ACRP Problem Statement: 454

*Describing, modelling and predicting passengers' arrival patterns*

**Recommended Allocation:** $450,000

**Tags:** Airport-Planning, Finance-Economics, Landside, Operations, Policy

**Thought Leader Forum on Emerging Issues:** Customer Experience

**Research Roadmaps:** N/A

**Staff Comments**

ACRP has conducted research in activity forecasting; however, the topic of passenger arrival/departure patterns has not been explored since ACRP Report 82: Preparing Peak Period and Operational Profiles in 2013.

**AVERAGE INDUSTRY RATING BY AUDIENCE SEGMENT**

<table>
<thead>
<tr>
<th>Audience Segment</th>
<th>Average Rating</th>
<th>Number of Responses</th>
</tr>
</thead>
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<td>Academicians</td>
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<td>1</td>
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<tr>
<td>Airline Representatives</td>
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<tr>
<td>Fed/State/Local Government Employees</td>
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<td><strong>Overall Total</strong></td>
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**AOC Disposition**

The average AOC rating among voting members was 3.3 on a scale of 1 to 5. Airports sometimes have difficulty accommodating alternate passenger arrival patterns. There was uncertainty as to how the research would be accomplished during the COVID-19 pandemic. The problem statement was not selected for ACRP funding and will be returned to the idea collection stage of ACRP's IdeaHub.
**Describing, modelling and predicting passengers' arrival patterns**

**Summary**

This project aims to address passengers' arrival patterns at airports through analyzing accessible information in order to provide an informed guidance for the resource planning of public airports in the U.S.

**Background**

Understanding passengers' arrival patterns could provide invaluable insights for effective resource planning of airports. While airlines have access to individual travelers' booking and historical check-in records to analyze and predict when travelers are likely to arrive, airports are presented with only obscure information to make such estimations for various key facilities, from parking lots, check-in counters, security check lanes, retail spaces, airport lounges to passenger boarding areas. There have been some sparse studies on this topic, but most of them only focus on one airport, rely on one known probability distribution (Poisson or Gaussian) to fit historical data, and deal with an extremely brief period (a week or several days at most). To the best of our knowledge, there is no systematic study that addresses passengers' arrival patterns in a spatial-temporal manner, which is to analyze multiple airports for an extended period of time (a year to several years). Therefore, it is often impractical for airports to have a good grasp of factors that may be crucial to determine passengers' arrivals, i.e., spatial similarities or temporal trend. Failure to recognize the contribution of these latent conditions may mislead airports to make costly, inefficient, and possibly erroneous resource allocation decisions.

**Objective**

This proposed study aims to address this knowledge gap for the airport industry by providing a systematic spatial-temporal analysis of passengers' arrival patterns at U.S. public airports. Using accessible datasets such as TSA security check throughput numbers, flight schedules and ticketing records, this study attempts to provide substantiated answers to the following questions:

1. What is the appropriate theoretical framework that can be used to describe, categorize, and compare passengers' arrival patterns at U.S. public airports?

2. What are the optimal probability distributions and associated parameters to fit passengers' arrivals of flights of different kinds departing in a 24-hour period?

3. Are passengers' arrival patterns consistent or variable across different periods in a year and across different airports in the U.S.?

4. What tools and models can be used to project future passenger arrivals with accessible information by airports to achieve effective resource planning?

**Research Approach**

To achieve the aforementioned objectives, we anticipate the following steps will be taken within an estimated time frame of 18-24 months:

1. Pool and examine accessible datasets, including TSA passenger throughout, BTS T-100 & DB1B databanks;
2. Conduct descriptive analysis to build a theoretical framework to describe, categorize, and compare passengers' arrival patterns using measures such as skewness, kurtosis, standard deviation, mean, median, 'global' and 'local' arrival peaks;

3. Use different probability distributions, such as Poisson, Gaussian, Gamma, or Gumbel distribution, and flight schedule information to fit historical passenger data and to estimate distribution parameters;

4. Decompose time series data of passenger arrivals for seasonal or weekly trend, daily variation, and white noise (error);

5. Analyze and compare airports of different regions for spatial effects, i.e. spatial heterogeneity, spatial autocorrelation and spatial dependence;

6. Simulate passengers' arrivals with the model developed by this study and test the validity of the forecasting model using actual operational data; and

7. Draft the project report and present the final deliverables to the industry panel and ACRP.

Cost Estimate/Backup

We anticipate the completion of the project requires at least 18 months with an approximate budget of $484,830 to support the following personnel and expenses:

