

# Personalized Passenger Experience in Airports: A Data-Driven Approach

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**Abstract.** *The rapid development of global aviation traffic requires the development of more sophisticated management and marketing strategies to enhance airport operations and improve passenger services. In modern airport management systems, real time data from security cameras, check-in counters and handling agents are extracted to establish a configurable framework that enhances the efficiency of smart airports in both commercial and operational sectors. In response to the increasing demand for seamless travel experiences, modern airports are testing and adopting automation systems, predictive analytics, and customizable services to address passenger requirements. The proposed MATLAB developed system provides real-time personalized recommendations for transit passengers, heightens airport marketing strategies and resource distribution in order to satisfy the passenger's needs. The system can employ predictive algorithms to determine variations in demand based on historical passenger data. This will enhance non-aeronautical sources of revenue and improve the utilization of limited commercial area. Research results indicate that AI driven recommendation systems may alleviate traffic congestion, facilitate employee management, and enhance passenger satisfaction. Future project may employ IoT sensors and big data analytics to implement real time adjustments to passenger flow systems, hence enhancing travel efficiency and fluidity.*

*The paper demonstrates the significance of customer experience marketing in transforming airports into commercial and service centers that respond to various traveler needs. The suggested approach facilitates real time adjustments to passenger flow, resulting in a more efficient and tailored travel experience. This research demonstrates that AI driven recommendation systems may be utilized in airport management, marking a progression in the digital transformation of aviation management systems. The suggested program offers versatile and scalable architecture suitable for integration into modern smart airports. This will enhance their efficiency and increase passenger satisfaction, and revenue.*

**Keywords:** smart airports, IoT, passenger flow optimization, experiential marketing, predictive analytics.

## Introduction

Over the past few decades, global air traffic has consistently increased. This has compelled airports to devise innovative strategies to ensure passengers enjoy a seamless and enjoyable experience while maintaining operational efficiency, integrating management and marketing strategies with

IoT technology that generates innovative methods to enhance passenger flow and optimize resource utilization.

Managing passenger flow at airports is a challenging task that is further complicated by the global rise in aviation traffic. The aviation business has experienced significant growth over the past few decades due to increased accessibility of air travel and the establishment of worldwide transport networks. The aviation sector must prioritize enhancing operational procedures and passenger experience as the volume of travelers increases with their expectations for comfort and short waiting time. Airports can effectively satisfy the requirements of their users by implementing modern management and marketing strategies. This will enhance their operational efficiency and promote environmental sustainability.

This research aims to suggest improvements for airport related infrastructure and operations that would accommodate a continuously increasing volume of air traffic. For instance, pre COVID over 4.5 billion passengers were transported worldwide annually. This exponential increase placed a lot of stress on the underlining infrastructure in many airports. The development is apparent as international. Airports have increased in passenger volume at a faster rate, signaling the need for improvements in facilities and subsequent technological integration. Furthermore, improvements must be made after the pandemic posed new challenges and changing passenger flow. Therefore, systems must be dynamic and flexible. There are many current issues complicating the passenger flow existing systems, compounded of greater threats to air safety. Security levels are heightened, meaning more controlled operations. This directly affects processing time and the overall airport experience.

COVID-19 complicated such problems as more requirements for social distancing, cleaning and health paperwork screenings were needed. Furthermore, the increased need for air travel means that many airports must improve to their already existing infrastructures, but financial constraints and the search for environmental safety often delay these additions

At an international scale, airports have created solutions to seek these opportunities, and internationally managed tendencies are already underway. Digitized measures have been a big part of reconstructing operations. The most common measures include automated check-in kiosks. Biometric gates and mobile applications that track arrivals and departures in real time. In addition, the greater emphasis on experiential marketing has been significant. This ranges from beautifying retail spaces to developing custom touch points to make time spent in airport more enjoyable. Additionally, airports have begun using emerging technologies, including AI and big data to predict and control arrivals and departures, which makes them even more reactive. Romania experienced heavy investment in technology and infrastructure, meaning such advancements would be successful across the board. For example, Bucharest, Cluj, Iasi and Timisoara airports have modernized with expansions, indicating how operational capabilities can grow. The implementation of systems, such as biometric gates and self-service check-in is a significant way to integrate a national industry with international standards. However, there are still issues faced by the uneven development of infrastructures in outlying areas and the necessity for these airports to be properly integrated with the operational national land transportation network.

