

# **AIRLINES DATA ANALYTICS FOR AVIATION INDUSTRY**

## **Data Science and Analytics In Aviation:**

**Authors: Sai-Ho-Chung,Hoi-Lam-ma**

The researcher in this article cited that, Due to the rapid development of advanced technologies nowadays, a massive amount of real time data regarding flight information, flight performance, airport conditions, air traffic conditions, weather, ticket prices, passengers comments, crew comments, etc., are all available from a diverse set of sources, including flight performance monitoring systems, operational systems of airlines and airports, and social media platforms. Development of data analytics in aviation and related applications is also growing rapidly. This paper concisely examines data science and analytics in aviation studies in several critical areas, namely big data analysis, air transport network management, forecasting, and machine learning. The papers featured in this special issue are also introduced and reviewed, and future directions for data science and analytics in aviation are discussed.

## **Data Analytics for Air Travel Data:**

**Authors:Haiman Tian,Yudong Tao**

The researcher in this article cited that, From the start, the airline industry has remarkably connected countries all over the world through rapid long-distance transportation, helping people overcome geographic barriers. Consequently, this has ushered in substantial economic growth, both nationally and internationally. The airline industry produces vast amounts of data, capturing a diverse set of information about their operations, including data related to passengers, freight, flights, and much more. Analyzing air travel data can advance the understanding of airline market dynamics, allowing companies to provide customized, efficient, and safe transportation services. Due to big data challenges in such a complex environment, the benefits of drawing insights from the air travel data in the airline industry have not yet been fully explored. They introduce existing data sources commonly used in the papers surveyed and summarize their availability. Finally, we discuss several potential research directions to better harness airline data in the future. They anticipate this study to be used as a comprehensive reference for both members of the airline industry and academic scholars with an interest in airline research.

## **Topological Data Analysis For Aviation Applications:**

**Authors: Max Z. Li, Megan S. Ryerson and Hamsa Balakrishnan**

Aviation data sets are increasingly high-dimensional and sparse. Consequently, the underlying features and interactions are not easily uncovered by traditional data analysis methods. Recent advancements in applied mathematics introduce topological methods, offering a new approach to obtain these features. This paper applies the fundamental notions underlying topological data analysis and persistent homology (TDA/PH) to aviation data analytics. We review past aviation research that leverage topological methods, and present a new computational case study exploring the topology of airport surface connectivity. In each case, we connect abstract topological features with real-world processes in aviation, and highlight potential operational and managerial insights.

## **Operational Efficiency versus Financial Mobility In The Global Airline Industry:**

**Author: Hoi-Lam-ma**

The researcher in this article cited that, The events of September 11th, 2001 precipitated an almost unprecedented financial crisis for the world airline industry. However, it is not clear that these events represent a discrete, industry disruption or whether, in fact, airlines were already entering a period of economic challenges that would demand new strategic orientations on their part. This study investigates the structural drivers of operational efficiency as well as the financial posture of airlines on the eve of September 11th. A sample of 38 airlines from North America, Europe, Asia and the Middle East was utilized to investigate whether relative operational efficiency implied superior financial mobility (as defined by Donaldson). Data envelopment analysis was utilized to derive efficiency scores for individual airlines. The underlying structural drivers of efficiency were then investigated. It was found that the traditional framework developed in the literature still provided reasonable explanatory power for realized relative operational efficiency. However, the second stage of the analysis found that relative operational efficiency did not inherently imply superior financial mobility. As such, airlines that had chosen relatively efficient operational strategies found themselves in positions of vulnerability with regard to financial mobility and thus suffered the consequences in the post-September 11th environment.

