Human factors
in layers of defense in airport security

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Abstract: Airport security systems are built up out of layers of defence based on the security-in-depth model (Talbot & Jakeman, 2008). The Transport Safety Authority (TSA) in the United States defined a staggering 20 layers of defence to control security risks. This means that not only security personnel is responsible for security at the airport but many others too. However, the perceptions vary between different users of airports so it is difficult to involve all airport users in the security process. This paper focuses on identifying these factors through surveys. Differences were found between the level of education, between employees and passengers, between job groups working in the airport for instance the perceived level of trust in technology used in airport security or the perceived level of safety in the airport.

Keywords: layers of defense, airport security, human factors

1. INTRODUCTION

In December 2009 an Al Qaeda-inspired Nigerian, Umar Farouk Abdulmutallab, tried to detonate the explosives sewn into his underwear on board North West flight 253 with 278 passengers. October 2010 security officers removed bombs hidden in toner cartridges from cargo planes in Britain and Dubai bound for Chicago. These bombs were timed to go off when the planes where flying over America. Allegedly, the maker of both bombs is one and the same person. The bombs did not damage airplanes but did find their way on board the plane. Airport security technology and procedures did not prevent the bombs from getting on board. As usual in the industry, new measures are investigated to prevent similar breaches in the future (Andriessen, 2010). Terrorists try to defeat security barriers but we do not understand how they identify the weak spots in the many layers of security barriers. Possibly, the standardization itself is a weak spot in standardized security measures. A system where one does not know what to expect might just be more effective. It is incidents like these that forces people to think about their safety while being in airports. Their perceptions and attitudes are influenced by their knowledge of the airport security system, their jobs and their personal experiences.

1.2. BRIEF INTRODUCTION IN AIRPORT SECURITY SYSTEMS

Polka defined three principles on which airport security is based and on which programs on airport security are developed (1994, cited in Singh and Singh (2003):

1. Every reasonable effort should be made to deny the terrorist access to civil aviation facilities (aim)
2. In the event that terrorists penetrate the first line of defense, they should encounter a system of explosives metal detection devices and procedures that will prevent further penetration into aviation facilities (layered defense)
3. If a device evades step two, aircraft systems and structure must be hardened to maximum extent feasible to negate a blast and minimize damage providing a higher probability of survivability of passengers and property (mitigation)

The emphasis on these points is clearly on technology since instruments are explicitly mentioned. A system one should encounter and structures that need to be hardened (for instance cockpit doors were hardened after 9/11, to prevent hijacking). The first point “making an effort to deny terrorist access” is a human endeavour. Also the second point contains behaviour as in following procedures. Procedures proscribe how a person should act in a certain situation. Compliance can be a problem when it comes to the human contribution to security (Reason, 2000). The way procedures are handled is dependent on the organization and the culture in

which the organization functions. Not only organizational culture can play a part, but also the culture of a country. Between airports in a single country there can be differences because of the size of the airport.

2. THEORY

Finding out how people work with, think about, and behave in relation to security is very much a human factors research topic. Although the human factor in airport security has not been researched in multidisciplinary domains, there has been some research on the human factor in airport security. In the first case passengers were subject for investigating the human factor in airport security. Passengers experienced more negative emotions in after a security check which would have a negative effect on their shopping behaviour (Bowes, 1997). Other research is used for training security officers in recognizing micro-expressions of faces of passengers and psychophysiological reactions as signs of nervousness of passengers and to be able mark them as suspicious (Ekman, 1993). TSA is currently developing a SPOT programme where behavioural officers are trained to recognize these micro expressions. Not only passengers were subjects of study the human factor in airport security also the influence of training, age, sex and experience on performance of the security officer behind the X-ray machine was studied by Schwaninger et al. (2004), Godwin, (2008). Most of the time these studies were conducted in laboratory settings to optimize the conditions for measurement and the focus of study were the cognitive functions influencing the level of performance. Security officers and other airport employees in the real world usually work in a more distracting environment than a laboratory where in the hubbub of an airport passengers are asking questions, boarding calls are made and stewardesses are walking by. This has an effect on the level of for instance concentration of a security officer. Schwaninger et al. (2004) also investigated what characteristics an ideal security officer should have when looking at X-rays screens. The idea was to design a screening tool for training and selection of staff. In another study graduate students were used as test subjects in laboratory research, had a different demographic background than airport security staff Schwaninger et al (2004).

Outside the topics described above, very little to no research was performed in other elements of behavior of individuals in airports. Therefore, methods used in the safety sciences is applied to study human factors in this study.