There are a few significant regional and international events that have required the quick change in passenger flow and thus impacted the development of this industry. These include the annexation of Crimea in 2014, the COVID pandemic 2020. To 2022. The war in Ukraine, 2022 in present and Romania's admission to the Schengen zone. The COVID pandemic had a critical impact on the Civil Aviation industry in Romania. It lowered passenger volume levels and financially drained airport operators. For example, in the airports across Romania, from social

distancing and scanning health certificates to automated checking and document control filters, this required a rapid change with already existing structures, yet at the same time allowed for rapid digitization and technological advancements. In addition, in a more recent stage, foreign policy measures had a stronghold on the air travel market, specifically Russia's annexation of Crimea in 2014 and Russia's war in Ukraine in 2022. These events have the potential to significantly impact air travel across Romania's air space. Because Romania is near war-torn areas, its international airports are increasingly becoming essential transfer points for refugees and humanitarian work, as well as redirection points for commercial airliners seeking to avoid Ukrainian and Russian airspace. Thus, airport operations within days have become critical at these international airports to successfully accommodate unexpected air traffic and passenger flows.

In addition, with so much geopolitical warfare tension, the need to solidify and improve airport security through monitoring and control system is highlighted. Romania's acceptance into the Schengen area is a new realm of air travel for the country. Flights entering and exiting from other Schengen nations will no longer have border checks. For entry and exit, navigating through the airports of Romania will be even more advantageous as part of the transport hub of Eastern Europe, as it minimizes processing time for travelers. Acknowledgement of this prospective transition has allowed for renovations of terminals, human resources and technological needs of the airport to align with Schengen expectations. Romania has become a more critical regional hub for Civil Aviation with multiple air routes. Leading in and out of the country, increased passenger volumes and marketing campaigns speaking to tourism and regional attractions all make air travel through Romanian airports more favorable. Figures 1 and 2 show how the number of passengers grew from 2023 to 2024.

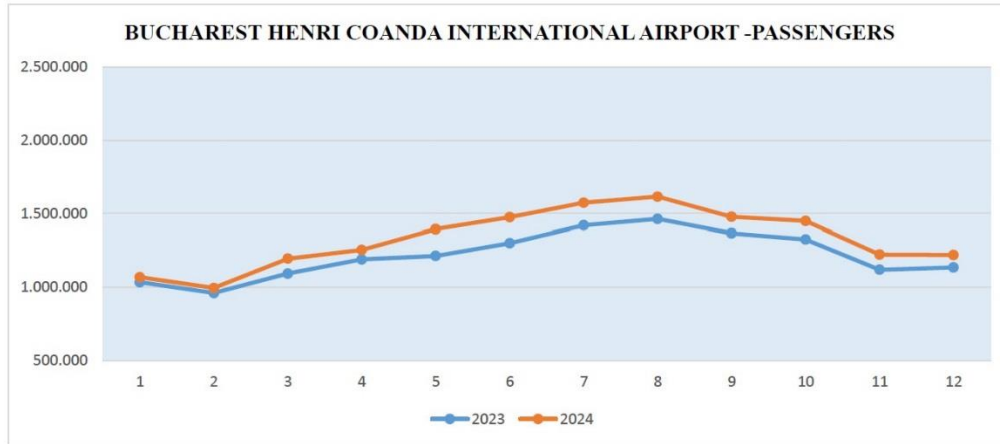
**BUCHAREST HENRI COANDA INTERNATIONAL AIRPORT**

**PASSENGERS**

MONTH /YEAR	2023	2024	%(2024/2023)
JAN	1.035.092	1.069.961	3,4%
FEB	960.966	996.003	3,6%
MAR	1.094.419	1.196.400	9,3%
APR	1.190.414	1.255.864	5,5%
MAY	1.214.480	1.394.698	14,8%
JUN	1.300.657	1.474.655	13,4%
JUL	1.420.245	1.573.636	10,8%
AUG	1.463.430	1.614.242	10,3%
SEP	1.368.033	1.478.212	8,1%
OCT	1.326.299	1.449.163	9,3%
NOV	1.121.081	1.223.531	9,1%
DEC	1.135.599	1.220.426	7,5%
<b>TOTAL</b>	<b>14.630.715</b>	<b>15.946.791</b>	<b>9,0%</b>

**Figure 1. Monthly passenger values evolution 2023-2024**

Source: <https://www.bucharestairports.ro/cnab/en/general-info/air-traffic-statistics>.



**Figure 2. Monthly passenger evolution 2023-2024 graph**

Source: <https://www.bucharestairports.ro/cnab/en/general-info/air-traffic-statistics>.