## **An Evaluation Of The Operational Performance And Profitability Of The U.S. Airlines:**

**Author: Emilio Collar**

The researcher in this article cited that, Since 2008, a series of megamergers has dramatically changed the U.S. airline industry. Despite the presence of fewer airlines in the market, the competition remains intense, which forces airlines to continually search for ways to increase their efficiency to maintain survival and financial sustainability. To evaluate airline performance and disentangle the causes of inefficiency, this paper applied a two-stage

network data envelopment analysis approach and a truncated regression to investigate the performance of nine U.S.-based airlines from 2015 to 2019. Our empirical results reveal that during the sample period, airlines' operating efficiency steadily improved, but the efficiency in the profitability stage stagnated. Therefore, strategic resource allocations are needed for airlines to see further advances in their overall efficiency. On average, airlines operating in the low-cost business model yielded higher efficiency scores than their peers operating in the full-service framework. While an airline's size, measured in terms of total assets, has a positive influence on operating efficiency, a larger number of full-time employee equivalents hinders efficiency outcomes, which indicates the importance of enhancing labor efficiency among carriers.

## **The Relationship between On-Time Performance And Airline Market Share:**

**Author:Yoshinori Suzuki**

The researcher in this article cited that, We propose a new method of modeling the relationship between on-time performance and market share in the airline industry. The idea behind the method is that the passengers' decision to remain (use same airline) or switch (use other airlines) at time  $t$  depends on whether they have experienced flight delays at time  $t-1$  or not. More specifically, we posit that the passengers who experienced flight delays are more likely to switch airlines for the subsequent flight than those passengers who did not experience delays. To capture such effect, we develop an aggregate level Markovian type model that estimates the transition probability matrices separately for the passengers who experienced flight delays at time  $t-1$  and for those who did not experience delays. The model was calibrated with the US DOT data. The study results imply that, once experiencing flight delays, passengers are more likely to switch airlines. The results also imply that on-time performance affects a carrier's market share primarily through the passengers' experience, and not through the "advertisement" of performance.

## **Airline Finance:**

**Author:Peter.S.Morel**

The researcher in this article cited that, it is supported at each stage by practical airline examples and recent data, *Airline*

*Finance* examines the financial trends and longer term prospects for the airline industry as a whole, contrasting the developments for the major regions and airlines together with critical discussion of key issues that affect the industry as a whole. Important techniques in financial analysis are applied to the airlines as well as their investors such as banks and other financial institutions. This book is written for employees of airlines, airports and their suppliers, and investment bank and other analysts. It is also popular for use by universities and in-house courses on air transport management, within both academia and industry.

## **Airline Route Profitability Analysis And**

# **Optimization Using Big Data Analytics On Aviation Data Sets Under Heuristic Techniques:**

**Authors: Kasturi E, Prasanna Devi Sb, Vinu Kiran Sb, Manivannan Sc**

Researchers in this article cited that, applying vital decisions for new airline routes and aircraft utilization are important factors for airline decision making. For data driven analysis key points such as airliners route distance, availability on seats/freight/mails and fuel are considered. The airline route profitability optimization model is proposed based on performing big data analytics over large scale aviation data under multiple heuristic methods, based on which practical problems are analyzed. Analysis should be done based on key criteria, identified by operational needs and load revenues from operational systems e.g. passenger, cargo, freights, airport, country, aircraft, seat class etc. The result shows that the analysis is simple and convenient with concrete decision.

# **Analysis Of Flight Data Using Clustering Techniques For Detecting Abnormal Operations:**

**Author:Lishau Li,Santanu Das**

The researcher in this article cited that, the airline industry is moving toward proactive risk management, which aims to identify and mitigate risks before accidents occur. However, existing methods for such efforts are limited. They rely on predefined criteria to identify risks, leaving emergent issues undetected. This paper presents a new method, cluster-based anomaly detection to detect abnormal flights, which can support domain experts in detecting anomalies and associated risks from routine airline operations. The new method, enabled by data from the flight data recorder, applies clustering techniques to detect abnormal flights of unique data patterns. Compared with existing methods, the new method no longer requires predefined criteria or domain knowledge. Tests were conducted using two sets of operational data consisting of 365 B777 flights and 25,519 A320 flights. The performance of cluster-based anomaly detection to detect abnormal flights was compared with those of multiple kernel anomaly detection, which is another data-driven anomaly detection algorithm in recent years, as well as with exceedance detection, which is the current method employed by the airline industry. Results showed that both cluster-based anomaly detection to detect abnormal flights and multiple kernel anomaly detection were able to identify operationally significant anomalies, surpassing the capability of exceedance detection. Cluster-based anomaly detection to detect abnormal flights performed better with continuous parameters, whereas multiple kernel anomaly detection was more sensitive toward discrete parameters.

