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**MMA 830**

**Pricing Analytics**

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**PRO Project Report – Airline Price Optimization**

**Due Date: December 06, 2022**

**Team Adelaide**

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**Airline Price Optimization**

**EXECUTIVE SUMMARY**

Global Airlines Market is expected to grow at a CAGR of 12.7% to reach US$744 Billion by 2026 whereas Passenger Airlines segment is projected to grow at a 15.2% CAGR to reach US$587.8 Billion. Airline industry worldwide, has reported significant losses as demand for air travel declined due to COVID 19 pandemic. In 2021, the situation seems to have improved a little and therefore airlines are expecting demand to increase. This is the time when airlines can restore their economic viability. For airlines to be profitable again, they need to maximize their profits while optimizing prices and charging the best price for each airline ticket. Pricing decisions can be highly time-consuming and cumbersome since each day and need adjustment depending on the demand. Most of the times, demand cannot be accurately determined[[1]](#footnote-1).

Our client, Canada Jetlines is the all-Canadian airline which is a value-focused leisure carrier providing air passengers another option to travel to their preferred destination for the best value possible[[2]](#footnote-2). Today, customers are prioritizing space requirements, entertainment, and service over buying a first or business class ticket. Our client currently uses static pricing to offer competitive pricing to its various customer segments**.** Fare structure is created using limited number of price points based on reservation booking designators. Each price point is developed for a specific customer segment and demand situation. Our client aims to provide competitive and affordable flight options to the Canadian market and beyond hence they have hired Team Adelaide to overhaul their current revenue management system. Our client has asked us to review its current pricing structure and develop at pricing model which would help in optimizing core ticket prices and maximizing its overall revenue. Leading airline players use linear, adaptive, and dynamic inventory pricing hence we’ll build revenue optimization model which will help our client select the best pricing strategy and maximize its ticketing revenue. Airline Pricing data for the existing players is confidential and hard to procure hence as part of our optimization engine, we would also build to demand model to test different pricing strategies. As per our model, dynamic pricing is the best fit for our client need since it generates the maximum average ticket price of $189 during the simulation period compared to $148 and $158 generated by Linear and Adaptive pricing.

**INTRODUCTION**

Airline industry has been severely impacted by the COVID-19 outbreak with lockdowns and other restrictions impacting air travel. The industry is expected to remain soft despite attempts to re-open economies across the world. As per updated airline industry outlook published by International Air Transport Association (IATA), financial performance of the industry is expected to improve as the pace of COVID-19 crisis recovery quickens in 2022. Financial losses are expected to reduce to -US$9.7 billion compared to previous forecast of -$11.6 billion with a net loss margin of -1.2%. North American market if expected to deliver US$8.8 billion profit in 2022. Losses are kept under control despite of rising labor and fuel costs by managing efficiency and improving yields. Air passengers are leveraging the benefits of reduced restriction and are flying in greater numbers. Despite of improvement in air travel there are still challenges around cost control and margin improvement.

Revenue has been a continuous pressure point for the airline industry hence price optimization is becoming one of the key focus areas for airlines looking to tie their business volume and revenue growth. Price optimization helps the aviation industry in improving overall customer satisfaction, creating a unique point of differentiation compared to competitors and achieving revenue growth. Core ticket prices change on a continuous basis and are impacted by various factors such as capacity, demand per route, probability of selling more tickets etc. Various pricing strategies such as long-term pricing and dynamic pricing are used by current players to determine the optimal ticket prices. Airlines need a deeper understanding of the market to maximize their revenue through price optimization.

As per statistics published by International Air Transport Association (IATA), in 2018 Aviation industry contributed $3.5 trillion USD to Global GDP and supported 87.7 million jobs. Europe, North America, and Asia passengers contributed to about 85% of all global air passengers followed by Latin America, Africa and Middle East. This showcases the immense opportunity for the airline industry in terms of optimizing price and maximizing revenue for the passenger segment[[3]](#footnote-3).

Global inflation rate has increased to 9.2% which has created affordability crisis from consumer. Customers are more price sensitive due to rising inflation. Global air passenger traffic is showing post pandemic recovery and expected to growth in the upcoming year hence presenting opportunity for aircraft carriers to gain market share by optimization their revenue management system. Global air passenger traffic is expected to reach US$8 billion by 2040 and domestic demand is expected to hit US$2.5 billion compared to international demand of US$2 billion providing another rationale for price optimization.