Ensuring that major and regional airports are developed along the same line and that they are better integrated into ground and rail facilities is, in the present, a very big challenge. Researchers explored what good service means in an airport and how such services may influence passengers' recommendations (Alanazi et al., 2024). They explored the impact of different interactions of service on passenger satisfaction (Bakır et al., 2022), as well as the various sides that passengers feel about these services (Jain and Pamula, 2021) Studies explore the implications of passenger preferences related to airport terminals as well as the decision-making implication from time pressure, store visibility and trajectory histories (Chung and Ku, 2023). Researchers explored the feelings centering on passenger experience so digital channels should become more immersive (Straker and Wrigley, 2016) Studies explored how passengers felt about biometric gate technologies (Kim et al., 2019); ow consumers felt about AI driven airport services (Miskolczi et al., 2021), and how willing passengers were to divulge personal data for digital services (Mwesiumo et al., 2023).

Researchers have sought to increase efficiency by understanding which passengers are likely to miss their connecting flights to modify transfer-passenger traffic (Guo et al., 2020), Ground Delay Programs that can ease passenger delays (Jacquillat, 2021), and the idealization of potential itineraries with least connecting time (Biolini et al., 2022).

For the personalization and real-time service fields, the potential for AI and Machine Learning is considered to establish a personalized generation system (Sumitha, 2023), a real-time advisory service that can be applied, that would improve passenger experience (Salis et al., 2018), and a real-time system application that can improve passenger tolerance (Knoch et al., 2020).

The common thread among all the research questions focused on analyzing through various means the best way to understand and improve the quality of life for passengers. Much was devoted to the notion of technological applications and data analytics in personalizing offerings and creating more efficient travel through airports.

This paper will seek to examine the application of management and marketing principles for improved passenger flow efficiency at the airport. The examination will compare new technological solutions, longstanding issues, and emerging opportunities that render this a global and local trend.

## Literature review

Current studies regarding airport operations relate to efficiency, safety, and sustainability. One of the principal considerations about operating an airport includes safety. For example, Di Graziano et al. (2024) created a clustering algorithm to evaluate the deterioration of specific segments of runways and taxiways; this alternative allocation of resources promotes safety in the short term while also reducing maintenance costs in the long term by ensuring that gradual wear and tear is assessed early on.

Another principal consideration includes efficient passenger management. For example, Anagnostopoulou et al. (2024) create AI-based simulation models to assess passenger behavior and peak hour predictions in terminals; they found that routes and resource allocation could be optimized to lower wait times significantly. The disadvantage of the simulation model is that it does not integrate real-time data, which would both improve accuracy and reduce time inefficiencies. Furthermore, the study does not take terminal layout and structures into consideration for crowds and passenger comfort; therefore, results may not apply to all terminals. Finally, real-world application of more sustainable and durable terminals may be more operationally intensive than what the study suggests.

Bugayko et al. (2022) offered improvements to air transport connectivity to other transportation means—rail and road—which made multimodal logistics integration a possibility, better transshipment flows for global trading, and improved operational efficiency.

The management of human resources and personnel was deemed a challenging obstacle to overcome, mainly regarding how to bring employees back. According to the Buhusayen et al. (2020) study, information went out and information management was challenging; thus, the recommendations of the results established a way to reoperate safely, including the use of means of remote communication.

The management of noise is a critical component of parts of airport operations. According to Heyes (2021), recommendations included the creation of preferred flight paths, the use of quieter aircraft, and assessment of noise output; implementation would contribute to a better quality of life for those who live surrounding airports and better quality of life improvements for airports and their communities.

Sustainability has been an aspect of much research dedicated to the sector from which the results imply a lessened carbon footprint. Di Mascio et al. (2022) suggested improved tow procedures for planes while on the ground to decrease fuel burn and carbon output, and Baxter et al. (2018) acknowledged that efficient systems of waste diversion are necessary to avoid excess waste being brought to landfills.

The aviation industry pledges to be carbon neutral by 2050, which is an aggressive goal. Yet Goh et al. (2024) constructed feasibility studies that blend renewable resources with energy and air travel including wind, solar, and waste-to-energy technologies. These options lower emissions while simultaneously aiding efforts of energy minimization at the airport.

In all, this aspect of the research supports the idea that management of airports is not only complicated but that customized solutions to operation, environmental, and strategic concerns are necessary. Thus, a sustainable plan for the future of aviation is obvious and will support both economic and environmental approaches.

Almost more than any other transportation sector, marketing is essential to the airport experience. Airports are in direct competition with one another, and constant changes define the industry. What was once only an airport for travelling has transformed into social and economic

opportunities at every turn. The increased competitive pressure, tourist tendencies, and a desire for more personalized experiences indicate that airports need marketing solutions.