# **Data Analytics of Skytrax's Airport Review and Ratings:**

**Author:KrityaBunchongchit**

The researcher in this article cited that, This study investigates the perception of passengers of airport service attributes, using data from the Skytrax Airport Review websites. Overall, a

Total of 7358 reviews were collected from the website, together with other related passenger data, namely review headers, passenger types, rating scores of airport attributes and the overall rating. This study focused on investigating each group of passenger types to identify underlying differences amongst airport's passenger segmentation, particularly on the leisure travellers. The study performed different techniques of data analysis including sentiment analysis, lemmatization and partial least square – structural equation modeling (PLS-SEM) to reveal key patterns derived from the available data, which the normal survey data or the interview data may not have revealed. The research contributes to airport passenger segmentation by highlighting the differences found in the travellers segmented by Skytrax. The study also provides practical implications to airport managers.

## **Post Pandemic Aviation Market Recovery: Experience and lessons from China**

**Author: Achim I. Czemy**

The researcher in this article cited that, China was the first aviation market in the world hit hard by COVID-19 and has been recovering gradually as the pandemic became largely under control within mainland China. This study reviews the recovery pattern influenced by the Chinese government's aviation policy choices, in the hope that our discussions and findings will help improve aviation policy responses elsewhere. While the domestic market in mainland China has enjoyed a quick recovery to about 80% of the pre-crisis level by July 2020, the recovery of international services has been much slower, due to the bilateral route and flight frequency/capacity control and strict requirements for health check and quarantine. China's domestic aviation market was recovered by about 80% in two months after the pandemic became under good control. Most other countries with a “curve flattening” strategy, instead of full pandemic control, may not expect the fast recovery path China has achieved. A British “travel corridor” approach may be more practical for Western countries to follow, albeit more likely to be subject to serious setbacks and disruptions. The aviation fee reductions and cost support China and many other countries have been using are helpful by reducing airlines' marginal costs, but not sufficient for carriers to return to profitability or sustainable operations. Capital injection and/or credit guarantee may be needed for many airlines to survive. With various, often uncoordinated, regulations imposed in international markets, airlines based in open economies that have small domestic markets will face particularly serious challenges during the recovery process.

## **Sustainability Reporting In the Airline Industry: Current Literature And Future Research Avenues:**

**Authors: Malgorzata Zieba and Eljas Johansson**

Researchers in this article cited that, sustainability reporting (SR) allows organizations to communicate their non-financial impacts to stakeholders. It has also become a widespread business practice in aviation, a transport sector that contributes significantly to global warming. Academia has begun to examine SR in the context of airlines surprisingly late, and no comprehensive reviews of its respective developments have been made so far.

Consequently, a systematic literature review was performed with an exclusive focus on airline SR to synthesize its associated scholarly research and distinguish the common concerns and gaps that have emerged from it. The analyzed publications indicate that the industry has lacked a unified policy and common understanding of how to define and measure sustainability, which has led to inconsistent SR practices. This causes ambiguity between the real actions and promotional communication through which airlines may legitimize their operations. Academia and various airline stakeholders would benefit from more in-depth studies examining the stakeholder views and quality of disclosures, helping the industry improve its SR.

