COLUMBIA UNIVERSITY
School of Professional Studies

APAN 5900: SOLVING REAL WORLD PROBLEMS W/ ANALYTICS

CAPSTONE PROJECT

TEAM FLYAHEAD CONSULTANTS

RESEARCH PROJECT: RESULTS AND RECOMMENDATIONS

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Introduction

The aviation industry operates in an intensely competitive environment, requiring airlines to continuously innovate to remain profitable and relevant. American Airlines (AA), a leader in the sector, faces increasing challenges from low-cost carriers, fluctuating economic conditions, and shifting consumer preferences. These challenges are amplified by complexities in leisure travel booking patterns, including varying travel purposes, booking windows, and seasonal demand. Recognizing these factors, our research aims to transform AA's customer segmentation strategy into a data-driven approach that maximizes marketing efficiency and revenue.

Since the research proposal, our team has made significant progress in analyzing customer behavior to achieve this goal. Initially, we refined the dataset by focusing on leisure travelers, filtering bookings with the highest probability for vacation, personal, or visiting friends and relatives (VFR) travel categories. Through exploratory data analysis (EDA), we identified patterns in booking windows, revenue, and advanced purchase behavior. We also engineered new features, such as **Revenue per Mile (RPM)** and **Cumulative Advanced Purchase Ratio**, to capture key aspects of **Willingness to Pay (WTP)**.

Our analytical approach evolved through iterative modeling. While our initial research design proposed K-prototype clustering to handle mixed data types, technical limitations prevented its execution. Instead, we pivoted to K-means and weighted K-means clustering, leveraging advanced data standardization and feature selection techniques. These models provided actionable insights into distinct customer groups, enabling us to align AA's marketing and operational strategies with specific traveler needs. This adaptive approach demonstrates the team's ability to overcome obstacles and still deliver meaningful outcomes.

This report presents the results of our segmentation analysis and offers actionable recommendations for American Airlines. The findings address key business challenges, including how to optimize revenue from high-value customer segments, increase engagement with cost-conscious travelers, and enhance overall marketing effectiveness. By focusing on actionable insights derived from rigorous data analysis, we aim to empower AA with strategies that foster sustainable growth in a highly dynamic market.

Results

Purpose of the Research

The primary objective of this research was to enhance American Airlines' ability to identify distinct customer segments among its leisure travelers. By leveraging booking behavior, travel preferences, and revenue potential, the analysis aimed to provide actionable insights for more targeted marketing strategies. Ultimately, the goal is to improve customer engagement and optimize revenue generation by understanding the diverse behaviors and preferences of AA's leisure traveler base.

Key Findings

Overview of Clustering Approach

We employed both unweighted and weighted K-means clustering to identify customer segments. While unweighted K-means offered a baseline segmentation of traveler behaviors, weighted K-means allowed us to refine the clusters by emphasizing revenue and booking behavior. Five clusters were identified in

both models, each with distinct characteristics, but the weighted approach offered clearer separation and strategic value.

Comparison: Unweighted K-Means vs. Weighted K-Means

1. **Cluster Definition and Clarity**:
    - **Unweighted K-Means**: Provided an initial understanding of customer segmentation, but clusters lacked clear distinctions between high-value and low-value travelers. For example, price-sensitive and high-spending travelers often overlapped within clusters.
    - **Weighted K-Means**: By assigning higher importance to key variables like **Revenue per Mile (RPM)**, **Revenue/AP Ratio**, and **Advanced Purchase**, this method produced more distinct and actionable clusters. High-value clusters (e.g., premium last-minute travelers) stood out more prominently.

2. **Revenue Variability**:
    - **Unweighted K-Means**: Revenue patterns were less pronounced, making it difficult to clearly identify high-revenue segments.
    - **Weighted K-Means**: Highlighted significant revenue differences among clusters, such as the sharp contrast between Clusters 2 (premium last-minute travelers) and 1 (budget planners). Weighted K-means revealed that Clusters 2 and 4 were disproportionately responsible for revenue generation.

3. **Behavioral Patterns**:
    - **Unweighted K-Means**: Captured general travel behavior but grouped customers with distinct preferences, such as off-peak planners and high-spending convenience seekers, into the same clusters.
    - **Weighted K-Means**: Captured nuanced behaviors like last-minute booking patterns and peak travel preferences more effectively. For example, Clusters 2 and 4 showed strong correlations with weekend and holiday travel preferences under the weighted model.