Prior to the pandemic Passenger revenue contributed to about 75% of overall revenue which dipped to around 49% during the pandemic and the industry is expected to hit pre-pandemic passenger revenue levels in the upcoming years. Historically, aviation industry has low margins and return on invested capital is lower than weighted average cost of capital hence pricing optimization can help airline industry improve its overall profitability.

**MODEL OVERVIEW**

Now let’s take a closer look at the problem that we have to solve for Canada Jetlines. The sale of tickets for any flight by Canada Jetlines starts 100 days before the flight’s takeoff date. Each of their flights has a capacity limit of 100 passengers. The task at hand is to decide the price of the tickets for each day in the given selling window. Through analysis of their own historical data, Canada Jetlines has also observed that their daily demand can be anywhere between 100 and 200 passengers with uniform probability.

The airline also found that the number of tickets they can sell on any given is represented by the demand function shown here: -

As we can see, the elasticity of the passengers towards the price is 1. The number of sales that happen on any day is subject to the demand observed on that day and the price of the ticket that we set for that day. So, by deciding the price, we can actually decide the number of tickets we are going to sell on that day. Thus, we must set prices in a way that we can manage the number of tickets we sell on high-demand and low-demand days. We also need to keep in mind the number of days remaining in the selling period, as we do not want to hold tickets when only a few days are remaining, as the demand for the remaining days is equally likely to be low. For simplicity, we have assumed that all the demand for the day is realized at the start of the day, so we know how many people are requesting a ticket when the day starts. We have also assumed that there are no network effects involved.

Finally, we use this information to price the tickets using the following three strategies: -

1. Linear
2. Adaptive
3. Dynamic

We tested the output of our strategies for the given selling period by running over 10,000 simulations to get a more accurate result.

**STRATEGY 1: LINEAR PRICING**

In linear pricing, we are just selling an equal number of tickets each day, which means, in our case, we are selling 1 ticket daily. We used this as a base strategy to get an idea of what the results are for a poor model. The equation for linear pricing is shown in *Appendix 9*.

**Pros: -**

Linear pricing is the easiest to implement as it just makes sure that we sell all the available seats.

**Cons: -**

This strategy has no flexibility to demand variations, the number of remaining seats or remaining days, or any other factors.

**STRATEGY 2: ADAPTIVE PRICING**

The adaptive pricing strategy is basically one where we try to adjust the ticket price according to the demand. Here, when the demand is high, we charge more, and when the demand is less, we charge less. To accomplish this, we multiplied the demand by a variable ‘adapt,’ and then we tried different values to find what is the best value to keep for the variable. We found the value to be 3. The equation for adaptive pricing is shown in *Appendix 11*.

**Pros: -**

This strategy is able to take advantage of demand fluctuations. We are pricing high to make more profits when the demand is high. On days when demand is low, we are pricing lower in order to maintain sales.

**Cons: -**

It only takes the current day’s demand into account. So, it does not account for factors such as days remaining or seats remaining. It also does not consider future demand. Thus, we might end up selling all the seats too early or not selling all the seats.

**STRATEGY 3: DYNAMIC PRICING**

Finally, we tried dynamic pricing for a multi-period pricing problem. This means that since we have been given a daily demand, we treat each day as a separate selling phase. And so, we dynamically set today’s price by considering the future expected value of the seats as well. The equation for dynamic pricing is shown in *Appendix 14*.

This means that given the number of days and the number of seats remaining for any particular day, we start by calculating the expected revenue for all the prices for the last day before the flight and then move backward till the current day.

*Appendix 17* shows the output of one of our simulation runs. We have only shown the first 10 days here. We can see that we are only selling when the demand is really high and are choosing to reserve the seats for later when the demand is low. *Appendix 18* shows us the expected revenue and the average ticket price for different selling periods. When we have more days to sell, we are able to sell more tickets and are able to charge more as well. Therefore, it is beneficial for the airline to start selling the tickets as early as possible.

**Pros: -**

Dynamic Pricing takes all the demand uncertainty into account, including that for future days. It tells us how many tickets to reserve for each future day and the price at which to sell them.