## **Changes In Air Passenger Demand As A Result Of The COVID-19 Crisis:Using Big Data To Inform Tourism Policy:**

**Author:Galle Immaculadago**

The researcher in this article cited that, this paper develops a methodology for the early detection of reactivation of tourist markets to help mitigate the effects of the COVID-19 crisis, using Sky scanner data on air passenger searches (>5,000 million) and picks (>600 million), for flights between November 2018 and December 2020, through Forward Keys. For future travel during the May to September 2020 period, the desire to travel (based on the number of flight searches) has dropped by about 30% in Europe and the Americas and by about 50% in Asia, while intention to travel (the number of flight picks, the final selections amongst flight searches) has dropped a further 10–20%. Most source markets remain optimistic about air travel during the last quarter of 2020, suggesting a U shape recovery. However, optimism has dwindled as time passes, suggesting a flat line L shape. A traffic light dashboard for domestic and inbound air travel demand to Spain shows how destination managers might use Big Data relating to the early recovery of key source markets to develop targeted marketing strategies. We show how Big Data provides timely granular data essential in highly volatile situations, and we argue that destination management organizations must improve their Big Data analytical and evidence-based, decision-making skills.

## **The Impact Of Social Media And Offline Influences On Consumer Behavior: An Analysis Of The Low-Cost Airline Industry:**

**Author:Carla Ruiz**

The researcher in this article cited that, this study analyses the impact of social media as well as offline environments upon tourist online purchase and recommendation behavior of low-cost airline services. Drawing on the Theory of Reasoned Action (TRA), this research considers the effect of offline social influences (interpersonal and external influences) and analyses online Consumer-to-Consumer (C2C) information exchanges as a driver of customer attitude towards online purchases. We propose that these factors improve online repurchase intentions and positive word-of-mouth communication (WOM and e-WOM) in

low-cost settings. Using structural equation modeling, the conceptual model is tested with a sample of 441 Spanish Internet buyers of low-cost airline services. Interpersonal offline influences (e.g. friends, relatives, and family) have a significant effect on online repurchase intentions and WOM but do not affect e-WOM. External offline influences (e.g. media and experts), however, only affect consumer intentions to recommend future purchases of low-cost airline services on social networking travel sites and have no effect on online repurchase intentions or WOM.

## **Assessing Quality Of Air Transport Service: A Comparative Analysis Of Two Evaluation Models:**

**Author: Denise Dumiko De Medeiros**

The researcher in this article cited that, this paper aims to analyze the opinion of tourists about airlines' service in a developing country. For this, the study proposes to make a comparative analysis of two evaluation models (SERVQUAL and SERVPERF) to investigate the factors that influence the formation of perceived quality in airline services, using statistical techniques such as Cluster Analysis and Structural Equation Modeling. Although the results were not the same, the result of both analyzes indicated two common dimensions (tangibles and empathy) that influence the customer's perception of the airline service quality. The main conclusion of this study is that the two analyzes are convergent for the study sample. The SERVQUAL and cluster analysis allow airline managers to identify and prioritize gaps in service delivery according to criticality, aiming at the allocation of efficient resources by the airline. The SERVPERF and SEM provide statistical evidence of the impact of different dimensions of service quality on customer satisfaction, highlighting the direct relationship between satisfaction and dimensions. Considering how customers evaluate the service provided by airlines, particularly regarding the service they receive from airport employees, this study has relevance for decisions taken by airline managers to develop quality services, and provide guidelines for improvements in airline services.

## **Domestic Code Sharing, Alliances, And Airfares In The U.S. Airline Industry:**

**Author: Harumi Ito, Darmin Lee**

The researcher in this article cited that, this paper examines the impact of domestic code-sharing alliances on airfares. Our analysis yields two novel and somewhat surprising findings that have yet to be documented in the literature. First, unlike with international code sharing, we find that the overwhelming majority of domestic codeshare itineraries involve a single operating carrier, a phenomenon that we refer to as virtual code sharing. Second, we find that these virtual code-sharing itineraries are priced lower than itineraries operated and marketed by a single carrier in the same market. We suggest that carriers may be using virtual code sharing—in large part—as a generic product to compete for the most price-sensitive passengers.

