A Study Of Passenger Perception And Sensitivity To Airport Backscatter X-Ray Technologies

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ABSTRACT

Because of September 11, security continues to be a concern in the airline business. Enhancing airport security is one of the highest considerations of the federal government, which is currently employing electromagnetic screening systems and metal detection portal technologies, in order to screen airline passengers for hazardous metallic objects. Improving security is considered critical in mitigating the perceived risk of terrorism and threat, though privacy sensitivity is frequently a consideration if not a concern of passengers. This study analyzes factors of public acceptability of airport backscatter screening systems, in a current survey of passengers in New York City and in Tel Aviv. The study furnishes findings that may benefit administrators in the federal government in the implementation of x-ray screening systems that are cognizant of not only the risk of terrorism but also of public sensitivity to intrusive technologies.

BACKGROUND

The events of September 11, 2001 exposed critical flaws in the airline industry that necessitated an in-depth analysis of security. Before September 11 airport security was not centralized and was the concern of airports, airlines, and the Federal Aviation Administration (FAA). With more than 400 airports in the United States, a number contracted security with firms, while others had police departments. The more than 100 airlines contracted passenger screening with firms. This was detrimental to security, as employees from firms did not have adequate education in security. Average learning for x-ray machine operators was 12 hours (Seidenstat, 2004). Operators were paid close to an hourly salary of $6.00 and were not always screened for criminal history (Seidenstat). Airlines partnered with security firms to lower costs. They opposed stern and rigorous security standards that would irritate passengers. The role of the FAA was regulating the aviation security system, but not strengthening standards.

Following September 11, restructuring of security was introduced in the industry. The Transportation Security Administration (TSA) was created in the Department of Transportation, in conjunction with the Aviation and Transportation Security Act, which was signed into law by President Bush. This agency centralized security of the airline system and federalized passenger screening at airports. In 2003 TSA was integrated into the new Department of Homeland Security (DHS). To improve passenger screening, TSA hired higher paid and trained operators screened for criminal history.

The number of TSA operators increased from 16,000 in 2001 to 44,000, of which 33,000 were screeners (Seidenstat). In 2003 they intercepted 1,000 guns, 1.5 million knives, 15,000 clubs, 40,000 box cutters, 125,000 flammable devices, and 2.5 million other objects at airports (TSA, March, 2003). Passenger screening increased from $600 million in 2001 to $3.3 million in 2003 (De Lollis & Coughlin, 2002). Checked baggage screening increased to $800 million in 2003 (De Lollis & Coughlin, 2002). In 2003 legislation furnished $3.5 million to airports and airlines for other incidentals, such as reinforcement of cockpits (Ghobrial & Irvin, 2004 & TSA, May, 2003).

Before September 11 passenger screening systems consisted of metallic detection portals and hand-wand detectors and included physical pat down as a secondary screening. These systems could not detect non-metallic hazards and plastics. In 2000, 2,000 devices were seized from passengers (Seidenstat), but detection of hazardous objects was 20% short (GAO, 2003). Following September 11 there were 1,400 explosive detection (EDS) and 6,500 explosive detection trace (EDT) systems (TSA, 2005). TSA continues to evaluate explosive detection trace portal systems at a number of airports in the United States. Passengers are screened in portals where air is blown at them, and the air is collected and reviewed for explosive and hazardous substances. The TSA is concurrently evaluating explosive detection document scanners that review documents for explosive substances.

Systems include the Computer-Assisted Passenger Prescreening System II (CAPPS II), an enhanced airline passenger profiling system designed to review security risk. To confirm the identification of passengers, their names, addresses, home telephone numbers and birth dates are compared to data in commercial files and governmental systems. Although CAPPS II can identify terrorists or those affiliated with foreign terrorist organizations before boarding aircraft, forged identities may defeat the system (Ghobrial & Irvin). Passengers flagged as high risk may not challenge risk scores that may be in error (Ghobrial & Irvin).

Systems of controversy in this study include backscatter human x-ray technologies. X-rays detect metallic and non-metallic devices, such as ceramic, metal, organic and plastic objects. High energy x-rays scatter radiation from the body of the passenger into detailed images. Signals interact with explosives, metals and plastics, furnishing darker images than those deflected off the skin. Energy is as high as CAT scans (Kaufman, 2005). Screening is done in seconds. Imaging of the passenger is in the nude (EPIC, June, 2005), as in Figures 1 and 2, and the information on passengers may be retained by the technologies (EPIC, 2005). Though the TSA feels that the technologies are less intrusive than physical pat down screening, the personal details from the body of the passenger is considered equivalent to a "virtual strip search" (EPIC, 2005).

