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ALLOCATION OF HUMAN RESOURCES TO THE SECURITY SCREENING PROCESS - CASE STUDY

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Abstract: *This paper presents the possibility of using simulation model in the planning of human resources for the execution of processes. The article refers to the process of security screening at the airport – where passengers proceed from a landside to the critical part of the restricted area on the airside. The case study concerns the reasonableness of the allocation of an additional operator to the process for one of the two types of security counters at the Wroclaw Airport, where the primary goal was adopted to achieve maximum system performance, while maintaining standards that ensure an adequate level of safety.*

Key words: *airport, security screening, security control,*

1 INTRODUCTION

All Safety aspects of air transport system are regulated by a numerous domestic or even international acts. Safety requirements are also applied to the processes occurring in the passenger terminal, which is divided into areas with different levels of access. The main law responsible for maintaining the level of security of air transport in Poland is the Regulation of the Minister of Transport, Construction and Maritime Economy of 31 July 2012 on the National Civil Aviation Security Program [1], referring to regulations ([2], [3] , [4]), setting out detailed procedures, the enforcement of which is the duty of the manager of the airport.
Departing passengers are required to proceed to the gate through a critical part of the restricted area via security screening process. Modelling of a security points at airports is of interest to a wide group of scientists. In the literature can be found completely different approach. This is connected with numbers of different input variables and the diversity of the objectives to be attained. There are several main directions of research. Very highly developed is the field of safety. Models in this area may even support in the development of technologies and procedures by assessing the impact of the implemented security technology

[5; 6]. Noteworthy are the models that in addition to the need to ensure the safety, indicate the need to minimize the inconvenience for the passenger [7]. Very well developed is also area of operational planning and design. Although for queuing systems are a variety of models for determining basic indicators - described in the literature as the queuing theory [8]. However, for complex processes, such as those at the airport are developed various models for engaging the wider analysis. From the old times, the models relate to the multi-criterion analysis of passenger flows [9]. The issue of shortening the waiting time in queues with minimal use of resources was also discussed a long time ago and repeatedly [10,11]. There are also a lot of models for allocating the appropriate number of resources [12,13].
Knowledge of the procedures of security screening process allows to forecast the basic efficiency characteristics of the carried process. Theoretical estimates, which may take into account even the reliability of technical system, are purely illustrative. Security screening system is a system with relation machine-operator-environment in which, besides the basic characteristics of the reliability of technical system - causing the failures, are also failures, generated by the operators and the environment. Assuming the environment as a passengers of air transport system, can be seen a close relationship to the functioning of the line operator-environment-efficiency [14].
The current development of literature is very useful for the planning process, both in terms of safety level and in terms of required performance. However there is a lack of literature, in case of a solution to current problems that occur during everyday operation of the systems already implemented. Here need to be taken into account primarily economic factors which are to achieve at least cost and highest efficiency of the process.
The authors have developed a simulation model that allows to make an analysis of the system depending on the varying structure of quantitative technical and human resources and capacity of the relevant zones.

2 SIMULATION MODEL OF SECURITY SCREENING AT WROCLAW AIRPORT

Access to the restricted area is performed by security control system via counters with special devices able to detect potentially dangerous items. Before screening, passengers are required to prepare the cabin baggage to control and put outer garment to suitably cuvette in the area reserved for this purpose. Operator can also ask the passenger to insert additional garment into cuvettes, depending on the probability of occurrence of potential causes to occur the error to pass through the detectors. It is important that from cabin baggage is the need to remove large electronic devices, whose density can significantly affect the results obtained from the x-ray. These devices are subject to a separate inspection. The next steps in the process are parallel baggage and passenger control. Screening of passengers is usually carried out using:

- metal detectors,
- manual control,
- In specific cases are usually used: manual metal detectors or dogs to detect explosives in combined with manual control.
- Screening of baggage is usually carried out using:
- x-ray,
- manual control,
- explosives detection systems,

