## GitHub and Links to Code

GitHub Link: <https://github.com/vibhuvanjari-Kellogg/MSDS422-Airlines-Project>

Link to Part 1 (EDA): <https://colab.research.google.com/drive/1e3BaBqnoDy3yb_xvaFqOZJYuhz_YEDMv?usp=sharing>

Link to Part 2 (NA Carrier Analysis): <https://colab.research.google.com/drive/1_itJ0k2WhjNTh1aKawhtxJn3zaLWCyQV?usp=sharing>

Link to Part 3 (Opportunity Analysis): <https://colab.research.google.com/drive/1A0AuW30CiUdbjBJzSzLt_p-6sO55sIc_?usp=sharing>

## Executive Summary

Taking the perspective of the CEO/CMO of United Airlines in August 2015 the goal is to explore how United Airlines can catch up with its competitors in North America and improve its customer experience.

## Problem Statement

### Background and Goal

At the time of the case, North American legacy airlines had the lowest overall rating scores across other airline categories (Asian full service, European full service, Premium international and ultra-low-cost carriers). Within this category of North American legacy airlines United has the lowest average overall rating score among its counterparts. For the purposes of this analysis its NA legacy counterparts are assumed to be Air Canada, Alaska Airlines, American Airlines, Delta Airlines, Jet Blue Airlines and Southwest Airlines. United’s overall rating score is 3.36 compared to the group average of 4.84 out of 10.

As the CEO/CMO of United Airlines, I am always trying to improve customer experience which is quantified through the overall rating and the percentage of customers who recommend United Airlines. Of course, some drivers are more expensive to improve than the others, this is out of the scope of this analysis. The goal is to compare various avenues of improving the experience and then determining which is best path forward and where the effect on recommendations and overall rating improve the most.

### About the Dataset

The data was extracted from Skytrax Reviews and has been discussed in previous articles and research. The Skytrax Airline Reviews dataset is derived from passenger-submitted reviews hosted on [Skytrax](https://www.airlinequality.com/), a globally recognized authority in airline and airport service quality. Skytrax is best known for its annual World Airline Awards and comprehensive airline ranking system, which are widely referenced by the aviation industry and travelers alike. The dataset captures detailed customer experiences including overall satisfaction ratings, sub-ratings for service elements like seat comfort, food, and staff, and free-text reviews. Each entry typically includes the reviewer's country, travel route, aircraft type, cabin class, and whether they would recommend the airline. Reviews are self-reported and voluntarily submitted on the Skytrax platform, providing a diverse and organic view of global air travel experiences. The dataset was created by scraping all user reviews found on Skytrax at the time.

In this analysis data from the airline reviews file was used as found [here](https://github.com/quankiquanki/skytrax-reviews-dataset) and [here](https://www.kaggle.com/datasets/austinpeck/skytrax-reviews-dataset-august-2nd-2015/data).

### Potential Exploration Questions

* Do different ratings impact overall ratings for different airlines or different airline types?
* Which ratings improve the overall ratings the most? Is there a need to focus on a specific customer type?
* How does different travel classes change the passengers expectations for the trip?
* What predicts the overall rating in specific airline type? For example do different factors impact overall ratings of luxury airlines vs low cost carriers?
* What can we learn from other airline types?
* What do we need to improve to get on par with other airlines in United’s category?
* Do passengers from different regions speak up more, have different expectations? Are airlines in different regions truly different in quality?

## Exploratory Data Analysis

Upon initial EDA, it was clear there was a lot of missing data. Critical information like route details were also missing for most entries. Ratings for various customer experience levers were not consistently filled. Ground service ratings and Wifi/connectivity ratings were barely available.

