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FUTURE OF X-RAY SCANNERS IMPLEMENTATION IN UKRAINIAN AIRPORTS

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Increasing efficiency of aviation transport functioning in Ukraine is impossible without optimization of the technology of airport formalities, namely aviation security check. Generalized methodology of technological parameters calculation of passengers handling in an airport during passing aviation security check with usage of the new X-ray scanners is presented in the article. Example of calculation according to the formed methodology, taking into account installed by investigations handling intensity, productivity of X-ray scanners and expenses on their operation, is presented in the article.

Keywords: aviation safety, airport, passengers, x-ray, passenger terminal, efficiency.

Підвищення ефективності функціонування авіаційного транспорту в Україні неможливе без оптимізації технології аеропортових норм, зокрема контролю на авіаційну безпеку. В статті запропоновано узагальнену методику розрахунку технологічних параметрів обслуговування пасажирів в аеропорту під час проходження контролю на авіаційну безпеку з використанням нової технології рентгенівського сканування. Наведено приклад розрахунку за узагальненою методикою з урахуванням встановленої дослідним шляхом інтенсивності обслуговування, продуктивності рентгенівських сканерів та витрат на їх експлуатацію.

Ключові слова: авіаційна безпека, аеропорт, пасажири, рентген, сканери, пасажирський термінал, ефективність.

Introduction

In an increasingly commercial and competitive business environment, airports must be able to collect sufficient revenues to finance their investments and operations, and to maintain a level of service which is acceptable to all airport users, including passengers and aircraft operators. Airports consist of many managing departments which implement all targets what airport faces. In any airport effectiveness of each department is important as they work as a complex system [1].

Security Department and Research and Development Department should be taken into account.

Airport security department attempts to prevent any threats or potentially dangerous situations from arising or entering the country. If airport security does succeed in this, then the chances of any dangerous situations, illegal items or threats entering into bothaircraft, country or airport are greatly reduced.

Research and Development Department constantly introduce methodology for effective airport functioning. Recent common investigation of Security Department and Research and Development Department has shown the need of X-ray screens implementation worldwide.

X-ray screens can provide high quality of security in airport and simultaneously increase passenger turnover.

Analysis of aviation security technologies, used in international Ukrainian airports, shows that in our country security check with basic full-body scannersare only used for these purposes. However, globalization processes, implementation of new technologies worldwide require adjustment of Ukrainian aviation transport infrastructure to the international standards in aviation safety in order to provide high competitive ability of our state in the world market [1].

Analysis of recent researches and publications

Theoretical and methodological issues of airport technologies in the sphere of passengers handling have been considered by A. M. Andronov, L. N. Khyzhnyak, A. N. Bochkarev, F. Hofer, A. Schwaninger and others [1–7].

A lot of researches in the sphere of aviation safety were made by Committee on Commercial Aviation Security of the United States and it leads to the two most important conclusions that for the first monitoring of passengers became faster with the implementation of new technologies at the airport and for the second all these technologies are safe for human health.

German scientists Hofer F. and Schwaninger A. proves that technology is only as effective as the humans that operate it.

Summarizing existing researches it should be said that all of them are very useful, but require further detailed elaboration and generalization of methodology of technological parameters calculation of passengers handling in an airport during passing aviation security check with usage of the new X-ray scanners.

Advantages and disadvantages of X-ray scanners

Current passenger security-screening requirements were developed in response to an increase in hijackings prior to 1972. Passenger screening procedures in place today focus on finding passengers carrying metallic weapons that might be used to intimidate the crew into changing the destination of an aircraft [10]. One of the greatest example is the “millimetre wave” technology. It uses uses radio waves at a power output many times lower than portable personal devices like mobile phones.More suitable type of scanner due to current security standards X-ray new generation so-called Backscatter X-ray must be used.

Backscatter X-ray was first applied in a commercial low dose personnel scanning system by Dr. Steven W. Smith. Dr. Smith developed the Secure 1000 whole body scanner and then sold the device and associated patents to Rapiscan Systems who now manufactures and distributes the device. Backscatter X-ray detects the radiation that reflects from the target [10]. It has potential applications where less-destructive examination is required, and can be used if only one side of the target is available for examination. The technology is one of two types of whole body imaging technologies being used to perform full-body scans of airline passengers to detect hidden weapons, tools, liquids, narcotics, currency, and other contraband. The body-scanners can detect a wide range of potential threats to security in amatter of seconds and will be used alongside the airport’s existing security screening systems. Backscatter technology is based on the X-ray compton scattering effect of X-rays.

The backscatter pattern is dependent on the material property, and is good for imaging organic material. In contrast to millimeter wave scanners which create a 3D image, backscatter X-ray scanners will typically only create a 2D image. For airport screening, images are taken from both sides of the human body [11].

X-Ray screening of passenger is an essential component of airport security. Large investments into technology have been made in recent years. However, the most expensive equipment is of limited value, if the humans who operate it are not selected and trained appropriately [13].