When studying risk perception there are a couple of theoretical perspectives that formulated a possible role of cultural influences in the perception of societal risks. Societal risks are less-known and more dreadful than individual risk (Slovic, 1987). Cultural theory has proposed a set of cultural personalities that are associated with certain attitudes which might be linked to behavior (Dake, 1991). Personalities referred to social values on social hierarchy and individualism. The proposed set personality allows comparison between cultures or between types of users; the effect of cultural personalities was avoided, by selecting participants that came from the same country. The social and unification of risk framework is used to describe the dynamics of societal risk matters. The emphasis lays on specific hazards and crisis that concern society. It is assumed that the context in which the risk is perceived plays part information of risk perception. (Eldridge and Reilly, 2003). In this case the context of the social amplification of risk framework was probably the same for all participants. Employees and passengers came from the same country and the airport employees all work in the same airport.

In this work we focus on the attitude towards security and perception of security that people on airports have. This focus was inspired by participant observation that suggested that attitude and perception are important shaping factors in this particular setting. The setting is particular because of the complex system of airport security and the veil of secrecy that covers relevant information for many people working in or passing through an airport. A survey was performed to gain insight.

2. METHODS

The methods used in this study are ethnographic methods to study the interactions of people in the airport in relation to security. Since this instrument is not often used in security only a few precedents exist: ICT security (Wellinger and Botta, 2007), and security adminstrators (Barret *et al.* 2004; Haber and Kandogan, 2005). In this work we observe the security worker himself. Enoma (2008) formulated KPI's for optimal functioning of airport security with interviews and questionnaires only given to airport managers.

The number of participants was 347 in total, 177 passengers and 180 staff members working in an airport where access was provided without any difficulty. Passenger group consisted of 90 male and 87 female, they ranged in age between 10 to 73 years with a mean of 30.61years.The staff group consisted of 102 males and 78 females, with a range in age between 18 to 60 years, with a mean of 26.83 years.

A questionnaire with likert scales was used for this research. It had to be translated from English to Latvian and Russian, for both groups. Only one question differed in the questionnaire between passenger and staff group, the question about feeling responsible for the safety of passengers the word other passengers was added in the passengers questionnaire. The exploratory part consists of 3 scales: satisfaction of safety, knowledge on airport security and personal responsibility.

Between airports in a single country there can be differences because of the size of the airport and differences in the local culture. These differences can also be caused by the way airport managers organize passenger flows, or the experience with terrorist threats in the past. These and other factors influence local differences in the execution of airport security. Compliance to rules and laws, following orders and deciding what to do on the spot, are examples of human behaviour that can make a difference even at the level of individual security guards. Also factors such as background, worldview and training will probably influence the way a security officer executes his job. And it could also influence a passengers' will to assist the security officer in his job of keeping the airport safe.

Findings of Mearns et al. 2004 to measure safety satisfaction of staff on oilrigs using an adjusted questionnaire created by Rundmo (1992) was used to formulate three dimensions for satisfaction of security. These dimensions were security training; detection system used and experienced safety of the airport in general. Effects within and between groups of gender, age, years of experience working in the airport, frequent traveling and education were also explored. The effect of level of security training was explored for staff only. With this questionnaire the level of trust in technology used in airport security and the level of trust in other employees to handle the risks were explored, as well as general feelings of being safe at the airport. Perceived responsibility in airport security and perceived knowledge about airport security where explored with two items each. A total of 8 questions were asked.

The staff group consisted of 3 job groups, security staff, check in and platform workers and staff group. Each play a different part within the layers of defense and have received a different level of security training. Looking at the effect of training differences between staff groups is interesting because it is airport policy that everyone with eyes and ears has to play a part in airport security and receives airport security training. Security staff of course get the most training in this area. It is difficult however to say something about the effect of training on the level of security as incidents rarely seemed to happen during the study.

The differences between security staff and check in staff were explored as they play an important role in the complex security system in airports. An important variation is the level of security training. This is also an interesting aspect because it is assumed in policy that everyone with eyes and ears has to play a part in airport security. The question is how this is perceived by the employees themselves. It is difficult however to say something about the effect of incident experience on the level of security as we did not give the questionnaire before and after an incident. This method can only give an indication about variables that have an indirect effect, for instance job satisfaction. There are indications for example that people who are satisfied with their work perform better.

A survey is given to passengers, security staff, check in staff and platform workers. Feelings of responsibility and perceived knowledge about airport security were explored. Also the level of trust in technology used in airport security, the level of trust in other employees to handle the risks were explored. Passengers taking part in this research were waiting for their flight at the gate and filled in the questionnaire to kill time before boarding. Staff filled in the questionnaire when they had the time to do so.