Relevant research about marketing solutions for airport behavior come from technological advancements and digital transformation contributing to airport operations and passenger needs. For example, there is a need for digitized products and services to improve the quality and reputation of airports, such as official airport websites and mobile boarding pass applications (L. Florido-Benítez, 2022). Limitations of the study are as follows. Primarily, Skytrax is not data extensive; for example, there aren't that many annual awardees from other categories over the past decade. Secondly, this study is based on the Skytrax database only, so it may not be applicable generalizable. Thirdly, future studies should base findings on varying international airport ranking databases to compare and contrast for thorough examinations.

Marketing within the airport infrastructure is complex as the marketplace occurs through a disparate segmented audience. An airport does not operate as a finalized market where products or services are the end results; it is a connection point. Subsequent connections occur with airlines, essentially passengers, commercial landlords/operators, and logistical entities, in addition to abbreviated municipal/federal governmental links. Therefore, every pertinent customer appears to render a customized experience.

Technology and digitalization propel the potential conversion of what an airport can be. An airport's website interface or application stands not only as an information-giving location but also a branding opportunity with customer engagement options (L. Florido-Benítez, 2022). Airports look for smart ideas, from self-driving snowplows to drone inspections, for improved maintenance, lower costs, and more productive construction (Kováčiková et al., 2022).

Airports are becoming multifunctional centers rendering various services. The “airport experience” is trending. Researchers examine comfort levels, accessibility, and quality of service and their relationships with satisfaction and intentions of travelers (Isyana, 2023). Yet the study's biggest flaw is the limited sample size of one investigation at Yogyakarta International Airport. It's difficult to generalize findings to other airports given varying characteristics and operations. Yet one literature gap assessed is the empirical approach that needs to be taken from sociological and psychological perspectives inclusive of service marketing assessment and airport service quality for a comprehensive understanding of what the airport experience is. The two elements that allow airports to dominate the market are sustainable developments and quality awards (L. Florido-Benítez, 2022 & Aydin, 2024).

While there are many articles published to combat passenger flow optimization or articles that use AI for marketing purposes, few paper articles transcend beyond a single aspect and use an integrative data-driven framework to assess both. This is where the following study adds to the existing literature by showing how MATLAB can be used to lay the foundation for a framework that can facilitate predictive modeling as well as a real-time analytics engine that will promote airport efficacy.

## **Methodology**

The airport industry plays a key role in the world economy while airports themselves remain the hub of passenger and cargo traffic. With internationalization, the growing trend of air travel year over year, and the increasing need for sustainable regulations, the management of airport activities has become a multidisciplinary field spanning engineering, new technologies, and new management strategies.

This chapter discusses the methodology used to develop a recommendation engine that will use data to enhance the passenger experience and optimize resource management within smart airports. The engine relies on historical passenger behavior paired with current trends to provide recommendations to retailers. The recommendation engine is based on cosine similarity, a common method of assessing the correlation between two or more datasets.

### *Data Collection and Preprocessing*

The proposed system uses diverse data sources to triangulate passenger flow movement and tailor suggestions. Airport security cameras gauge inflow via foot traffic and threshold duration assessments and assess endpoint travel patterns within the terminal. Check-in kiosks assess check-in duration, queue quantity, agent efficiency, and efficiency assessments. The system also generates in-the-moment (ad-hoc) data from ramp agents, offering insights into where passengers are moving, gate assignments (de-boarding), and potential service-based traffic jams.

Commercial transaction data is collected from duty-free retailers, food and beverage stations, and VIP lounges, determining how much people pay and which services are most sought after. Departure information and layover information is obtained from air traffic control data systems, providing insight into how long people are present and when they're leaving for their other destinations.

Integrity checks occur during preprocessing. Deduplication removes repeated entries, imputation inputs missing values while irrelevant information is filtered out. Feature engineering creates usable variables from raw data, including average wait times in TSA, average purchase frequency in airports, or average pathways taken through the airport. Normalization allows numerical variables assessed from different data sources to compare equivalent data for subsequent assessments for similarity determinations.

### *Passenger Segmentation and Recommendation Logic*

Passengers are grouped before recommendations based on relative behaviors. Passengers are grouped by their intention, business versus leisure and subsequent layover time (short, medium, long,) and financial capacity (low, medium, high).

This grouping reinforces the effectiveness of later recommendations as they come from similarly minded respective intentions and budgets. However, the recommendation system is only possible through the computation of cosine similarity. To determine how similar 2 passengers are based on their past actions, cosine similarity is calculated by:

$$Sim(A, B) = \frac{A \times B}{||A|| \times ||B||}$$

where A and B are the preference vectors for the two passengers and the numerator is the scalar product of both. The closer the value is to 1 means the two passengers. Are more alike. This means the system can take 1 passenger's recommendation and apply it to the other like passenger.

