Optimization of Passenger Screening Operations in Airport Terminals

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Introduction

Airports today play an important economic role. As intermodal transport terminals, they have to channel important flows of passengers and goods.

In recent decades, they have been the target of terrorist attacks and the place where all types of traffic pass.

Consequently, they are faced with the dual objectives:

- maximization of security system as well as maintenance of consistent quality and insurance of fluid traffic flow passengers;
- minimization of the expected amount of time a passenger spends in this system.
Introduction

In this article, we are interested in the evaluation of the system of control of passenger flows at boarding, whatever their subsequent path, through a probabilistic approach.

Airports’ queues longer than flights!
Introduction

- Securing air transport means giving it immunity against accident, sabotage, assault, aggression, hijack, but also giving it immunity from being exploited to commit a terrorist act. The problems of the airport security cost and its management are present today.

- Annex 17 of the ICAO Chicago Convention says that each Contracting State shall take measures to prevent weapons, explosives or any other dangerous devices to be used to commit an illegal act. Therefore States must ensure that the carriers develop and implement effective complementary security programs compatible with those of the airports out of which they operate.

- The main objective of this study is to bring a methodological contribution to this issue.
In order to better understand the context and to be aware of all the underlying issues, we worked on a Literature Review of the work done on different simulations as follow:

Total cost minimization:
- Cost of space;
- Operating costs;
- Cost of uneasiness endured by passengers when the waiting time exceeded the tolerable limit.

All passengers behave differently, and the development of a simulation model helps to predict, taking into account the available capacity and the fact that the volume of passengers depends on day time and the week day and the passenger behavior.
Passengers Flows in an Airport

Organization scheme of a passenger terminal

- Aircraft parking position
  - Boarding Lounge
  - Emigration Control
  - Immigration Control
  - Baggage Sorting
  - Security Control
  - Security Screening Control
  - Check-in Counter
  - Baggage Delivery
  - Customs Control
  - Baggage Sorting

- Public Hall
- Esplanade

Passengers’ circuit

Baggage Circuits

Transit passengers

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Probabilistic Modeling of the Checkpoints

Security system treatment process
Probabilistic Evaluation of a Control System with Pre-Filtering

Example of a Security Control Structure

- First, two types of checkpoints are considered:
  - Those that are mandatory (named C1).
  - Those that reinforce these controls in certain circumstances (named C2).

Passenger flows at the entrance of the security checkpoint system

Passenger flows at the exit of the security checkpoint system

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Optimizing the Assignment of Passengers to Screening Checkpoints

- The aim here is to minimize the probability of non-detection of a threat while trying to guarantee a maximum level of false alarms and taking into account the average availability of the checkpoints.

\[
\text{Min} \left( \sum_{i=1}^{N} \left( \sum_{m=1}^{\mu} \pi_m \prod_{j \in C_2^i} (1 - p_{mj}) \right) x_i \right)
\]

\[
(1 - \tau_A) \sum_{i=1}^{N} \left( (1 - \prod_{j \in C_2^i} q_j) x_i \right) \leq P_{FA}^{\text{max}}
\]

\[
\sum_{i=1}^{N} x_i \leq y_j^{\text{max}} \quad j \in C_2
\]

\[
\sum_{i=1}^{N} x_i = 1
\]

\[
0 \leq x_i \leq 1 \quad i = 1, \ldots, N
\]
Conclusion

The probabilistic approach used in this study has several advantages:

- It allows putting in equation the dilemma (Probability of non-detection \( \times \) Probability of false alarm).

- It shows the interest of the differentiated treatment of passengers who have all taken a first step.

- It shows the interest of establishing a first filtering before implementing a differentiated treatment that only becomes more efficient.

- The degree of complexity of the probabilistic models developed leads to problems of linear programming in small continuous variables.
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