3. STATISTICAL ANALYSES

Of the 380 questionnaires handed out staff returned 93.15% was returned, N = 177. Passengers returned 94.7% of all questionnaires, N = 180. Passengers sometimes had to catch a flight and were not able to fill in the questionnaire entirely. Questionnaires that were not filled in completely were left out of the analysis and added to the amount of questionnaires not returned. In table 1 demographics of passenger and staff are summed up, in table 2 the demographics of different job groups working in different locations is displayed. Differences between job groups is explored in order to explore sense of responsibility and perceived knowledge on airport security. Airports are complex socio technological system where everyone plays a part. Airport authorities prepare safety and security training for all employees. Security staff of course get the most training in this area. It is investigated if there is any difference between groups to look at the effect of the training.

Variable	Staff N, (%)	Passengers N, (%)
Gender		
Male	102 (56.7)	90 (50.8)
Female	78 (43.3)	87 (49.2)
Age		
< 20	13 (7.2)	35 (19.8)
21-30	137(76.1)	75 (42.4)
31- 40	19 (10.6)	30 (16.9)
41-50	10 (5.6)	17 (9.6)
51>	1 (0.6)	20 (11.3)
Education		
Course	3 (1.7)	36 (22)
High school	91 (50.8)	27 (16.5)
Graduate/trade	78 (43.6)	69 (42.1)
School	7 (3.9)	32 (19.5)
University		
Frequent traveler		
Very Often	5 (2.8)	19 (10.7)
Often	17 (9.5)	49 (27.7)
Neutral	55 (30.7)	61 (34.4)
Not often	47 (26.3)	37 (20.9)
Not often at all	55 (30.7)	11 (6.2)

Table 1 Demographics staff and passengers

(i) Comparison between passenger and airport staff

In order to make sure the differences in variances between groups are larger than within groups and that these differences are not caused by coincidence but a systemic deviation an ANOVA was performed. ANOVA is one of the common statistical tests when differences in variances of two or more groups are compared and the variability of the independent variable is studied. Because two groups where compared, a post-hoc test was not performed, instead an independent samples test was done at 95% confidence level. ANOVA analysis demonstrated a significant overall difference in opinions between staff and passengers, Wilk's lambda = 0.213, $p < 0.001$. Because two groups with the same size were compared an independent sample t-tests was performed. First perceived knowledge on airport security was explored. Staff had a significantly higher score than passengers, $t(349) = 4.146$, $p < 0.05$. Also on perceived knowledge about a security check specifically, for instance knowing what to do when for instance knowing what to do when standing in line for a security check for a security check, staff scored significantly higher than passengers, $t(351) = 4.630$, $p < 0.05$. When working at the airport staff undergoes a security screening quite often. Depending on the location of the job, the employee has to pass security check every time they enter the clean area. When it was explored whether other employees are trusted to take security decisions passengers and staff did not differ significantly and were slightly positive about this point.

When asked about being responsible for the security of passengers, passengers were asked if they felt responsible for the security of the other passengers, staff felt significantly more responsible for security than passengers, $t(349) = 9.502$, $p < 0.05$. The more frequent passengers flew, the less responsible they felt for other passengers security. 69.3% of the passengers considered the airport to be a safe place to be in,

compared to 94.6 % of the airport staff. Also this difference was significant, t (350)=6.180, p=< 0.05) . No difference was found between groups when asked if other airport employees would be capable of making the right security decisions. Also about trust in technology used in airport security no significant difference was found between the groups. The answers of passengers and staff were between neutral and not really.

	Security staff N= 53 (%)	**Check in staff N= 60 (%)**	**Platform worker N=47 (%)**
Gender			
M	27 (50.9)	13 (21.7)	46 (97.9)
F	26 (49.1)	47 (78.3)	1 (2.1)
Age			
< 20	3 (5.7)	5 (8.3)	5 (10.6)
21-30	41 (77.4)	50 (83.3)	36 (76.6)
31- 40	3 (5.7)	5 (8.3)	4 (8.5)
41-50	5 (9.4)	0	2 (4.3)
51>	1 (1.9)	0	0
Seniority			
< 1 year	19 (36.5)	30 (51.7)	42 (89.4)
1-5 years	28 (53.8)	24 (41.4)	2 (4.3)
6-10 years	4 (6.9)	4 (7.7)	0
10-20 years	1 (1.9)	0	2 (4.3)
>20 years	0	0	1 (2.1)
Education			
Course	1 (1.9)	1 (1.7)	0
High school	27 (50.9)	39 (65.0)	20 (42.6)
Graduate/trade School	22 (41.5)	18 (30.0)	27 (57.4)
University	3 (5.7)	2 (3.3)	0
Frequent traveler			
Very Often	2 (3.8)	0	1 (2.1)
Often	3 (5.7)	10 (16.7)	1 (2.1)
Neutral	13 (24.5)	25 (41.7)	13 (27.7)
Not often	15(28.3)	14 (23.3)	13 (27.7)
Not often at all	20 (37.7)	20 (37.7)	19 (40.4)