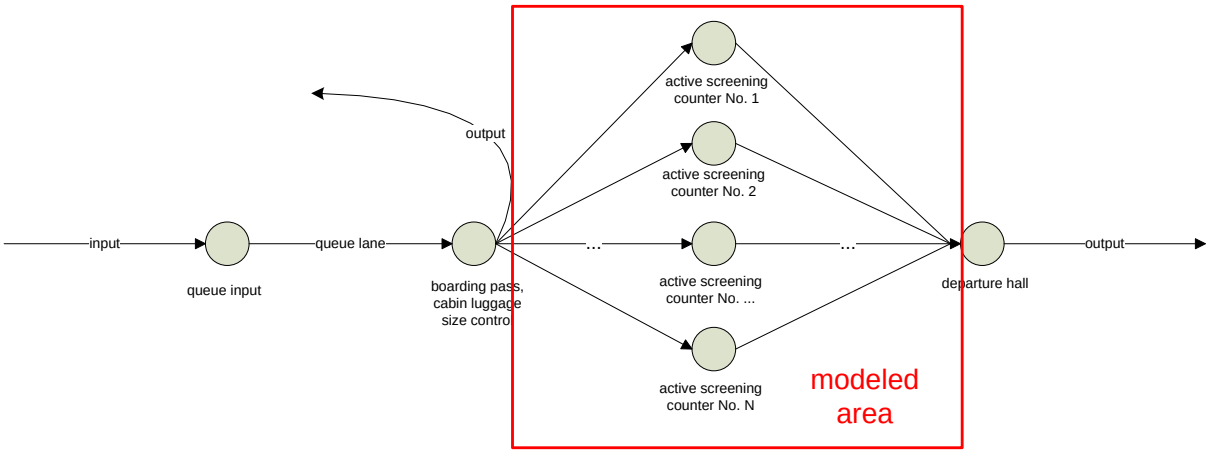

Fig.1 *Security control area*

In specific cases are usually used: dogs to detect explosives in combined with manual control. Sniffer dogs and equipment for the detection of trace amounts of explosives may be used only as a supplementary means of screening during periods of increased risk. Control of passenger and baggage ends with a positive result only in case when the operator of the process is able to recognize clearly that the requirements of the screening process were pro-vided. Any incorrect indication of control equipment must be diagnosed and eliminated. Otherwise, the passenger or luggage is subjected to re-inspection or decision is taken to refuse passenger from boarding the aircraft. After completion of the screening process, passengers and their cabin baggage are protected from baseless intervention until departure of the aircraft, unless it would be "contamination" the passenger or luggage (contact with the passenger, luggage, which was not subjected to security checks).

To the security control can proceed only authorized persons - who have valid boarding card or pass issued by the airport, so before security control is also a sub-process checks boarding passes.

Diagram of the whole process is shown in figure 1, which also marked the area that directly concerns of this simulation model. The goal necessary to achieve requires a micro approach to a given process, and therefore it was necessary to develop the characteristics of the individual sub-processes identified in Figure 2.

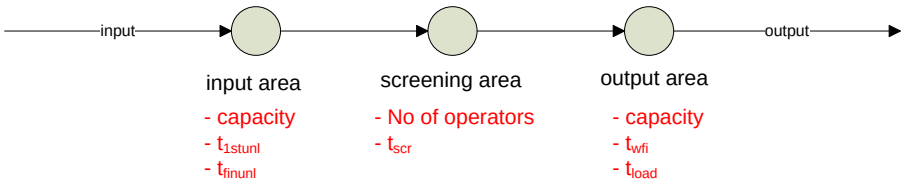

Fig.2 *Input data*

Research conducted at the airport led to the development of characteristics that were used in the simulation model (Table 1). For all the random variables are no grounds for rejecting the hypothesis of compliant empirical distributions with given theoretical. Kolmogorov test performed at a significance level of α=0,05. It should be noted that the input process is divided into two sub-processes: first unloading and final unloading. It is due to the structure of the process followed in Wroclaw Airport. The detailed algorithm and the functioning of the model has already been presented in [14]. Such microscopic approach gives the ability to control the

input data such as capacity zones. This is an advantage that gives the ability to analyze the appropriateness of the extension or reduction of the positions.

Tab. 2 *Probability density function for specific tasks*

task	sign	probability density function
first unloading	t_{1stunl}	$f(t_{1stunl}) = \frac{{t_{1stunl}}^{3,42}}{13,74^{4,42} \cdot \Gamma(4,42)} e^{-\frac{t_{1stunl}}{13,74}}$
final unloading	t_{finunl}	$f(t_{finunl}) = \frac{e^{-\frac{23,62}{t_{finunl}-0,94}}}{23,62 \cdot \Gamma(2,02) \cdot \left(\frac{t_{finunl}-0,94}{23,62}\right)^{3,02}}$
manual control	t_{mcont}	$f(t_{mcont}) = \frac{(t_{mcont}-16,95)^6}{2,13^7 \cdot \Gamma(7)} \cdot e^{-\frac{t_{mcont}-16,95}{2,13}}$
waiting for items	t_{wfi}	$f(t_{wfi}) = \frac{1}{B(0,67;2,56)} \cdot \frac{(t_{wfi}-2,93)^{-0,33} \cdot (139,10-t_{wfi})^{1,56}}{136,17^{2,23}}$
loading time	t_{load}	$f(t_{load}) = \frac{2,01}{23,62} \cdot \left(\frac{t_{load}-0,94}{23,62}\right)^{1,01} e^{-\left(\frac{t_{load}-0,94}{23,62}\right)^{2,01}}$