PI: Total full-time commitment: 6 months; Salary: $70,000

Co-PI: Total full-time commitment: 3 months; Salary: $35,000

Fringe Benefits: (29.64% for PI and Co-PI): Expense: $31,122

Two graduate research assistants, 18 months each: Salary: $80,000

Facilities & administrative cost: $253,708

IT equipment, office supplies and consumables: Expense: $5,000

Trips to airports and to ACRP Expense: $10,000

Estimated Total: $484,830

Related Research

We have thoroughly reviewed existing literature on or related to the proposed topic. Within the ACRP community, the most relevant study is ACRP Report 23 - Airport Passenger-Related Processing Rates Guidebook (Cassidy & Navarrete, 2009), which primarily focuses on passenger processing rates at various airport facilities. Passenger processing is a subsequent step to passenger arrival in the passenger analysis flow chart, and both steps should be thoroughly investigated to provide accurate inputs for airport resource planning. Outside of ACRP publications, Robertson, Pendergraft, Johnson, and Silhert (2002) use check-in curves for passengers departing at different times in a day. Though they do not mention the distribution type, curves presented in their study resemble normal distribution. Another relevant study was conducted by Postorino, Mantecchini, Malandri, and Paganelli (2019). They estimate the arrival patterns of passengers travelling from Bologna Marconi Airport, a regional airport located in Northern Italy, on the flight
level, and their model considers carriers' business types (full service & low cost), flight destinations (domestic, Schengen region and international), and departing time (morning and afternoon). The model selects Weibull distribution to describe passengers' arrival process. In a study specifically addressing Baltimore–Washington International (BWI) Airport, Reed (2003) fitted the passenger arrivals with different combinations and types of probability distributions at the airport facility level. His study confirms the significance of knowing the patterns of passengers' arrivals, and the distribution variation at different facilities in an airport. In a working paper by Mehri, Djemel, & Kammoun (2006), they use Poisson distribution to simulate the arrival of passengers at Monastir Habib Bourguiba International Airport in Tunisia. And in other modes of transportation, the arrival of passengers are estimated with Gumbel minimum distribution (Janosikova & Slavik, 2015).

From the brief review of aforementioned literature, it can be seen that existing studies on passenger arrivals focus mostly on one airport for a very brief period of time and use different types of probability distributions. There is no systematic study that addresses passengers' arrival patterns in a spatial-temporal manner, which is to analyze multiple airports for an extended period of time. And this is the right gap to be addressed by this proposed study.

References


Author: Yi Gao, Purdue University
INDIVIDUAL COMMENTS FROM THE INDUSTRY REVIEW

Applicable, achievable, and implementable: Will be immediately useful to many Airports.

Describing, modeling and predicting passengers arrival patterns could be very beneficial to provide informed guidance and resource planning for airports. The problem statement has identified a gap that needs to be analyzed. However due to COVID and the expectation that it may take up to five years to have the same amount of passenger movement as pre COVID may make this project less successful. The data may be skewed. The problem statement is very good under normal circumstances and would be very achievable. However this project may need to wait until passenger movement has readjusted in order for the data to really assist in resource planning.

Excellent problem statement that could result in actionable information for airports.

Excellent project premise. This is a problem faced by airport facilities with little guidance available. This would also address some planning issues to avoid "building a church for Sunday Service". Additional considerations should be given to how specific local economies contribute to passenger arrival patterns. For example, how passenger arrival patterns are impacted by the cruise industry at port cities.

It is important for airports to have a good grasp of factors that may be crucial to determine passengers' arrivals. Often times arriving passengers are like wanderers in the airport. To have a fixed path to baggage claim, transportation and other exits would be excellent and stop the "wandering" passenger episodes.

Research should expound on predictive analytics in airports as tool to engage and empower airport personnel, to properly forecast and manage airport facilities.

seems interesting but don't necessarily understand what is going to be done and how the results will be usable for airport professionals

The problem statement identifies the need for pax arrival patterns that is useful for airport planners when planning both existing facilities as well as future expansion.

This is an exercise that needs to be airport specific. A one-size fits all approach is not appropriate.

This is an expensive proposition for a project that can't be universally used or adapted for each Airport. Many characteristics influence this behavior which would be different at nearly every airport.

This topic and 290 are related also the current work being performed on TNC's but helping airports understand and model arrival patterns would be useful.

Very important topic; the statement is well-written and the research should result in a better understanding of ground access behavior.

Very interesting and valuable modeling.
Idea Number: 454

**Describing, Modelling and Predicting Passengers' Arrival Patterns**
Input Provided by ACRP IdeaHub Community

The votes and comments below were provided by the IdeaHub community prior to the idea’s submission as a problem statement.

Idea Link: [http://ideascale.com/t/UKsrZBj1t](http://ideascale.com/t/UKsrZBj1t)

Tags: Airport-Planning, Finance-Economics, Landside, Operations, Policy

Votes:

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Comments:

N/A