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A hazard-based analysis of airport security transit times☆

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A B S T R A C T

Airport security screening, and the amount of time it costs travelers, has been a persistent concern to travelers, airport authorities, and airlines – particularly in recent years where changes in perceived threats have resulted in changes in security procedures that have caused great uncertainty relating to security transit times. To gain a better understanding of the factors influencing travelers' security transit times, determinants of security transit times are studied by using anonymous Bluetooth media access control address matching to determine the actual security travel times of individual passengers at the Cincinnati/Northern Kentucky International Airport. These transit-time data are then analyzed using a random-parameters hazard-based duration model to statistically explore the factors that affect airport security transit times. The estimation results reveal, as expected, that a wide variety of factors affect security transit times including the number of enplaning seats (reflecting flight schedules), weather conditions, day of week, as well as obvious variables such as traveler volume and the number of open security lanes. The detailed statistical findings show that current security procedures are reactive instead of proactive, and that substantial reductions in security transit times could be attained by optimizing security operations using a statistical model such as the one estimated in this paper.

1. Introduction

To improve traveler security and deal with new perceived threats, there have been many changes in airport screening practices and technology in recent years (Leone and Liu, 2011). However, as these practices and technologies have evolved over time, there is the continual need to strike a balance between the level of safety provided to travelers and the inconvenience being caused by airport screening practices, which can be measured in terms of factors such as lost time and intrusions on traveler privacy. While traveler perceptions and satisfaction with airport screening procedures can be difficult to measure and may change over time (Gkritza et al., 2006), the factors that affect travelers' transit times through airport security screening can be readily assessed and such an assessment can serve as a basis for new policies and procedures that seek to reduce security transit times.

Airport security transit times have historically been analyzed with traditional queuing theory approaches, using various assumptions with regard to traveler arrival and processing rates, or by applying statistical analyses of observed transit times (Gilliam, 1979; Zografos and Madas, 2006; Castaneda et al., 2007; Marin et al., 2007; Manataki and Zografos, 2009; Lee and Jacobson, 2011; Seo et al., 2012). These approaches (and really all approaches that assess security travel times) require a sizeable amount of data collection. Queue length, the length of time it takes to transit through the queue, and processing time are all potentially important considerations (Goswami et al., 2007; Correia et al., 2008).

Over the years, different methods have been used to collect this airport security data, including manually handing out time-stamped cards at the entrance of security and time-stamping them at the end of security, and using videos to observe queue length, travelers transit times through the queue, and security processing times. More recently, technology such as anonymous Bluetooth media access control (MAC) address matching (Bullock et al., 2010; Remias et al., 2013), radio-frequency identification (RFID) (McCoy et al., 2005), iris or facial recognition (Elgendi, 2005), and WiFi tracking have been used to collect security transit-time data. In addition to providing data for in-depth statistical analysis, these real-time data-collection approaches can potentially allow security operators to make immediate changes to security

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operations in high-demand time periods by opening more security-processing lanes or by adding more personnel to decrease processing times in open lanes.

Unfortunately, security operators are often restricted by staffinglevels and other constraints that can make real-time adjustments in response to such data difficult. However, statistically analyzing technologically-enabled security transit-time data could help security operators to better understand the important variables that affect these transit times and make more informed long-term staffing and operation decisions. The analysis of such security transit-time data would presumably provide important insights into the effects of flight schedules, different days of the week, seasonal and weather changes, as well as security operational configurations such as the number of open checkpoint lanes, the type of security screening protocols, and other important elements of the security-screening process.

In the current paper, anonymous Bluetooth MAC address matching is used to observe security transit times over a one month period at the Cincinnati/Northern Kentucky International Airport. These data are then analyzed using a random-parameters hazard-based duration model to statistically explore the factors that affect airport security transit times. As will be shown, the model estimation results provide information that is useful in quantifying the effect that a variety of factors have on security transit times.