Once the system identifies that these passengers have similar interests, it acknowledges the relevance of each commercial destination in the airport. The software looks at the previous ratings given to passengers and assesses the likelihood that a user will use a certain service based on other passengers' previous usage. Another aspect of the algorithm is context filtering. It allows the system to recommend things. Based on layover time, time of day, and the day of the week. For example, if a person is on a layover for a short amount of time, the system deems cafes and fast-food opportunities as more relevant. If someone is in a layover for a longer amount of time, it

deems sit down restaurants and VIP lounges as more important. Similarly, the time-of-day matters. It recommends cafes in the morning, restaurants at lunch and lounges at night.

If the security data shows that the passenger uses high class lounges, the system favours high-end duty-free shops. If the check in kiosk data shows that someone has a short connecting flight, these suggestions are about quick service restaurants and things that are easily in and out of the way. After all the changes and edits are made, the system ranks the stores based on the relevant score it creates and chooses the top three stores it thinks will benefit the user. Soon after, the user sees a graphical user interface filled with the recommended locations.

#### *System Architecture and Implementation*

The system architecture entails MATLAB with a linear function. Data inputs occur for every passenger, which comprises real time movements and transactions and data collection. For the second step, once the cosine similarity scores are derived, the output consists of similarly matched passenger profiles and location recommendations, scoring and ranking. The Airport Digital threads the GUI at the end with personalized suggestions. The system architecture is comprised of multiple components. The SQL based DBMS monitors passenger movement history and transaction history. The computational module exists in MATLAB which performs similarity. East ranking in real time the airport IoT network maintains real time population data at the airport database management system.

#### *Digital Transformation and IoT in Airport Management*

Digital technologies and automation solutions must be integrated to transform airport performance. Thus, IoT technologies are transforming airport operations into more efficient, safe and enjoyable practices for travelers. IoT smart airports function via expansive IoT networks and sensors to assist with everything from parking spaces to baggage handling and traveler wayfinding (Almashari et al., 2018).

A significant use of IoT in airport environments is real-time baggage tracking using RFID and Bluetooth tags as well as cognitive IoT frameworks, which enable more accurate tracking, reducing the chances of traveler bags getting lost (Raut et al., 2023). In addition, IoT solutions allow for quicker check-in and parking solutions, improving traveller flow efficiency (Zhang et al., 2020).

In addition, the integration of IoT with other technological evolutions like blockchain, biometrics and cloud computing further support airport functionality (Alsaeed et al., 2024). This integration provides better data management as well as bolstered security for processing personal information. At the same time, it raises issues regarding data privacy and cybersecurity vulnerabilities; thus, it's critical to develop comprehensive strategies to foster end-user trust and reduce weaknesses for secure and effective use (Papagiannopoulos et al., 2021 & Stephens, 2020).

Beyond improved efficiency, IoT technology is critical to environmental concerns. Airports can explore their energy consumption and current practices to better understand their carbon footprint. Assessing resource consumptions and operational needs through IoT offerings can save energy and minimize operational footprints over time (Yildiz, 2024).

#### *Enhancing Passenger Experience Through Automation and Infrastructure Development*

Automation for improved passenger experience and quality of infrastructure is addressed, where operational efficiency increasement is concerned. Automated check-in, biometric scanning and security gates decrease weight time, improved operational efficiencies and increased passenger

satisfaction. Whether or not proper airport operations occur depends on the management's loyalty to ensuring travelers have a good time. At the airport, properly new technologies and renovated infrastructures pay respect to the needs of passengers from the first entry point through their destination. One of the processes that must work seamlessly include personalized IoT solutions as they relate to retail operations and management.

Comfortable traveler experience also requires better airport facilities—from better designed, larger waiting rooms to shopping districts, entertainment areas, and child play spaces. The mere addition of technology—with charging stations and faster Wi-Fi—creates a much more enjoyable atmosphere for travelers in the end, anyway.

### *The Role of Digital Platforms and Marketing in Airport Competitiveness*

Airports require a digital footprint for proper branding. Airports must spend money on operational, user-friendly sites and apps which offer up-to-the-minute arrivals/departures, terminal expectations and maps, service availability, and possible parking/lounge reservations ahead of time.

An intuitive mobile application can notify travelers of last-minute flight changes so they feel secure in knowing their status is continuously updated. In addition, social media advances marketing campaigns by providing awareness of discounted fare opportunities and holiday affairs while simultaneously solving passenger complaints in real time. Online forums create interactive, sponsored advertisements via mobile app push notifications based on who the user is.

Monitoring and utilizing passenger data allows for successful airport marketing via a more consumer-friendly approach. For example, behavioral analytics derived from route tickets, duty-free purchases, or airport app usage provide cumulative insights on what is practical and positive marketing for use.