Table 2 Demographics job groups

(ii) Comparison between staff groups

An ANOVA was also performed to compare the differences in variances within and between jobgroups. Bonferroni post-hoc test was performed; this can be used for equal and unequal sample sizes, at 95% confidence level, in order to take a closer look at the sign differences that where found. Seniority was explored as a factor between job groups only as this data was not collected for the passenger group. When looking at the differences between job groups, a significant difference was found on perceived knowledge on security between all job groups, where security staff perceived their knowledge to be the highest and the platform workers perceived knowing less on airport security F (2) = 10.76, p<0.005. After Bonferroni post hoc test only the differences between platform workers and security staff (M = 0.42, SD = 0.15), F(2,155) = 10.76, p = 0.018) and platform workers and check in staff (M = 0.73, SD = 0.16), F(2,155) = 10.76, p =0.00). On this point no differences between check in staff and security staff was found. Also on considering the airport to be a safe place to be in the differences between job groups were significant F (2) = 4.54, p<0.05. Check in staff considered the airport to be the safest, followed by platform workers and security staff . The significant difference in the perception of the airport being a safe place was found between check in staff and platform workers (M = 0.40, SD = 0.14), F(2,156) = 4.54, p = 0.016). All answered with slightly positive tendency, although the security staff was the less positive. Looking more closely at these job groups, males

and females are not distributed homogeneous as compared with the male female distribution between passengers and staff. Probably to no one's surprise check in staff mostly consists of women, platform staff mostly of men; security staff had an equal male/female distribution.

(iii) Comparison between passenger groups.

When looking at being a frequent traveler, an indicator for experience, passengers showed differences within the passenger group. The more often passenger said they had flown, the more perceived knowledge they had $F(4) = 7.636$, $p < 0.05$ and had the more perceived knowledge on what to do when standing in line for a security check $F(4) = 4.234$, $p < 0.05$ compared to these factors within the staff group. When looking at the effect of education only within the passenger group high education had an effect on perceived knowledge on airport security $F(3) = 4.0394$, $p < 0.05$ and on perceived knowledge on what to do when standing in line for a security check, $F(4) = 7.749$, $p < 0.05$. The higher the education, the greater the perceived knowledge in both areas. Also people with a higher education trusted airport employees other than security to make the right decisions in when it was necessary, $F(3) = 2.818$, $p < 0.05$ more compared to passengers with a lower education.

4. SUMMARY OF FINDINGS

The results show a number of themes that are important for understanding perceptions and attitudes of people working in or passing through airports. They are treated per theme.

(i)Responsibility

Security staff feel the responsibility for security the most when compared to other airport employees. Check in staff rated second on responsibility and platform workers lowest. We theorize that the amount of security training contributes to this effect.

(ii)Frequent flyers

Frequent flyers represent a special group in airports. Despite being well informed about security procedures, they felt the least responsible for the security on other passengers.

(iii)Education

The level of education of individuals influences their perception of security. For airport staff, there was little evidence of differing perceptions between staff groups. However, passengers with higher education said to know more about security and the process, maybe because of a higher learning curve or other reasons that explain the level of height of education, for instance having an above average good memory.

(iv) Trust in technology used in airport security

Technology used in airport security was found to be little trusted by both passengers and staff. This is a remarkable finding, on average everybody undergoes security screening, passengers and staff, without really trusting the technology that is used. Security staff themselves feel responsible for doing their job right, but cannot trust the tools they use.

(v) Airport is a safe place to be in

Although not statistically significant, all airport employees considered the airport to be less safe than non-employee. Whether this is caused because of specific knowledge they possess or their distrust of the technology is important here is not clear from this investigation.

5. CONCLUSION

Undergoing security is also often seen as a nuisance both by passengers and staff, especially when you are in a hurry to handle or catch a flight or having a short break, between flights or on your shift. However, different airport user groups think differently about these nuisances, which probably reflect in different behaviors toward security. Generic factors seem to be whether the subject is an employee of the airport, the level of education and the level of trust people have in security technology. A deeper analysis is required to find out the exact relations between these factors and their relation to instruments to influence the perception and attitude of employees and visitors such as training, dissemination of information about security, and perhaps some openness about security technology and how it works so that people can trust it more.

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