In response to the increasing threat of terrorist attacks, large investments were made into X-ray screening machines of the newest generation in order to inspect passengers at airport security checkpoints [10]. The last decision however is always made by a human operator (screener). That’s why results of aviation accidents and incidents analysis show that the most expensive equipment is of little value if the screeners who operate it are not selected and trained appropriately.

The public acceptance issues associated with new passenger screening technologies focus on the extent to which people are willing to tolerate the screening procedures. While a screening technology and its operator may function properly, the ultimate success of the procedure requires its acceptance by the people being screened. The term people does not refer to a homogeneous body but to a group that includes airline passengers, friends and relatives of passengers, flight crews, and airport and air carrier employees [5].

Some people are exposed to screening infrequently, while others are screened more often. Thus, these two groups may react quite differently to the implementation of a new screening technology.

On the basis of conducted investigations it was found that the X-rays scanners have the list of **advantages** as follows:

- Improvement of flight safety;
- Passengers will be randomly selected for scanning or on activation of the normal security checks;
- The scanners do not produce an image of the person being scanned;
- It has potential applications where less-destructive examination is required, and can be used if only one side of the target is available for examination;
- It gives a good image of what the items are made of based on how easily the X-rays penetrated the objects.
- Substantial increases of detection performance were found as a result of training, which depended on the threat category (guns, IEDs, knives and other prohibited items) [7].

The **disadvantages** were also found, they are as follows:

- Poor soft tissue resolution contrast media can be unpleasant and hazardous(barium meal) harmful radiation unsuitable for pregnant women;
- A large and representative image library of prohibited items depicted from different viewpoints is necessary to provide a good basis for training x-ray image interpretation competency. In addition to knowledge based factors, also image based factors play an important role [11].
- These can rather be attributed to the visual abilities of a person, that is, to the abilities to cope with image difficulty resulting from rotation of a threat object, superposition by other objects in the bag, and bag complexity.

One more important aspect of using X-ray scanners is its influence to people's health. Exposure to radiation and to electric and magnetic fields associated with passenger screening devices are not expected to cause adverse health effects in passengers. Radiation levels used by the technologies under consideration in this report are far below the levels that have been linked to health effects [5].

Passenger screening devices operate using radiation and electric- and magnetic-field levels well below the maximum allowable exposure levels established to protect public health. The health effects of theoretical concern in passenger screening include cancer, reproductive and teratogenic effects, and cardiac effects in passengers with pacemakers [14].

To understand how many X-ray scanners are needed to be installed in a modern airport the generalized methodology of their calculation must be elaborated.

Generalized methodology and case study

Equipment and operational space must be determined by the number of checkpoints and the size of the equipment the air carrier wishes to install. Queuing space is directly linked to projected passenger traffic, which depends on the size of the aircraft and the number of flights anticipated by the air carrier [16].

For calculations of X-rays quantity we proposed to find the following indexes:

1) inbound flow intensity of passengers during peak loading at the airport;
2) passengers flow intensity that comes through the registration;
3) passenger handling intensity;
4) security check points at airside required.

Let's apply these methodology on the example of Terminal D of Boryspil International Airport.

One of the most important disadvantages of Ukrainian airports is that there is no clear information about transit passengers or about loading of aircraft. So, in order to make a calculation and test the methodology, we have investigated the statistics about the load factors of passengers at the Boryspil International Airport. The results of the research are represented on the Figure.

Inbound flow intensity of passengers during peak loading at the airport can be found according to the formula [15]:

$$\lambda_{passenger} = \frac{1}{T_{computation}} \sum_{i=1}^{m} P_i(t) N_i K^{(i)}_{occupyingseats} (1 - K_a), \quad (1)$$

where, $\lambda_{passenger}$ — amount of passengers during the last minutes of handling at the airport; $T_{computation}$ — is the amount of departure flights; $P_i(t)$ — is the probability of arrival passenger at $_i$ — flight to the airfield for the time; t — before the take-off of aircraft according to the schedule; N_i — is the aircraft capacity; $K_{occupyingseats}$ — load factor of passengers; K_a — sum of passengers seats occupied and transit passengers.

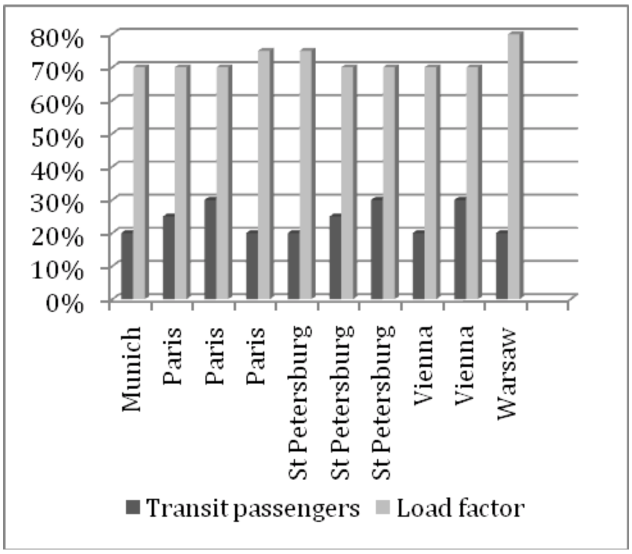

Fig. 1. Passenger's Load Factor Investigation

Calculations should be based on the time of the airport peak period which was investigated and is shown in the Table.