For input capacity equal 5 and output capacity equal 4, where were also 2 operators in screening area, chi-square test at a significance level α=0,05 was verified hypotheses about the consistency of data obtained in the simulation model and observed in the Wroclaw Airport. Verified were also times between subsequent notifications of passengers to the metal detector of security screening received in the simulation model and those observed in a functioning system. Results (after the split into time intervals) are presented in Figure 3. On significance level α = 0.05 was verified compliance of distribution. Kolmogorov Smirnov statistic is equal λk=1,18, whereas the limit value, obtained from the tables is equal λ0,05=1,36. This proves the compatibility of empirical data with simulation.

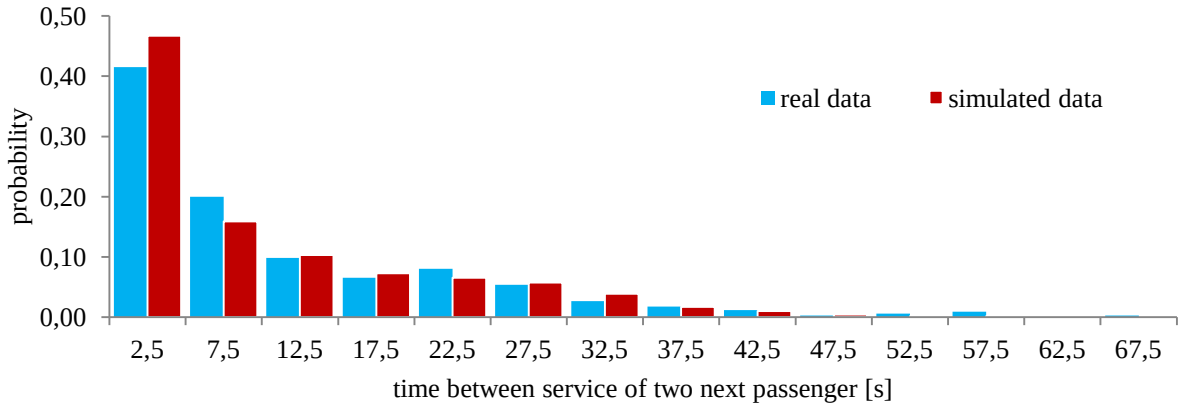

Fig.3 *Comparing simulation results with the actual data*

3 HUMAN RESOURCES ALLOCATION - CASE STUDY

The intensity of air operations is variable during the day and also unstable due to various delays. Taking into account the availability of slots and the preferences of the airlines it is impossible to control the passenger flow and streams of notifications to security control is not constant. Such a situation would occur in the case of overload of the system in which the number of passengers constantly exceed capacity of the security control and then could be assume a constant stream of notifications (no gaps). However, such a situation would result in steadily growing queue and a heavier delays. During the day, there are periods of low flow streams of passengers and to the larger and as large peaks. While for some flow is sufficient to open the three lanes of security control, in the case of the peak may be necessary to open the fourth. The problem arises when a peak takes a slight period of time. The minimum crew of one security counter is 3 workers of Airport Security Guard. Employment additional three operators resulting in large additional costs. The rest of this article conducted an analysis of the functioning of counters for employment of one another operator.