4. **Actionability for Marketing and Operations**:
    - **Unweighted K-Means**: While helpful for initial segmentation, the lack of clear distinctions limited its utility for targeted strategies.
    - **Weighted K-Means**: Provided actionable insights for marketing campaigns and operational planning by highlighting specific segments that contribute disproportionately to revenue and engagement.

Visualization Support:

Elbow Method Results: Both models suggested an optimal number of five clusters. Weighted K-means, however, demonstrated clearer inflection points in cluster separation (Figure 1).

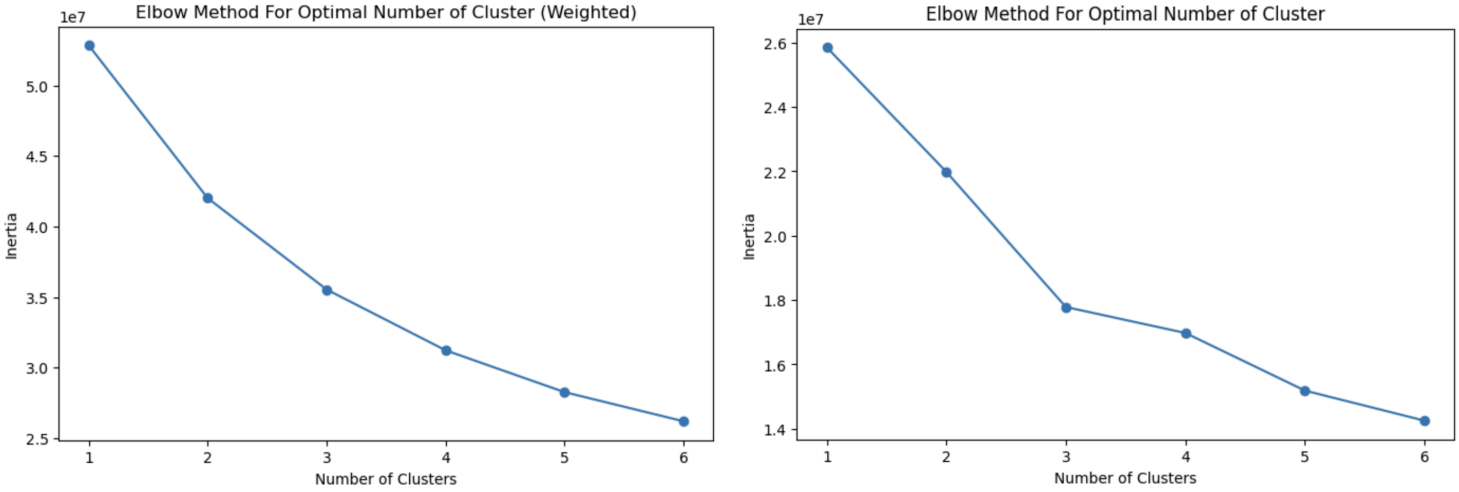

Figure 1: Elbow Method for Optimal number of clusters

Revenue per Mile Across Clusters: A Revenue per Mile comparison graph (Figure 2) showed that weighted K-means more effectively separated high-spending groups, particularly Clusters 2 and 4.