Figure 1: Male Passenger With Firearm
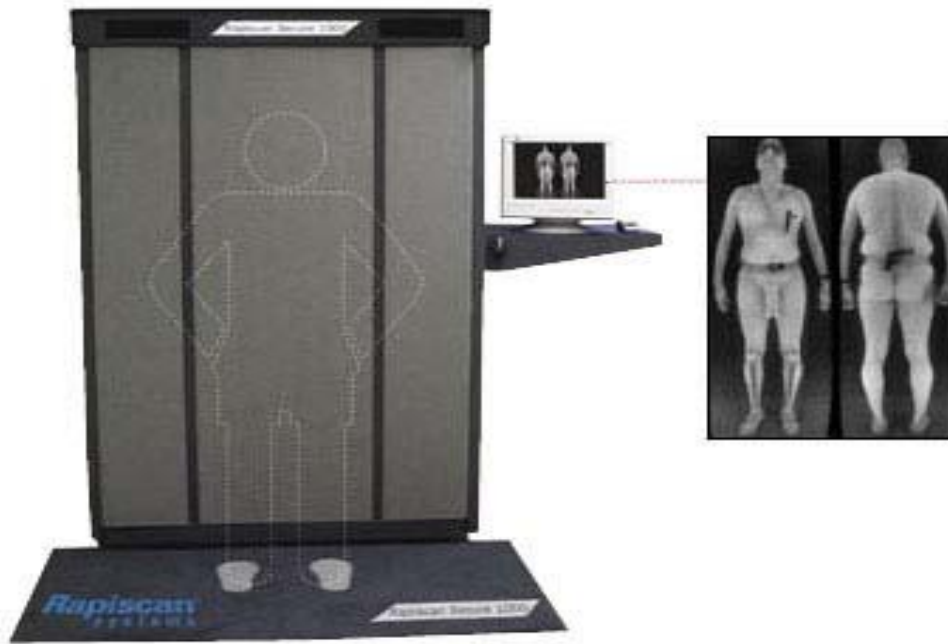
Source: Electronic Privacy Information Center (EPIC), 2005

TSA continues to employ backscatter x-ray technologies at close to 20 airports in the United States, though the privacy of passengers is at the center of the controversy. Passengers may be reluctant to be screened with these technologies (EPIC, June 2005). American Science and Engineering Inc., a manufacturer of backscatter human x-ray technologies, is one of a number of businesses continuing to grapple with issues of privacy with the TSA (Forman, 2005), as the TSA continues to introduce the technologies. The American Civil Liberties Union (ACLU) opposes the technologies as a routine screening step (ACLU, June, 2002). It is uncertain if the privacy of passengers will be resolved by the TSA, as it anticipates full deployment of backscatter x-ray technologies in the United States.

Figure 2: Female Passenger With Firearm
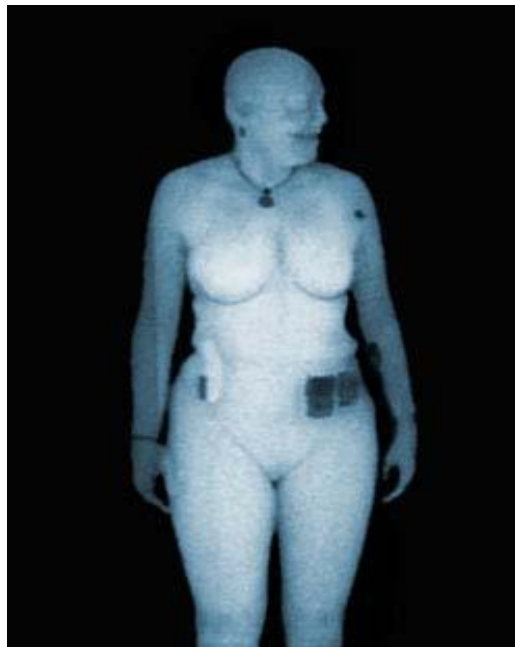
Source: Electronic Privacy Information Center (EPIC), 2005

INTRODUCTION

Security consists of the protection and safety of passengers, and security systems are designed to overcome threats (Sugiyama, 2004). Passengers may sacrifice personal freedom for more security (Peissl, 2003). The balancing of privacy sensitivity and security is a beginning factor of study of backscatter passenger x-ray technologies. Privacy is defined as the "general right of [passengers] to be left alone" by government, and the right to privacy is defined by the Fourth Amendment of the Constitution of the United States (Fujawa, 2005). Passengers are considered to be protected from illegal search and seizure.