### Feature Creation

* *year*: Feature *date* was split into *year*, *month* and *day*. Most important to the analysis was extracting *year* information as it is best to only consider the most recent data when making strategic decisions for United.
* *airline\_type*: The dataset contained a list of 362 different airlines, to make the analysis more meaningful to explain to the team it made sense to focus on airlines with many reviews (most popular airlines) and specifically group them into different categories. The categories selected for this analysis were:
  + *ulcc*: ultra low cost carriers (ex: Spirit Airlines)
  + *na\_legacy*: North American legacy carriers (ex: United)
  + *premium\_international*: Premium carriers with world-wide coverage (ex: Qatar Airways)
  + *european\_full\_service*: Airlines with extensive coverage of Europe (ex: British Airways)
  + *asian\_full\_service*: Airlines with extensive coverage of various regions of Asia (ex: Asiana Airlines)

Figure 1 shows how overall\_quality varies based on the different airline types highlighted above.

* *100pluscount*: This variable is set to 1 if an airline has more than a 100 reviews, indicating the most popular airlines
* *author\_region* and *author\_subregion*: While the variable author\_country provided exact data on where the review’s author, aka the passenger, is from it was too granular to use in understanding the data. To generalize information further these additional variables were created.

Figure 2 shows the breakdown of passenger regions and subregions and Figure 3 shows how ratings for *overall* differs by subregion. It’s interesting to note that North American passengers have the lowest mean and median ratings across all passengers. Is this because they are harsher or because standards are higher?

* Finding *origin* and *destination* information: There are two features from which origin and destination information can be extracted. The *route* feature provides information that can be easily parsed. However, most entries do not provide this information and those who do input it differently. For example, using airport name abbreviations vs city names. This makes this feature hard to work with. The other feature that was considered is the *content* feature. This feature is the review the author/passenger submitted about the airline to Skytrax. Some submissions include origin and destination information, however to each author writes their review differently so the use of an LLM is necessary. A partially successful attempt to extract this information was done using Google Gemini, however restrictions on run limits per minute and run limits per day made this unusable for a large dataset. Ultimately, the ideal final product would be to create additional features to indicate number of layovers and a boolean to indicate whether a route was international or domestic could be helpful to identify how ratings were different.

### EDA focused on NA Legacy Airlines

Filtering down further from the top 100 carriers and reviews since 2010 to also focus on just the NA legacy airlines. It’s surprising to see that United not only ranks the lowest in the *overall* but also across almost all the other rating categories. The magnitude that it misses the mark by across the board is also similar across different ratings. From this it is clear a lot of improvement is needed everywhere. But realistically, it makes sense to focus on a few categories that provide the largest uplift to the overall\_rating.

Figure 4 showcases how the different NA legacy airlines compare across ratings with each other.

Next to see if there were regional differences in customer in how they rated United Airlines customers a comparison was done comparing United Airlines ratings across passenger regions and all NA legacy carriers ratings across passenger regions. From this analysis ratings from Africa and South America could not be considered because the customer count for United was too small. United performed poorly with customers in all the remaining regions (Asia, Europe, North America and Oceania) across all rating categories.

Asian customers particularly were not impressed by United’s seat comfort, cabin staff, food and beverages as well as inflight entertainment. Europeans rated United slightly lower in all categories. North Americans found that cabin staff and food and beverages were particularly worse compared to other carriers and those from Oceania had the biggest issues also with cabin staff. The differences between average passenger ratings for United vs all NA legacy carriers is shown in Figure 5. The larger negative values indicate the biggest gaps and areas of improvement needed. I think it can also be assumed that passengers using United from not North America can broadly be considered travelling internationally. This analysis also shows for a need for improvement specifically in flights from Asia or services Asian customers would appreciate. It’s also interesting to see Asian ratings across airlines to be the highest (see Figure 3), this indicates that Asians may expect a higher quality of service from NA Legacy carriers considering the higher standards at home set by the Asian Full Service carriers and others.

### Methodology – Regression Analyses

Considering the nature of the task – improving an airlines operation, it was critical that the findings be interpretable. For this reason, regression analyses were the best option to proceed forward. While, random forests or neural networks would like be better for a prediction task such as “what would a customer with characteristics x, y and z rate United Airlines”, for the question “what do we need to improve to increase the ratings of United”, it didn’t make sense to go that route.