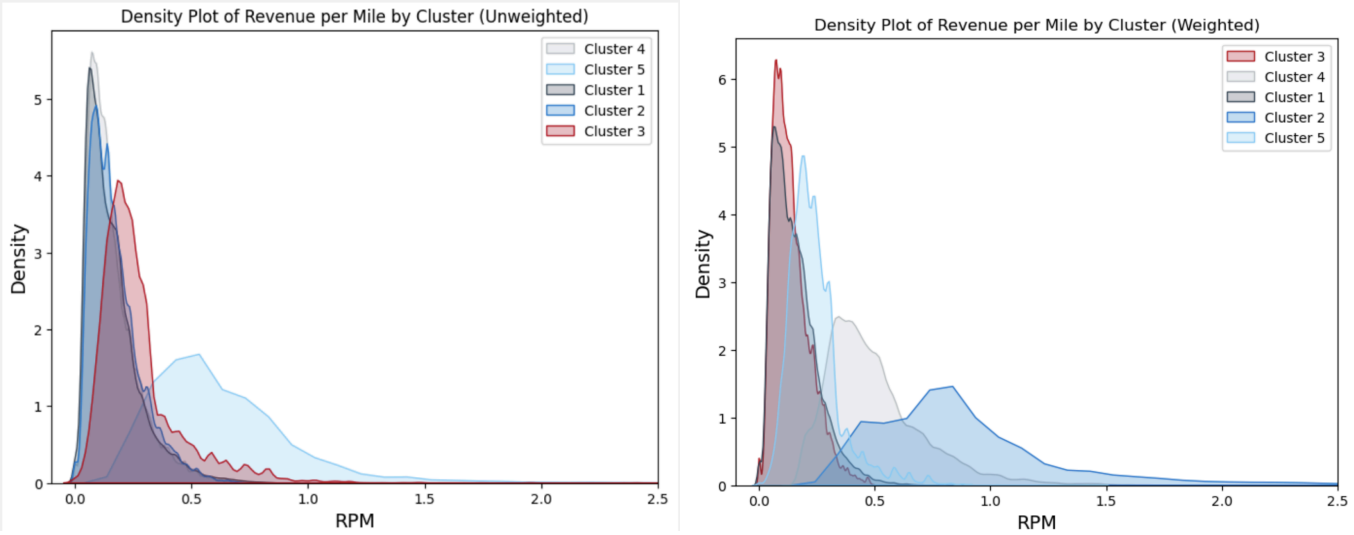

Figure 2: Density plot of Revenue per mile by cluster

In the above figure, the narrow peaks in the unweighted K-means Revenue per Mile density plot suggest a concentrated distribution around the lower Revenue per Mile values. In contrast, the weighted plot shows the widely spread distributions of Clusters 4 and 2, reflecting greater revenue variability. This higher variability may signify these clusters' potential importance when considering variables depicting a higher willingness to pay.

Revenue per Person Across Clusters: A comparison of Revenue per Person across clusters (Figure 3) further highlights the advantage of the weighted K-means model. The graph reveals that the weighted clustering method produces more distinct median distributions for Revenue per Person, particularly in Clusters 2 and 4.

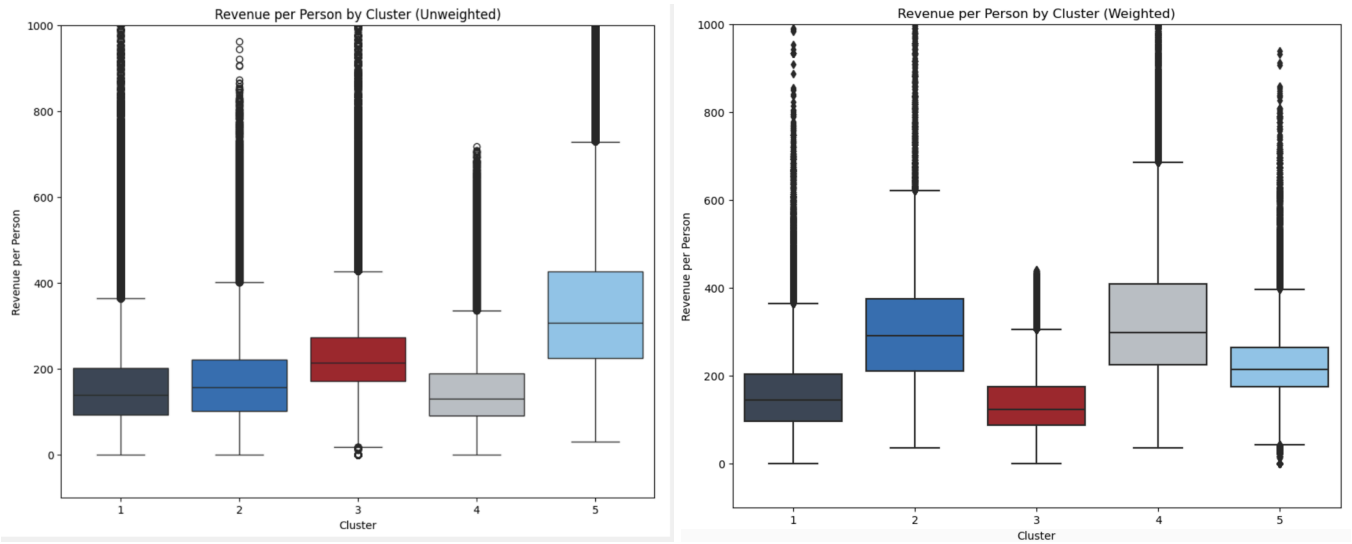

Figure 3: Revenue per person by cluster

These differences suggest that the weighted method is better equipped to capture nuanced customer behaviors and spending patterns, enabling more effective segmentation.