Airport screening by x-ray technologies is classified into conditions of administrative search, consent to search, and search by stop-and-frisk (National Research Council, 1996). Administrative search is considered justified because of aviation safety and of fulfilling a defined objective in society. Interest in airline security may outweigh the invasion of privacy, but "that invasion must still be minimized to the extent feasible because the invasion is justified only to the extent necessary to achieve the government goal of safety" (National Research Council). Search by stop-and-frisk is when an operator suspects that the passenger is a security threat. Consent to search is when passengers surrender their rights to be searched by operators. Screening technologies are considered effectively justifiable, irrespective of passenger perception of security threat and of privacy sensitivity.

Further referencing to privacy is in Article 12 of the United Nations Universal Declaration of Human Rights (Johnson, 2004).

Following September 11 however, the Uniting and Strengthening America by Providing Appropriate Tools Required to Intercept and Obstruct Terrorist Act (USA PATRIOT Act) was introduced in late 2001. The act enables officials to have search warrants without having specific evidence or just cause (Fujawa), impacting the privacy right in the Fourth Amendment. Such legislation is of concern as privacy and the intrusion of x-ray technologies are perceived to be issues of passengers.

This study introduces *passenger sensitivity to privacy* (Leo & Lawler, 2006) as an exploratory factor of consideration in passenger acceptance of backscatter x-ray technologies. The factor of *passenger perception of security threat* (National Materials Advisory Board, 1996) is introduced as a consideration that security threat may be more important than privacy in passenger receptivity to the technologies. The study integrates *passenger perception of effectiveness of screening technologies* (National Materials Advisory Board), *passenger knowledge of functionality of screening technologies* (National Materials Advisory Board), and *passenger knowledge of imaging and information storage by screening technologies and of information usage* (Leo & Lawler, 2006) as further factors of importance that may impact receptivity. The evaluation factors of the study are summarized below in Table 1.

Table 1: Evaluation Factors Of Study

Factors of Study	Definition of Factors	Sources of Factors
Passenger sensitivity to privacy	Passenger sensitivity on personal and perceived private information	Leo & Lawler, 2006
Passenger perception of security threat	Passenger perception of reality and severity of airport security and terrorism threat	National Materials Advisory Board, 1996,
Passenger perception of effectiveness of screening technologies	Passenger perception of airport success of screening technologies in detecting explosive and hazardous objects	National Materials Advisory Board, 1996
Passenger knowledge of functionality of screening technologies	Passenger knowledge of airport techniques of screening technologies	National Materials Advisory Board, 1996
Passenger knowledge of imaging and information storage by screening technologies and of usage	Passenger knowledge of information storage techniques and information usage subsequent to screening by technologies	Leo & Lawler, 2006

These factors form a foundation for an exploratory perception and sensitivity study of x-ray screening technologies.

FOCUS OF STUDY

The focus of the study is to explore passenger sensitivity to privacy, passenger perception of security threat, passenger perception of effectiveness of screening technologies, passenger knowledge of functionality of screening technologies, and passenger knowledge of imaging and information storage and of usage, as factors of consideration in public acceptability of airport screening technologies. The extent of the importance of personal privacy, security threat and perceived risk of backscatter x-ray screening technologies *in tandem*, that is not clear in the scholarly literature, is the goal. The contribution of the study is in furnishing insight in passenger perception and sensitivity that may benefit administrators in the government in their implementation of screening technologies in the United States.

METHODOLOGY

The study began as a project by the principal author in a graduate *Information Systems Research Seminar*, in the Ivan G. Seidenberg School of Computer Science and Information Systems of Pace University, in New York City, in January 2006. The bulk of the methodology of the study comprised an analysis of a beginning sample of airline passengers in metropolitan New York City, on the factors of evaluation in the aforementioned Table 1. The study was conducted in *3 stages*.