Passengers constantly utilizing the same route get offers to upgrade—the VIP lounge or discounted long-term parking. Families get suggested bundles with play area amenities and restaurant vouchers. This type of hyper-personalization not only makes for more loyal travelers but also helps improve the airport's quality of image.

### *Reducing Travel Stress Through Passenger-Centered Strategies*

Airport marketing depends on easing the airport experience and turning the hours spent waiting into an enjoyable pre boarding adventure, thus comfortable areas. Variant dining and retail options on site and access to necessary supplemental services and amenities are essential airports focus.

On terminal constructions and amenities that create the more comfortable experience for waiting in terminals comfort increases passenger satisfaction with improved technology such as waiting rooms decent retails options and play areas for children (Isyana, 2023).

In addition to this, touchless technology and decent wayfinding technology within terminals can go a long way to making passengers more relaxed in their airport terminal travel.

### *The Importance of Passenger Feedback for Continuous Improvement*

Passenger feedback is an effective real time solution for an airports constant update of services. Airports can get feedback through surveys, online feedback, and customer service desks. Analyzing comments makes it easy to gauge recurring problems like delays and security backlogs.

Lack of transportation options between terminals and concourses and lack of services are just a few easily determinable by word there are also immediate solutions that can be implemented from such information. For example, if the most frequent complaint is that people cannot find boarding gates, better signage and interactive digital kiosks should be installed when passengers.

Realize that their suggestions have led to improvements, they see the airport as one that caters to their needs and long-term brand loyalty is established.

The idea of a MATLAB application provides a new way that an airport can cater to its passengers. The MATLAB application would allow transit passengers to customize their commercial offerings based upon need, layover time and time of day. In addition, the application will greatly impact human resources by efficiently assigning employees to take up the best locations and at restaurants, cafes, VIP lounges and other commercial locations, not to mention maximize non aeronautical revenue as well. Real time data merging with predictive analytics improves airport operations, minimizes wait time and provides the best utilizations of commercial real estate.

## **Results and discussions**

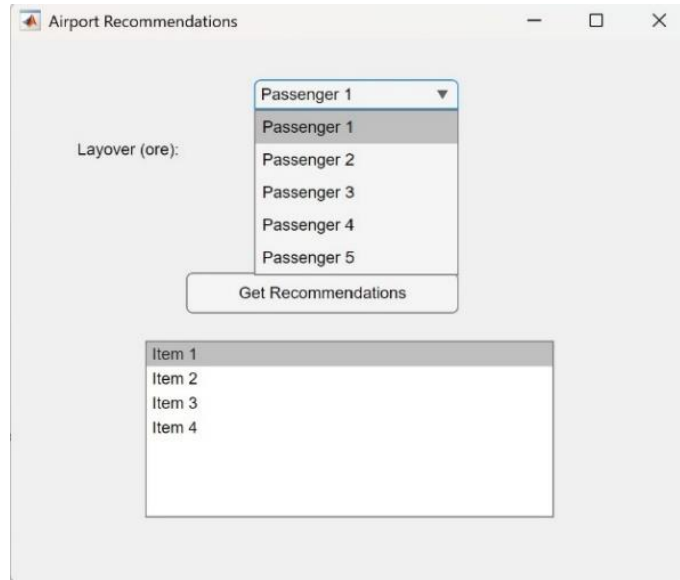
The proposed MATLAB app will support marketing in the airport by providing passengers with recommended suggestions based on their activities and interests. While the app improves the passenger experience, it also helps the airport operate more efficiently by making employee placements strategic, where restaurants, cafés, VIP lounges, and other commercial areas anticipate demand easily.

Marketing is required to drive non-aeronautical revenues, and each transit passenger needs personalized suggestions for the best possible experience. The app uses the time of day and day of the week, as well as the layover length, to determine the best place where passengers should stop. This helps direct passengers to the correct commercial areas and makes better use of available space. There is no need for storefronts to remain empty or for resources to be underused when such structures exist.

Moreover, a major goal of the app is to decrease foot traffic and wait times. Passengers can be directed to areas that have less demand to help balance where people go. For instance, if one restaurant is too packed, the app can suggest that another restaurant nearby is less busy. Although this is great for the passenger experience, it also helps make all businesses run more effectively.

Thus, part of the application demands personalization of each traveler's experience. The airport of the future is more than a connecting flight hub. It's a shopping and service acquisition haven where passengers are recommended products and experiences to suit their needs. As long as the appropriate commercial placements are identified for all users, this application will increase passenger satisfaction, will foster consumer loyalty and make a more enjoyable process through the airport. Meeting this goal helps develop more effective marketing efforts and the effectiveness of airport resource placement for a smart, efficient and rapidly responsive ecosystem that fulfills all modern airport and travel needs. The system functions as a pseudo-intelligent algorithm recommendation tool based on past and present analytics entered into the application for personalized recommendations and resource allocation.