Timetable of the investigated peak period of KBP

Time of departure	Flight number	Place of destination	K_a	$K_{occup.\ seats}$
17:15	LH 2545	Munich	20 %	70 %
17:35	AF 1253	Paris	25 %	70 %
17:35	DL 8644	Paris	30 %	70 %
17:35	PS 9283	Paris	20 %	75 %
17:40	FV 844	St Petersburg	20 %	75 %
17:40	PS 9144	St Petersburg	25 %	70 %
17:40	SU 4435	St Petersburg	30 %	70 %
17:55	OS 7174	Vienna	20 %	70 %
17:55	PS 847	Vienna	30 %	70 %
18:30	LO 754	Warsaw	20 %	80 %

Firstly, we are calculating amount of passengers for the given flight

$$\lambda_{pass} = 137{,}82 \div 15 = 9{,}18 = 9 \text{ pass.}$$

Passenger flow systems must provide live automated wait time information for passengers, as it is essential to enable passengers to select their optimum route through the airport. Without such information passengers tend to join the back of queues without checking or even realizing that there are alternative routes.

Determination of passengers flow intensity that comes through the registrationcan be found according to the formula [15]:

$$\lambda = E(K_{\lambda}\lambda_{passenger}), \quad (2)$$

where, K_{λ} — is a ratio, which takes into account those passengers, who carry out the registration of multiple tickets. For our case λ = 7 passengers

Passenger handling intensity can be found according to the formula[15]:

$$\nu = \frac{1}{M\left[T_{handling}\right]}, \quad (3)$$

where, v — handling intensity (passenger/minute); $M[T_{handling}]$ — is average passenger handling time at air terminal building of the airport; a — peak hour number of originating passengers; b — number of transfer passengers not processes airside; c — total amount of originating and transfer passengers.

After calculation we receive ν = 0.015 pass/min.

In order to determine security required number of check points with X-ray scanners in airside the following indexes must be determined:

1) curb length;
2) departure concourse area;
3) queuing area at check-in;
4) check-in desks and control positions number;
5) X-ray scanners number in airside.

Curb length can be found according to the formula:

$$L = \frac{a \times p \times l \times t}{60 \times n} = 0.095 \times a \times p, \quad (4)$$

where, p — proportion of passengers using car/taxi; n — average number of passenger per taxi; l — average curb length required per car/taxi, m; t — average curb occupancy tome per car/taxi, min.

In our case L = 25.65 meters.

Departure concourse area can be found according to the formula:

$$A = s \times \frac{y}{60} \times \frac{3\left(a(1+o)+b\right)}{2} = 0.75(a(1+o)+b), \quad (5)$$

where, o — number of visitors per passenger. In our case A = 1302.75 m^2.

Queuing Area at check-incan be found according to the formula:

$$A = s \times \frac{20}{60} \times \left(\frac{3\left(a+b\right)}{2} - (a+b)\right) = = 0.25(a+b)\text{m}^2 \ \ (+10\,\%). \quad (6)$$

In our case A = 164.25 m^2.

Number of check-in desks and control positions requiredcan be found according to the formula (7) and (8) correspondently.

$$N_1 = \frac{(a+b) \times t_1}{60} desks \ (+10\,\%), \quad (7)$$

$$N_2 = \frac{(a+b) \times t_2}{60} positions \ (+10\,\%), \quad (8)$$

where, t_1 — average processing time per passenger, min; t_2 — average processing time per passenger, min. In our case N_1 = 15 desks and N_2 = 11positions.

X-ray scanners number depends upon its capacity and number of passengers passing thought it and can be found in the following manner:

$$N = \frac{(a+b) \times w}{y} = \frac{a+b}{300}, \quad (9)$$

where, y — capacity of X-ray scanners; w — number of passengers passing through X-ray scanner.

So, finally, using proposed methodology, we found required number of X-ray checking units to be installed in Terminal D of the Boryspil International Airport taking into account current handling intensity, productivity of X-ray scanners. It equals to3 units.

Conclusions

X-Ray screening of passenger is an essential component of airport security.

X-ray scanners has been proposed as an alternative to personal searches at airport and other security checkpoints easily penetrating clothing to reveal concealed weapons. It has potential applications where less-destructive examination is required, and can be used if only one side of the target is available for examination.

The opportunity to use X-ray scanners will give the possibility for Ukrainian International Airports to use new modern technologies in order to eliminate dangerby passing the security control effectively than erenow. On the basis of conducted analysis, researches and calculation investments should be directed on the purchase of modern security technologies, namely X-rayscanners, which increase capacity of an airport. Making a decisions regarding changing security equipment of its modernization must be grounded the generalized methodology, presented in the article and airport development forecasts. Made calculations shows that purchase and installation of three X-ray cannersin Boryspil International Airport could be a profitable inclusion to its further development and does not affect costs a lot.

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