In *stage 1* 25 generally experienced passengers in New York, described in Table 2, were e-mailed an instrument of survey. The instrument consisted of 10 quantitative structured summarized questions on the factors of sensitivity to privacy, perception of security threat, perception of effectiveness of screening technologies, knowledge of functionality of screening technologies and knowledge of imaging and information storage by screening technologies and of usage. The instrument included 5 detailed quantitative structured questions on factor impact on intrusion on the passengers. To the answers of the questions was applied a 6-point 5 = very high, 4 = high, 3 = intermediate, 2 = low, 1 = very low, and 0 = none scale. The survey was conducted in January – March 2006.

(Instrument of survey is available upon request of the corresponding author.)

In *stage 2* the data from *stage 1* was collected from the full 25 passengers and analyzed by the principal author in Microsoft Excel in March 2006.

In *stage 3* of the study, the first of a sample of experienced passengers in Tel Aviv, Israel, was e-mailed an enhanced copy of the instrument of survey in *stage 1*. Because the Ben Gurion International Airport in Israel is perceived to be the highest in implementation of screening and security technologies, the authors considered the passengers in Tel Aviv as likely insightful subjects. The instrument of survey included 5 detailed qualitative semi-structured questions and the 10 and 5 quantitative structured questions in *stage 1*. The survey of the first but highly knowledgeable Israeli passenger was conducted in April – May 2006, and the data was analyzed in May 2006.

(*Stage 3* was curtailed in June 2006 due to the crisis in Israel and Lebanon.)

Table 2: Description Of Passenger Subjects In United States – Stage 1 Of Study

Gender	Number	Percentage
Male	10	40%
Female	15	60%
Total	25	100%
Age		
22-24	1	4%
25-30	3	12%
31-40	17	68%
Over 40	4	16%
Total	25	100%
Education		
Undergraduate Degree	11	44%
Graduate Degree	13	52%
Post-Graduate Degree	1	4%
Total	25	100%
Type of Travel		
Business	5	20%
Vacation	14	56%
Personal	6	24%
Total	25	100%
Frequency of Round-Trip Travel		
Less Than 3 Times a Year	9	36%
Between 3 and 5 Times	7	28%
More Than 5 Times	9	36%
Total	25	100%

ANALYSIS

The analysis of the data from the evaluation by the United States passenger subjects disclosed *intermediate sensitivity to privacy* (means = 3.84) *and intermediate perception of security threat* (3.64), *low perception of effectiveness of screening technologies* (2.68), and *very low knowledge of functionality of screening technologies* (1.52) *and of imaging and information storage by screening technologies and of usage* (0.84). The analysis also disclosed *lower willingness to accept personal intrusion by screening technologies* (2.20) and (2.64), assuming inadequate knowledge of the functionality, storage and usage of backscatter x-ray screening technologies. These analyses are summarized below in Table 3 and detailed in Table 4.

Table 3: **Means Summary Of Passenger Subject Survey In United States - Summary**

Factors of Study	Means
Passenger sensitivity to privacy	3.84
Passenger perception of security threat	3.64
Passenger perception of effectiveness of screening technologies	2.68
Passenger knowledge of functionality of screening technologies	1.52
Passenger knowledge of imaging and information storage by screening technologies and of usage	0.84

Means Scale: 5 = Very High, 4 = High, 3 = Intermediate, 2 = Low,
1 = Very Low, and 0 = None

Table 4: **Means Summary of Passenger Subject Survey in United States - Detail**

Factors of Study	Impact on Intrusion	Means
Passenger sensitivity to privacy	Passenger willingness to accept personal intrusion by technologies in general	3.04
Passenger perception of security threat	Passenger willingness to accept personal intrusion by screening technologies if security threat is perceived tangible by public	3.52
Passenger perception of effectiveness of screening technologies	Passenger willingness to accept personal intrusion by screening technologies if technologies are perceived successful by public in deterring terrorism and threats	3.84
Passenger knowledge of functionality of screening technologies	Passenger willingness to accept personal intrusion if screening techniques of technologies are perceived to be understood by public	2.64
Passenger knowledge of imaging and information storage by screening technologies and of usage	Passenger willingness to accept personal intrusion by screening technologies if storage techniques and usage are understood by public	2.20