By comparing the distributions of our primary features across both clustering methods, we chose weighted K-means as our recommended solution because it demonstrates greater variety in identifying customer behaviors for segmentation.

Cluster Analysis and Profiling

Our refined profiling of each cluster provided a deeper understanding of customer behaviors, enabling us to segment AA's leisure travelers into five distinct groups. Below are the key characteristics and revenue insights for each cluster:

- **Cluster 1: "Budget Planners"**
  - **Characteristics**: Highly cost-sensitive travelers who book well in advance to secure the best deals. They avoid peak travel times such as weekends and holidays and prioritize affordability.
  - **Revenue Insights**: This segment drives a high volume of bookings but contributes minimally to revenue due to low revenue per mile and per person.

- **Cluster 2: "Premium Last-Minute Travelers"**
  - **Characteristics**: High spenders who value flexibility and convenience. They frequently make last-minute bookings and prefer traveling during peak times, such as weekends and holidays.
  - **Revenue Insights**: This segment generates the highest revenue per mile and per person, representing a critical group for maximizing yield.

- **Cluster 3: "Careful Planners"**
  - **Characteristics**: Travelers who are price-sensitive but exhibit flexibility in booking closer to their travel dates. They prefer non-peak travel periods to avoid paying premium rates.

    - **Revenue Insights**: This group contributes moderate revenue, with potential for growth through strategic offers.

- **Cluster 4: "Premium Spenders"**
    - **Characteristics**: Travelers with varied booking behaviors. They mix advance and last-minute bookings and occasionally spend on premium services for special occasions.
    - **Revenue Insights**: This segment shows varied revenue contributions, offering opportunities to encourage higher spending on premium experiences.

- **Cluster 5: "Weekend Travelers, Moderate Spenders"**
    - **Characteristics**: These travelers prioritize convenience and are willing to pay for premium services. They frequently make last-minute plans and prefer traveling during peak periods.
    - **Revenue Insights**: This segment has the second-highest revenue potential, driven by frequent purchases of premium services and upgrades.

This detailed profiling highlights the diversity within AA's leisure travelers, providing critical insights into their booking patterns, spending behavior, and travel preferences. The findings emphasize the importance of tailored strategies to optimize engagement and revenue generation from each segment.

Recommendations

Based on the findings from our clustering analysis, we have developed targeted recommendations to optimize American Airlines' marketing strategies, operational efficiency, and overall revenue potential. These recommendations are designed to address the distinct behaviors and preferences of each customer segment, aligning with American Airlines' strategic goals of enhancing customer satisfaction, increasing profitability, and maintaining a competitive edge in the market. Below, we outline actionable strategies tailored to the unique characteristics of each cluster, alongside broader implications, implementation steps, and considerations for potential challenges.

Revenue Maximization Strategies

- **Target Clusters 2 and 4**: Focus marketing campaigns on premium services such as priority boarding, premium seating, and exclusive offers. These high-value groups demonstrate a strong willingness to pay for convenience and flexibility.
- **Weekend and Holiday Promotions**: Concentrate marketing efforts on Clusters 2, 4, and 5, leveraging their preference for peak travel times to maximize revenue during holidays and weekends.
- **Premium Services Expansion**: Enhance premium service offerings to include add-ons like in-flight upgrades and lounge access, targeting Clusters 2 and 5 for convenience-driven travelers.

Cost Management and Efficiency

- **Off-Peak Promotions**: Offer discounted pricing and value-oriented packages to Clusters 1 and 3 during off-peak periods to boost seat utilization.

- **Personalized Offers**: Use cluster-specific insights to develop personalized marketing messages, enhancing engagement and customer retention.
- **Inventory Optimization**: Manage inventory efficiently to ensure availability of seats for high-revenue clusters while maximizing utilization during low-demand periods.

Strategic Marketing Initiatives

- **Seasonal Campaigns**: Align marketing initiatives with travel seasonality. Promote vacation packages for Clusters 4 and 5 during summer and holiday periods, emphasizing their higher willingness to pay.
- **Value-Based Messaging**: Highlight affordability and flexibility for Clusters 1 and 3, addressing their cost-conscious behaviors.