2. Empirical setting

The Cincinnati/Northern Kentucky International Airport was selected as the source of data for this study. The airport serves a wide area throughout Ohio, Kentucky, and Indiana. Since the airport consolidated from being a hub airport, security operations have been shifting to a new terminal facility and Fig. 1 shows the security layout for this terminal. Referring to this figure, as travelers enter the terminal (callout "a"), they either proceed to the ticket counter or directly to the security screening area. As travelers proceed to the security screening along either side of the central staircase, they proceed past either Bluetooth monitoring Station A or Station B. If any traveler has a Bluetooth enabled device, their unique media access control address (MAC address) is collected. Travelers will wait in a queue and then be processed through one of the ten security lanes (callout "b"). For the Cincinnati/Northern Kentucky International Airport, checkpoint lanes are opened in pairs (lanes are operated in groups of two), so there are effectively 5 lane-pairs. Once through security, travelers will recollect their belongings and head down the elevators or escalators (callout "c"). They will finally pass Bluetooth monitoring Station C where their MAC address will again be noted and then continue on down the walkway to the terminals.

The Bluetooth monitoring stations used class II antennas and sampled up to 8 times a second. Because travelers walking through the zone of detection would register multiple entries, careful filtering was used to eliminate repeat observations. Once the repeat observations were removed, travel times could be determined by matching the time of MAC address observed at either Station A or Station B with the time observed at Station C. The difference in the time would be the security transit time. It should be noted that security personnel and airport employees could be filtered based on repeat matches over various days. But filtering these observations was done with care to not eliminate repeat travelers who used the airport multiple times over the month.

It should be noted that security transit time was the measure recorded. This included the walk time, wait time (or time in queue), processing time, and re-composure time (gathering belongings and such). Under "free flow" conditions without a queue, the security transit time was measured at about 3 min and 15 s.

3. Data collection

From November 11, 2011 to December 8, 2011, over 660,000 Bluetooth MAC address records (6200 unique MAC addresses) were

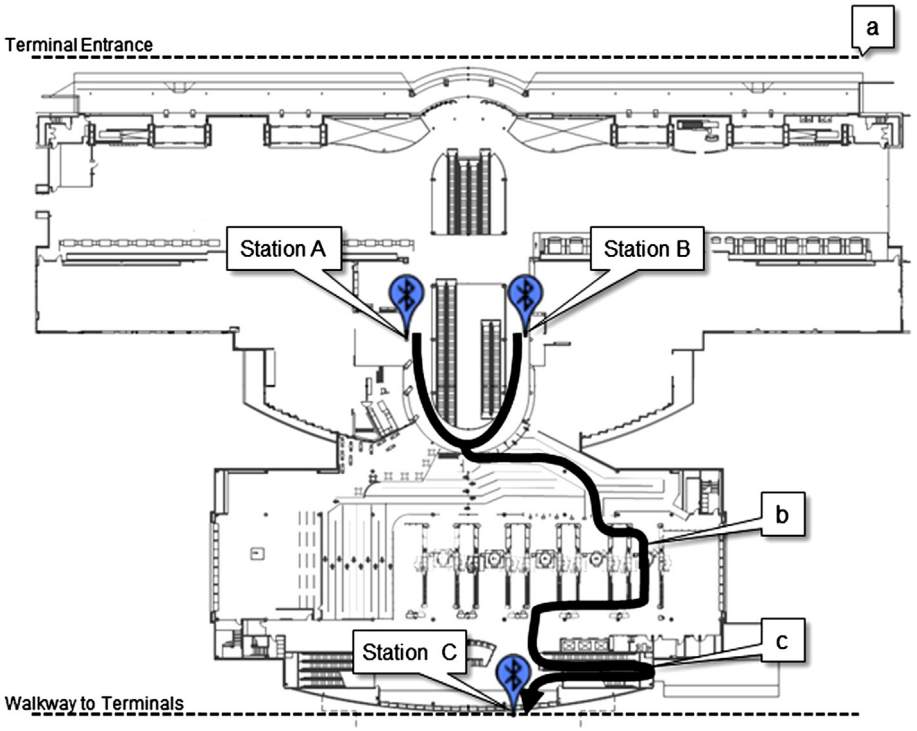

Fig. 1. Airport security arrival process at Terminal 3 of Cincinnati/Northern Kentucky International Airport.