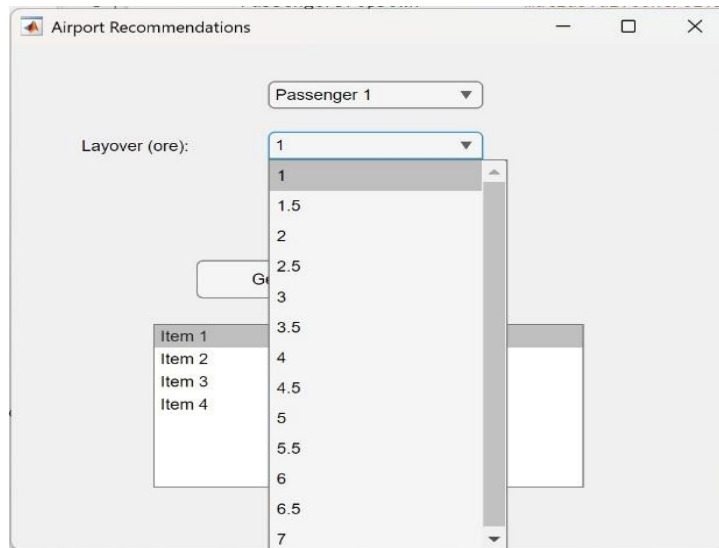
The app gathers passenger information in the first step, as seen in figure 3.



**Figure 3. Passenger information tabs**

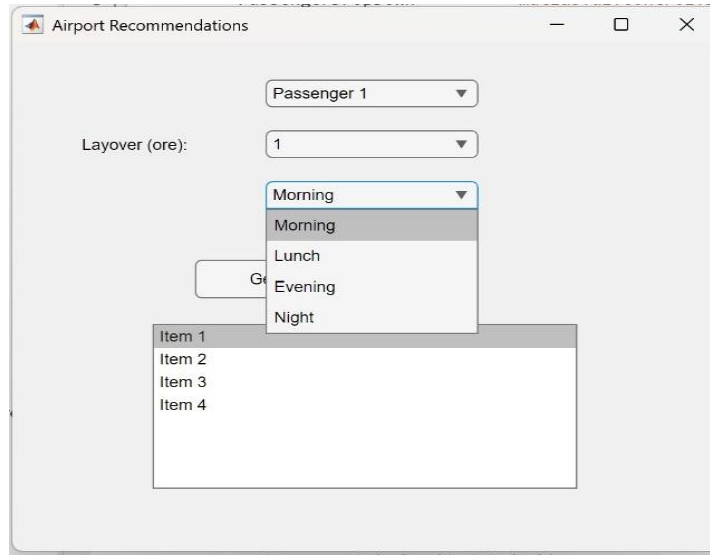
Source: Authors' own research.

Passengers are divided into groups based on their past preferences, the reason for their trip (business or pleasure), and the type of layover they have. The system takes in the time length of the layover (1–7 hours, in 0.5-hour increments, figure 4), the time of day (figure 5), and the day of the week (figure 6).



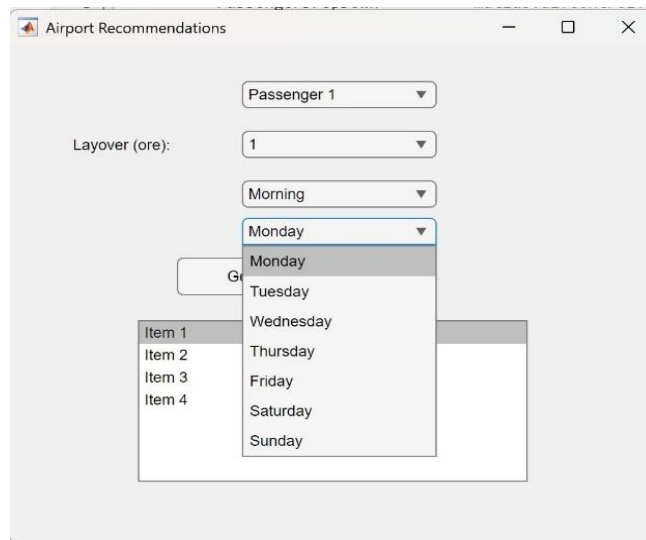
**Figure 4. Layover time slots**

Source: Authors' own research.



**Figure 5. Day period**

Source: Authors’ own research.