# **Customer segmentation revisited: The case of the airline industry:**

**Author: Iwan von Wartburg**

The researcher in this article cited that, although the application of segmentation is a topic of central importance in marketing literature and practice, managers tend to rely on intuition and on traditional segmentation techniques based on socio-demographic variables. In the airline industry, it is regarded as common sense to separate between business and economy passengers. However, the simplicity of this segmentation logic no longer matches the ever more complex and heterogeneous choices made by customers. Airline companies relying solely on flight class as the segmentation criterion may not be able to customize their product offerings and marketing policies to an appropriate degree in order to respond to the shifting importance and growing complexity of customer choice drivers, e.g. flexibility and price as a result of liberalization in the airline industry. Thus, there is a need to re-evaluate the traditional market segmentation criterion.

By analyzing the stated preference data of more than 5800 airline passengers, we show that segmenting into business and leisure (a) does not sufficiently capture the preference heterogeneity among customers and (b) leads to a misunderstanding of consumer preferences. We apply latent class modeling to our data and propose an alternative segmentation approach: we profile the identified segments along behavioral and socio-demographic variables. We combine our findings with observable consumer characteristics to derive pronounced fencing mechanisms for isolating and addressing customer segments receptive for tailored product packages.

## **A Hierarchical Model of Service Quality in the Airline Industry:**

**Author: Ching Chang-Cheng**

The researcher in this article cited that, the purpose of this study is to enhance understanding of service quality in the airline industry by developing a conceptual framework and measurement scale. Based on an extensive literature review, qualitative and empirical research, a hierarchical model of service quality for the airline industry is proposed. Analysis of data from 544 passengers indicates that the proposed model fits the data well. Reliability and validity of the measurement scale are established using a pilot test and the substantive survey. This study extends the literature on service quality in the fields of transportation management by providing a comprehensive framework and measurement scale. Theoretical and managerial implications are discussed.

## **Applied Cognitive Task Analysis in Aviation:**

**Authors: Thomas L. Semester and Richard E. Redding**

Researchers in this article cited that, due to the requirements of automatic system design, and new needs for the training of complex tasks, Cognitive Task Analysis (CTA) has been used with increasing frequency in recent years by the airline industry and air traffic control



Community. Its power is reflected in the literature on professional training and systems design, where CTA is often cited as one of the most promising new technologies, especially for the complex cognitive tasks now confronting those working in aviation. The objective of this book is to bridge the gap between research and practice, to make what we know about CTA available to practitioners in the field. The book focuses on cognitive psychology and artificial intelligence analyses of aviation tasks. It is designed to help readers identify and solve specific design and training problems, in the flight deck, air traffic control and operations contexts. Distilling experience and guidelines from the best aviation cognitive analyses in accessible form, it is the first comprehensive volume on CTA, and is written for practitioners of cognitive analysis in aviation. It provides an overview of analyses to date; methods of data collection; and recommendations for designing and conducting CTA for use in instructional design, systems development, and evaluation. The first part of the book provides the principles and foundations of CTA, describing traditional approaches to task analysis and ways that cognitive analyses can be integrated with the analysis and development processes. The next part details how to: select the appropriate method or methods; determine job tasks that can be trained for automatic performance; extract knowledge structures; analyse mental models; and identify the decision-making and problem-solving strategies associated with experienced job performance. The authors also describe when to use and how to design and conduct a cognitive task analysis; how to use CTA along with traditional task analysis and ISD; and how to use CTA in training program development and systems design, as well as in personnel selection and evaluation. The current demand for cognitive analyses makes this a timely volume for those in aviation and, more generally, the industrial development and training communities. Readers will find this a thorough presentation of cognitive analyses in aviation and a highly usable guide in the design, implementation and interpretation of CTA. The book will be useful to instructional developers, aviation equipment and systems designers, researchers, government regulatory personnel, human resource managers, instructors, pilots, air traffic controllers, and operations staff.