**Cons: -**

As more factors and uncertainties are added to the model, it becomes more complex. Thus, implementing this model might become computationally heavy and require much memory. Thus, this method can be costly.

**STRATEGY 3: DYNAMIC PRICING (2-day Selling Period)**

To better understand our dynamic pricing strategy, let’s assume that we have only 2 days to sell all the tickets. The algorithm will first start with the last day. Expected revenue is calculated for all the possible prices for a given demand level and seats left, and the maximum ER is stored along with its price. *Appendix 16* is a graph showing how the maximum expected revenue is related to the demand level and seats remaining. Next, similar steps are followed for the first day and a similar output is produced for this day. And finally, we select the prices which give the highest combined revenue.

**IMPLEMENTATION PLAN AND MODEL RESULTS**

We broke down our project implementation plan into three phases: model building, deployment, and continuous monitoring. Phase 1 – model building process is already done with the creation of three different pricing models: linear pricing, adaptive pricing, and dynamic pricing. As of now, we tested our models on only one airline and one seat class. Upon that, we simulated and optimized our model based on results.

During phase 2, we will further deploy our model to wider range of flights and seat classes across the company and implement a pricing strategy which could enhance the revenue for the entire company. We will also add customer profile data into our models, such as demographic data and purchase behavior, to better understand demand trends and seasonality; thus eventually, we are able to leverage this comprehensive pricing model to provide more financial value to the company.

Phase 3 would be the continuous improvement stage of our pricing strategy. During Phase 3, we will continuously monitor the model in real-time. We can track the relationship between demand, actualized revenue, and profit and compare it with our predicted value. We will further improve this pricing model by eliminating the result variance.

From our initial linear pricing model, the predicted revenue is $14,839, with an average ticket price at $148. By further implementing it with adaptive pricing method, our revenue increased slightly by $957 to $15,796, and average ticket price increased to $158. We realized huge improvement in revenue from our final pricing model, the dynamic pricing, which the predicted revenue increased by $2,782 to $18,578 total revenue, and the average ticket price increased by over thirty dollars to $189.

The dynamic pricing model generates most revenue as it captures real time fluctuation in demand, remaining tickets for sale, and provide instant feedback on pricing which best fit the market.

**ASSESSMENT OF POTENTIAL BENEFITS**

As seen from above results, the dynamic pricing strategies is beneficial to the company in terms of financial impact. The benefits and potential value of dynamic pricing can be reflected from several aspects. First, dynamic pricing model maximizes the profitability of the business because it provides an efficient venue for us to sell more and earn more. With the use of dynamic pricing, we could increase selling prices on the tickets when we see the demand have risen. By doing so, we could sell all available seats at their optimum prices at given demand level. With enhanced average ticket price, dynamic pricing has brought considerable growth in terms of total revenue, profit, and occupancy rate.

Post pandemic, we’ve seen strong signals of rising competition in the aviation industry to gain more customers and expand their market share. It gives carriers good enough reasons to not overcharge customers. However, to ensure healthy profit margin for our shareholders, we also need to be careful not to undercharge customers as well. Under dynamic pricing, as the prices are adjusted with responding to current demand level, customers can easily find a cheap price from us when demand is low. This helps us attract more customers, keep our competitiveness in the market, increase market shares, as well as solid our brand image as a company provides affordable price with great service.

Dynamic pricing also helps us initiating customer profile analysis by categorizing purpose of travel and price affordability as reflected from demand level. We can further improve our pricing model by leveraging customer profile data, which not only helps us better understand our customers, but also bring significant value for marketing strategies and campaign actions.

Last but not the least, dynamic pricing provides significant flexibility in our pricing strategies. We could modify our model easily to capture market fluctuation, and at the same time, dynamic pricing provides the freedom for us to focus on other aspects of business with the additional profit.

**RISKS AND NEXT STEPS**

With all the benefits and business values of our dynamic pricing model, we can’t deny that there are also some potential risks associated with it. First, our current dynamic pricing model did not take additional flight services into consideration, such as baggage allowance, in-flight meals, and wireless internet etc., which could also play a big role when customers are choosing their flights. As our next steps, we will quantify the value for each service, and build them into our model. We can also optimize our websites’ user experience, to highlight features and services provided, so that to attract more customers.

