topic modeling for negative reviews after March 2020

We present Word Cloud visualizations about these reviews in Figures 9 to 12. Overall, our results indicate that the implementation of new COVID preventive policies from public sector organizations are adding to the potential concerns of air travelers.



Figure 9: Word cloud for positive reviews before March 2020

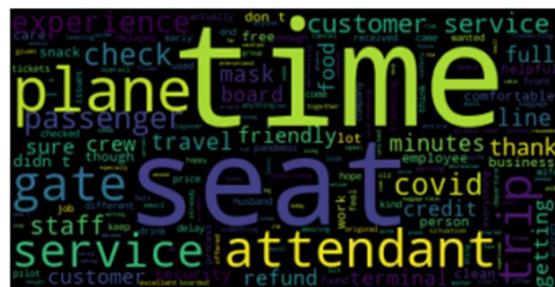


Figure 10: Word cloud for positive reviews after March 2020

Learning for Recommender Applications, *IEEE Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON)*, pp. 57-63.

Hutto, C., and Gilbert, E. (2014), Vader: A parsimonious rule-based model for sentiment analysis of social media text. *AAAI conference on web and social media*, Vol. 8, No. 1, pp. 216-225.

Piccinelli, S., Moro, S., and Rita, P. (2021), Air-travelers' concerns emerging from online comments during the COVID-19 Outbreak. *Tourism Management*, 85, 104313.
<https://doi.org/10.1016/j.tourman.2021.104313>

Pathak, D., Varde, A. S., De Melo, G., and Alo, C. (2020), Hydroinformatics and the web: Analytics and dissemination of hydrology data for climate change and sustainability. *ACM SIGWEB*, (Autumn Issue), 3:1-3:17.

Puri, M., Varde, A.S. and de Melo, G. (2022), Commonsense based text mining on urban policy. *Language Resources & Evaluation (LREV)*,
<https://doi.org/10.1007/s10579-022-09584-6>

Puri, M., Varde, A. S., and Dong, B. (2018), Pragmatics and semantics to connect specific local laws with public reactions. *IEEE International Conference on Big Data*, pp. 5433-5435.

Salas, E. B. (2022, March 11). U.S. Airline Industry Market Share 2019. Statista. Retrieved April 20, 2022, from
<https://www.statista.com/statistics/250577/domestic-market-share-of-leading-us-airlines/>

WebDriver. Selenium. (2022). Retrieved May 14, 2022, from
<https://www.selenium.dev/documentation/webdriver/>

Sheluchin, A., Johnston, R. M., and Van Der Linden, C. (2020), Public responses to policy reversals: The case of mask usage in Canada during COVID-19. *Canadian Public Policy*, 46(S2).
<https://doi.org/10.3138/cpp.2020-089>

Treloar, C., and Fraser, S. (2007), Public opinion on needle and syringe programmes: Avoiding assumptions for policy and Practice. *Drug and Alcohol Review*, 26(4), 355–361.
<https://doi.org/10.1080/09595230701373867>

TSA. (2022), Coronavirus (COVID-19) information. Coronavirus (COVID-19) information | *Transportation Security Administration*. Retrieved April 2022, from <https://www.tsa.gov/coronavirus>

WHO. (2022), COVID-19 Pandemic All Information, *World Health Organization*, Retrieved April 2022, from <https://www.who.int/>

Wieczerek, T., Lal, P., Witherell, B., and Oluoch, S. (2022), Public preferences for green infrastructure improvements in Northern New Jersey: A discrete choice experiment approach, *Springer Nature Social Sciences 2* (2), 1-20.