A strong relationship between overall ratings and whether a passenger recommends an airline was also found (see Figure 7). These two factors went hand in hand. Nearly every customer who had an overall experience between 7-10 recommended the airline they chose for their journey. Conversely, nearly everyone who rated their overall experience between 1-4 did not.

### Factors that impact Overall Rating

Initial analysis was done using a correlation matrix (Figure 6) to understand how all the ratings impacted the overall rating. Further analysis was done on *na\_legacy* carriers dataset to understand what predicted *overall* rating (see Figure 8). The base case in the regression analysis was United airlines, North American customers flying in economy class.

Insights from regression analysis:

* Overall, the regression was statistically significant and generalized well, there were no major autocorrelation issues.
* Value of money, cabin staff, seat comfort and food/beverage ratings were all statistically significant predictors of overall rating. The regression output helps determine what moves the needle the most.
  + Value of money (coefficient 1.2) is 2x more important than cabin staff (coefficient 0.5), and 4x more important than seat comfort (coefficient 0.3)
* Asian and Oceanic origin passengers tended to rate the experience higher by 0.2-0.3 points (out of 10) on average. This highlights possible regions to expand into in order to improve overall ratings or possibly customer segments to market towards.
* Air Canada, Alaska Airlines, Delta Airlines and Southwest Airlines tended to have a higher rating than United Airlines. Coefficients ranged from 0.6 for Southwest Airlines to 0.2 for Air Canada. Considering that this was a regression output, this means that controlling for all other tangible factors the perception of United Airlines was weak and needed to be improved with respect to competition.

### Factors that impact Recommendations

Like the analysis for Overall Rating, a logistic regression analysis was done to determine what factors increase the probability of someone recommending an airline (see Figure 9).

* Again, value of money, cabin staff and seat comfort were the best predictors of whether someone recommended an airline. The ordering was like the above and once again significant p-values.
* First class passengers were significantly likely to recommend the experience.
* While Asian-origin customers were once again “easy” customers (more likely to recommend) whether, Oceanic customers were is hard to say due to insignificant p-values. However, South American customers were likely to recommend the airlines, opening another potential market to consider.
* Similar to the above, customers were significantly more likely to recommend Air Canada, Alaska Airlines, Delta Airlines and Southwest Airlines than recommend United.

### Summary of top 3 opportunities for United to Consider

1. Avenues to improve the customer ratings and perceptions with regards to value of money, cabin staff and seat comfort.
2. Route expansion opportunities into Asia, Oceania and South America, as well as targeted marketing to people of origin from these regions.
3. Opportunities with First Class passengers, such as increasing routes or loyalty programs.

The perception of United with respect to other competitors is a harder issue to tackle and might require years of quality service to change. Improvements through the above avenues might lead to changes in perception down the line and close the gap between United and its competitors.

The next step is to explore if any of these opportunities are viable for United by comparing them to other competitors and seeing where the largest gaps to improve lie.

### Boost the airline through rating improvements

Analysis included revisiting Table 4 to understand how United’s ratings compared to the NA average as well as the leader in each rating category.

* Value money rating – United sits 0.5 points below the average and 1.2 points below the leaders Jet Blue and Southwest Airlines.
* Cabin staff rating – United sits 0.5 points below the average and 1.2 points below the leader Alaska Airlines.
* Seat comfort rating – United sits 0.4 points below the average and 1.3 points below the leader Jet Blue.

There seems to be opportunities to improve in any of these rating categories but considering the regression coefficients again value money should be prioritized.

#### Value of money rating

Breaking down the rating further by cabin groups (see Figure 10) revealed a similar pattern, United does poorly in all categories compared to the average of all NA airlines. However, the difference is most prominent in Business Class and Economy. This could potentially indicate overpricing of tickets for these categories or delivery of lower value for the pricing.