Channel Recommendations

Optimizing engagement across distribution channels is critical to reaching and serving each customer segment effectively:

- **Direct Channels**:
  - Prioritize direct channels for **Cluster 1 (Budget Planners)** to reduce commission costs and maintain competitive pricing. Use loyalty programs and early-bird notifications to retain this cost-sensitive group.
- **Online Travel Agencies (OTAs)**:
  - Leverage OTAs for **Cluster 2 (Premium Last-Minute Travelers)** and **Cluster 5 (Convenience Seekers)**, who value flexibility and seamless booking experiences. Highlight premium services and dynamic pricing options on these platforms.
- **Leisure-Specific Channels**:
  - Use leisure-specific platforms and campaigns to target **Cluster 4 (Moderate Spenders)** and **Cluster 5 (Convenience Seekers)**, emphasizing customizable travel packages and upgrades for special occasions.
- **Corporate and Travel Management Companies (TMCs)**:
  - Engage high-revenue segments, such as **Cluster 5**, through TMCs for enhanced services like business travel support and luxury offerings.
- **Mobile App and Website**:
  - Invest in digital experiences across AA's mobile app and website to capture all segments, with tailored recommendations and offers based on user profiles and previous booking behaviors.

By tailoring messaging and promotions to each segment's preferred channels, American Airlines can improve engagement, reduce acquisition costs, and enhance the customer experience.

Implications

- **For AA's Strategy**: The insights from clustering provide a clear framework to align marketing campaigns and operational strategies with distinct customer needs. Focusing on high-revenue segments while efficiently engaging cost-conscious groups ensures sustainable growth.

- **For Customers**: Tailored offers improve customer satisfaction and loyalty by addressing specific behaviors and preferences.
- **For Competitors**: Enhanced segmentation strategies allow AA to differentiate itself in a competitive market, gaining an edge over both low-cost carriers and premium competitors.
- **For Operations**: Optimizing seat inventory and pricing strategies supports effective resource allocation and profitability.

Implementation Steps

- **Data Integration**: Incorporate cluster profiles into AA's CRM systems to automate personalized marketing and dynamic pricing strategies.
- **Marketing Rollout**: Launch targeted campaigns for high-value clusters, highlighting premium services for Clusters 2 and 4 and affordability for Clusters 1 and 3.
- **Operational Adjustments**: Align inventory and pricing systems to reflect cluster-specific demand, ensuring availability during peak periods for high-revenue segments.
- **Monitoring and Refinement**: Continuously track the performance of campaigns and adjust strategies based on real-time feedback. Use KPIs like revenue growth, seat utilization, and customer retention to measure success.

Potential Obstacles

- **Dynamic Market Conditions**: Economic fluctuations or shifts in customer behavior may require frequent adjustments to strategies.
- **Data Limitations**: Ensuring the accuracy and timeliness of data is critical for effective segmentation and marketing.
- **Operational Challenges**: Implementing dynamic pricing and inventory systems requires investment in technology and staff training.
- **Customer Expectations**: High-value segments like Clusters 2 and 5 may have elevated expectations for premium services, necessitating consistent quality delivery.

Conclusion

This research project has successfully transformed American Airlines' customer segmentation approach into a data-driven framework designed to optimize pricing strategies, enhance operational strategies, and maximize revenue. In our initial proposal, we identified the need to better understand leisure travelers and their booking behaviors. Since then, we have progressed significantly, refining the dataset, performing exploratory data analysis, and overcoming challenges in clustering methodologies to deliver actionable insights.

The final analysis segmented AA's leisure travelers into five distinct clusters, each with unique characteristics, revenue potential, and preferences. These insights formed the basis for tailored recommendations aimed at addressing key business challenges, including revenue maximization, cost efficiency, and customer satisfaction. By aligning marketing strategies and operational decisions with the distinct needs of these clusters, AA is well-positioned to sustain its competitive edge and drive growth in a dynamic aviation market.

Our recommendations offer a roadmap for AA to implement targeted campaigns, optimize distribution channels, and enhance resource allocation. While challenges such as market fluctuations and operational constraints exist, the strategies outlined in this report equip AA with the tools needed to adapt effectively. This project underscores the value of leveraging advanced analytics to unlock opportunities, and we are confident that the insights and recommendations provided here will empower American Airlines to achieve its strategic goals and better serve its customers.