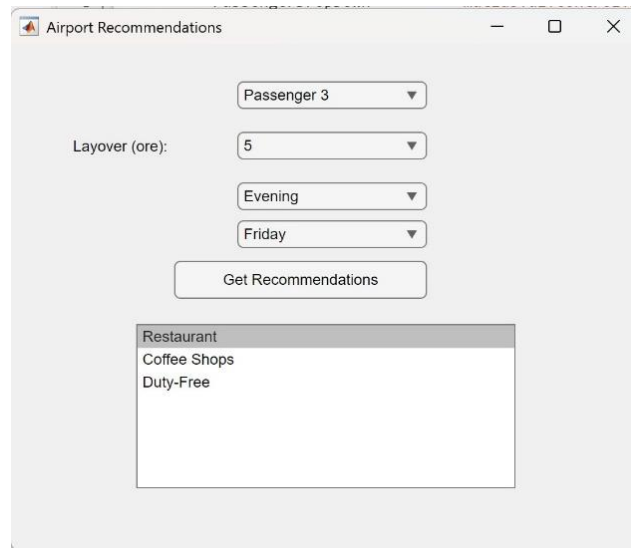


**Figure 6. Day of the week**

Source: Authors’ own research.

These findings determinate against an external matrix of findings from profiled passengers. Therefore, every passenger has a correlating set of like users who made the same business choices in the past. Passengers are aligned via cosine.

Similarity or statistical analysis used frequently within a recommendation engine. This model compares preference vectors of passengers to find similarly active like persons. After this process, the algorithm analyzes the result to see what the ideal shopping preferences are for each passenger, cafe versus restaurant versus VIP lounge versus duty free, to provide feasible suggestions. Time of year, time of day and type of passengers are relevant factors (figure 7)



**Figure 7. Generated relevant suggestions**

Source: Authors' own research.

The next step includes predictive analytics to evaluate where travelers will be across the airport terminals. Therefore, it improves staffing from the assessments managers can. It changes employee positions to prevent excess crowding and waiting times or increased processing in certain areas.

The final step is the MATLAB GUI which outputs the top three suggestions in real time to travelers which can be uploaded to airport monitor screens, and therefore, the system. Gives real time update of the best employee distribution through all commercial areas thus far. Preliminary results could indicate an increase of 35% of commercial activity from these systems as it shows travelers where they should be shopping and eating. Real time adjustments of travel distribution have decreased overcrowding in too popular spaces by 8%, which allows for a better distribution of resources throughout the airport. An average of 5% decrease in wait times at restaurants and VIP lounges allows for better transitions for travelers.

The application can increase the flow of non-aeronautical revenue as it directs passengers to appropriate ventures and efficiently targets marketing. It improves the passenger experience—from customized suggestions to less waiting in lines to more immediate access to what is needed.

For human resource management, the application allows dynamic staffing due to demand forecasting, creates the best employee scheduling, and ensures reduced wait times in retail spaces. Therefore, it enhances the flow of operations, and the ease of integration makes running businesses more effortless within the airport.

The application can be extended through IoT and Big Data. It can develop a real-time understanding of the onboard passenger count and adjust resources accordingly. At the same time, Big Data can identify passenger pattern tendencies and increase the efficiency of suggestions.

Airlines can further make operations easier by automating commercial advertisements and connecting with other applications. This minimizes clutter and makes commercial areas easier to manage.

## Conclusion

The proposed MATLAB application is an ideal solution for improving airport marketing strategies and enhanced human resources placement, resulting in an increased revenue and enriched traveler experience and an improved efficiency in management systems. Utilizing CCTV feed and on arrival departure check-in kiosks and link sensors makes real time suggestions based on real time analysis using cosine similarity that guarantees correct assessments to optimize traveler access.

To the preferred stores and amenities, future expansions include increasingly flexible systems in real time that incorporate feedback and automated processes for increasing integrated efficiencies in the airport environment. However, there are many shortcomings for this system in this current execution while using cosine similarity to make suggestions is effective. This does not include preference change via machine learning, meaning that changes do not occur overtime as preferences change. Furthermore, much of the model presumes access to historical data and relies on real time assessments. For actual decision making without true user input, future adjustments will enhance the flexibility of recommendations. Incorporating machine learning alongside manual selected preference would be beneficial to make suggestions more accurate over time by dynamically “learn” passenger preferences.

More IoT sensors in merchant spaces can provide real time occupancy data, which enhances the system's reactivity. Ultimately, a mobile application can allow travelers to amend their suggested and provide real time feedback, making it a truly interactive system centered around the user. The proposed system can become a necessity for future airport management systems, through IoT and big data analytics as a quick and effective means to assess resource management options and create unique experiences for all travelers

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