The data from the New York City subjects is indicating that they were intermediately sensitive to privacy, but not highly sensitive (3.84 / 5.00), and intermediately perceptive of the severity of terrorism and threat, but not highly perceptive (3.64). They were less perceptive of the effectiveness of the success of screening technologies (2.68). Significantly, they were less knowledgeable of the storage, techniques and usage of the technologies (0.84) and (1.52). Their willingness to accept personal intrusion of screening technologies given their lack of knowledge (2.20) and (2.64) was less than their willingness to accept intrusion given their perception of the effectiveness of the technologies (3.84), perception of the threat (3.52), and privacy sensitivity (3.04). The data on these subjects is implying that subject knowledge of backscatter x-ray screening technologies may be more important than privacy sensitivity in subject receptivity to the technologies.

The analysis of the data from the first of the Tel Aviv passenger subjects disclosed very high perception of security threat (5.00) and of the effectiveness of screening technologies (5.00), though no knowledge of the storage, techniques, and usage of the technologies (0.00) and no privacy sensitivity (0.00). Willingness to accept personal intrusion was therefore very high (5.00). These findings are not consistent with any of the New York subjects, due to

the continued culture of security alert, if not fear, and the discernable tangibility of threat in Israel. Such conditions effectively eliminated knowledge of screening technologies in the receptivity of the Tel Aviv subject to the technologies. The literature on Ben Gurion International Airport and on Israel (Black, 2003, Croft, 2005, & Schwartz, 2002) indicates the deterrence focus and risk management of Israel, in contrast to countermeasures of the United States. The data on the Tel Aviv subject has to be confirmed with further Israeli subjects, and the findings may not be extendable to the United States.

IMPLICATIONS

The first initial implication of the study is the importance of both better knowledge of backscatter screening systems and knowledge of imaging and information storage and usage, in the receptivity of the technologies by passengers. If the passengers have clear knowledge of the fundamental functionality of the systems, they might be more comfortable and receptive to the screening techniques and to the technologies. *The federal government might consider enhancing its methods in notifying passengers of the benefits and features of screening technologies*.

Further implications include the importance of perceived effectiveness of screening technologies. If passengers have creditable government neutral information on the success of the technologies, they might be more receptive and less sensitive to intrusion of privacy. *Federal government might consider improving its media interactions in informing the public of successful screening of threats*.

Other implications include the importance of perceived security threat. If passengers perceive not rote reiteration of threats, but seriousness and the tangibility of threats, such as in Israel, they might be more receptive to intrusive screening technologies. *The government might consider improving its methods in notifying the public of creditable security threats and of successful solutions to the threats*.

Overall implications include the importance of privacy sensitivity in the society of the United States. Other non-invasive methods that do not consist of digital imaging might be considered by government officials. Overly privacy sensitive passengers might be given options if they object to screening technologies. Operator screening might be performed by the same sex as the passenger. Screening might be in a private setting by such personnel. Pat down or wand screening might be options. Sensitive sections of the bodies of passengers might be distorted or camouflaged by the systems. If passengers are reassured that imaging and information are not retained by the screening, they might be more receptive to the technologies. *The government might concurrently consider backscatter x-ray screening technologies as not the sole security techniques*.

LIMITATIONS AND OPPORTUNITIES IN RESEARCH

The results of a small sample of passenger subjects in one geographic location of the United States, in the limited spring semester of 2006, cannot be generalized without caution and is a clear limitation of the review. Results from larger samples of subjects in other geographic locations of the United States and in European and international locations, not only in Israel, can form creditable hypotheses for further study. Reviews of scholarly studies may be helpful in clarifying practices of privacy solutions. Surveying of officials of the Transportation Security Administration (TSA) and of practitioners in screening technologies might be helpful in further clarifying security threats. The study will continue in the future in the *Information Systems Research Seminar* of Pace University.

CONCLUSION

The study is helpful in identifying knowledge of functionality of x-ray screening technologies and knowledge of imaging and information storage by the technologies and of usage as fundamentally important in United States passenger receptivity to backscatter technologies. Initiatives in further informing the public of the technologies and of security threats might be considered by administrators in the federal government. Research with other passenger subjects on these technologies will be continued at the university in 2007 and 2008, in order to improve the insight of the study.

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