As of now, we’re only focusing on the dynamic demand for overall market but neglected its relationship with competitor’s prices, which in return may bring some bias to our model. When competitors are doing promotions on their flight prices, we may notice decreasing demand for our company, however the current model cannot identify what could be the root cause of declining demand. Thus, as part of our next steps, we will also add in a pricing tracking system over competitor’s prices. For any attributes that may cause price fluctuations, such as flight schedules, target customers, we will quantify the impact and build them into the model.

**TECHNICAL APPENDIX**

**Timeline, map

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Appendix 1: Aviation Industry by the numbers

**Chart, bar chart

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Appendix 2: Global Inflation Rate (2019 - 2022)

**Chart, line chart

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Appendix 3: Global Air Passenger Traffic (Historical and Predicted)

**Chart, line chart

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Appendix 4: Global Air Passengers in billions (Past and Future)

**Chart, histogram

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Appendix 5: Domestic and International Air Passengers (Historical and Predicted)

**Chart, bar chart

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Appendix 6: Airline Industry Revenue breakdown (2016 - 2021)

**Chart, line chart

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Appendix 8: Return from Capital Invested for Airlines Globally

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Appendix 9: Linear Pricing Model Equation

Chart, histogram

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Appendix 10: Expected Revenue for Linear Pricing Model

Text

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Appendix 11: Adaptive Pricing Model Equation

Chart, histogram

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Appendix 12: Expected Revenue for Adaptive Pricing Model (Adapt = 1)

Chart, line chart

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Appendix 13: Expected Revenue vs. Adapt value for Adaptive Pricing Model

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Appendix 14: Dynamic Pricing Model Equation

Chart, histogram

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Appendix 15: Expected Revenue for Dynamic Pricing Model

Chart, surface chart

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Appendix 16: Last Day Expected Revenue vs. Seats Left vs. Demand

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Day** | **Tickets Left** | **Demand** | **Price** | **Sales** |
| 1 | 100 | 163 | 163 | 0 |
| 2 | 100 | 160 | 160 | 0 |
| 3 | 100 | 187 | 183 | 4 |
| 4 | 96 | 185 | 182 | 3 |
| 5 | 93 | 102 | 102 | 0 |
| 6 | 93 | 163 | 163 | 0 |
| 7 | 93 | 101 | 101 | 0 |
| 8 | 93 | 168 | 168 | 0 |
| 9 | 93 | 148 | 148 | 0 |
| 10 | 93 | 159 | 159 | 0 |

Appendix 17: First 10-days Sales

|  |  |  |  |
| --- | --- | --- | --- |
| **Selling Duration** | **Revenue** | **Average Ticket Price** | **Tickets sold** |
| 2 | $12,731.00 | $137 | 92 |
| 3 | $13,779.00 | $149 | 92 |
| 4 | $14,389.38 | $155 | 92 |
| 5 | $14,824.37 | $159 | 93 |
| 6 | $15,161.71 | $162 | 93 |
| 7 | $15,435.36 | $165 | 93 |
| 8 | $15,664.12 | $167 | 93 |
| 9 | $15,859.95 | $168 | 94 |
| 10 | $16,029.65 | $170 | 94 |

Appendix 18: Revenue for different Selling Windows

Graphical user interface, text

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Appendix 19: Comparison of the model results

1. Research and Markets. (2022, June 28). *Global Airlines Market Report 2022: A severely battered aviation industry struggles to revive*. GlobeNewswire News Room. Retrieved December 5, 2022, from https://www.globenewswire.com/en/news-release/2022/06/28/2470107/28124/en/Global-Airlines-Market-Report-2022-A-Severely-Battered-Aviation-Industry-Struggles-to-Revive.html [↑](#footnote-ref-1)
2. Canada jetlines. (n.d.). Retrieved December 5, 2022, from https://www.jetlines.com/AboutUs [↑](#footnote-ref-2)
3. *Economic performance of the airline industry - IATA*. (n.d.). Retrieved December 5, 2022, from https://www.iata.org/en/iata-repository/publications/economic-reports/airline-industry-economic-performance---october-2021---report/ [↑](#footnote-ref-3)