#### Cabin staff rating

Doing a similar analysis breaking down cabin staff ratings by cabin groups (see Figure 11) revealed that while United does particularly poorly across the board, the starkest difference seems to comes in the First Class category, where all the other airlines significantly outperform United. Even American Airlines, one of United’s biggest competitors that falls at the end of the pack with United, significantly outperforms when it comes to how First Class passengers rate cabin staff (0.8 point difference). This also ties into the third opportunity of improving the First Class experience as they are a big proponent of the airline they choose to travel with.

#### Seat comfort rating

A similar breakdown was also done for Seat comfort rating, no new significant findings came out of it, except that United performed better than the average in the Premium Economy category. However, this is likely not the best target segment to focus on considering the negative correlation coefficients this segment has with overall ratings and recommendations (see Figure 8 and 9).

### Boost the airline through international route expansions and targeting people of specific origins

It’s unclear whether the passenger origin correlates with the route they are travelling. Unfortunately, without data on origin and destination information that could be challenging to determine. Based on limited data and manually reading through route information there seems to be a strong pattern. Under the assumption that increasing routes to different international destinations increases the number of passengers from those origins, analyzing passenger origin data can be helpful. For the following analysis, origin information of the author was taken as proxy for international routes provided by the airline.

Breaking down passenger origin data by NA airlines (see Figure 12) reveals that United is a leader international flights (or attracting international customers). The biggest opportunity here lies in taking share from American Airlines for South American routes.

### Final Recommendations

Two focused and final recommendations for the United team to visit can be concluded from this analysis.

1. Effort to improve the experience of First Class passengers primarily by driving cabin staff quality to be on par with the average north American carrier can go a long way. This improves not only the cabin staff rating but also the experience of First Class passengers who are strong proponents of the airlines they choose.
2. Effort to increase routes to South American destinations who are once again strong proponents of the airlines they choose.

In addition to these, efforts to drive value of money score higher across the board is critical to ensure United’s success going forward.

## Figures

A screenshot of a graph

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Figure 1: Comparison of overall\_quality across airline\_type

A screenshot of a computer screen

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Figure 2: Breakdown of passengers by author\_region and author\_subregion

A table with numbers and letters

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Figure 3: How overall\_rating varies by author\_subregion

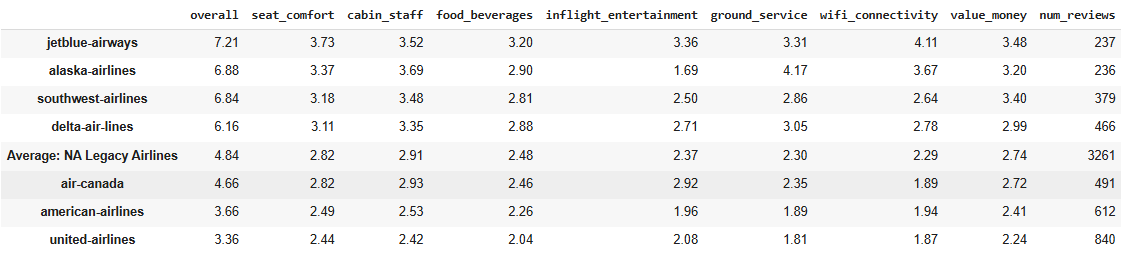


Figure 4: Comparison of various ratings across NA Legacy Carriers

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Figure 5: Delta between United and NA Legacy Carriers ratings across passengers by region

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Figure 6: Correlation matrix between different ratings

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Figure 7: Distribution of Overall Ratings by Recommendation

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Figure 8: Regression: factors that predict overall rating

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Figure 9: Regression: factors that influence recommendations

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Figure 10: Value of Money rating broken out by cabin groups

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Figure 11: Cabin Staff rating broken out by cabin groups

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Figure 12: Breakdown of each airlines’ share of various international destinations (%)