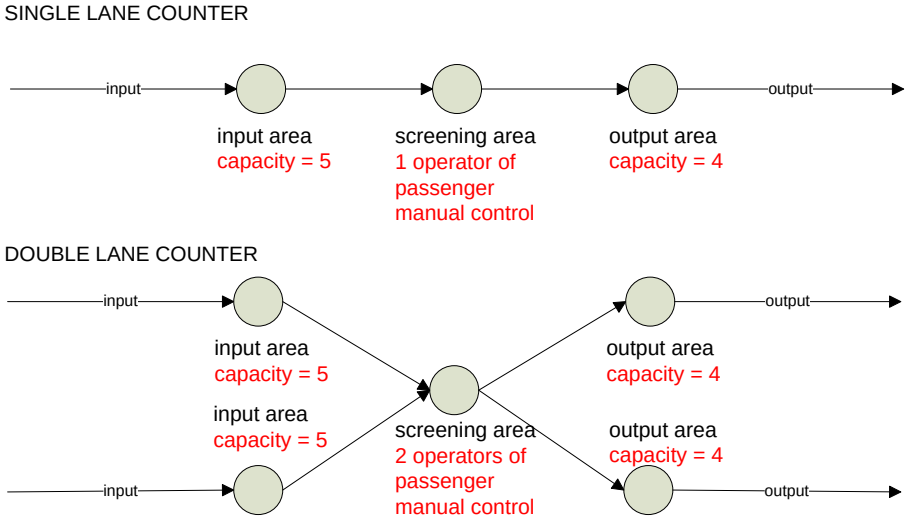

Fig.4 *Current scenario at Wroclaw Airport*

Current scenario of screening takes place at three positions (one single lane and one double lane). This scenario is shown in Figure 4. The main problem concerns the question: to which counter should be added the fourth operator. The obtained results shown Figure 5.

The capacity average of a single counter with one operator is 112 passengers per hour (PAX/h). Additional operator of manual control increases capacity by 12 PAX/h. Average capacity of dual counter with the two operators is 253 PAX/h. Additional operator for this counter increases the capacity of 5 PAX/h. The obtained results show that it is preferable to enter the scenario: a single counter with 2 operators and double counter with two operators. The total capacity average equal 377 passengers per hour. In the scenario, the single counter with a single operator and a double with three operators gives a capacity equal 370 passengers per hour.

Although additional operator increased average capacity in this case study only on 12 PAX/h, in the boundary cases it may be an extremely important benefit. It should be noted also that the capacity system of 377PAX/h has a lower scatter of data, which in the case of dual counter is caused mainly by mixing streams. Temporarily unequal flow of one of the lanes through the metal detector causes for example reaching the capacity of the output area,

through which the second lane is not a fully utilized. It is also important that the results can only be achieved if for the amount of more than one operator, there must be operators of different gender at the manual control area.

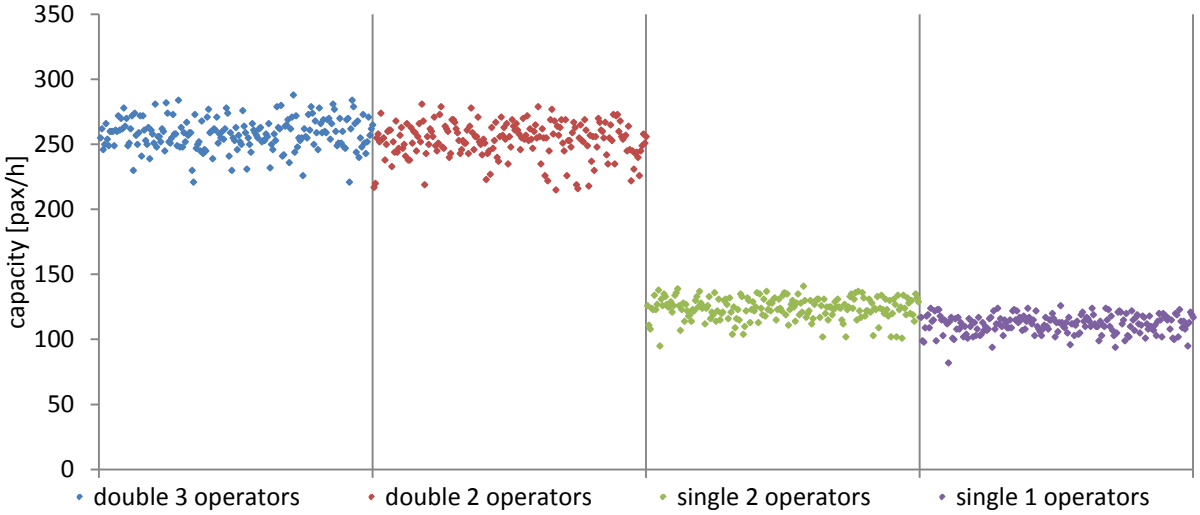

Fig.5 *Simulation model results for different counter configuration*

4 SUMMARY

The paper presents the possibility of using simulation models to analyze the impact of the amount of operators on the process capacity. This is extremely important from an economic point of view as well as to the possibility of instantaneous control efficiency of the process and ensuring adequate performance.

The paper presents a concrete case, however, considering the entire security control area is possible to carry out a wider analysis. However, taking into account the human factor, which plays an important role in the whole process and can cause significant failures should be initiate a further verification of the model to the real system.

There was established as the boundary condition, that the input stream is constant. In fact, it is limited by flight schedule and limited by the process of boarding passes control at the input. Recognition of this aspect can cause that in the daily operation of the system, other results will be more efficient. This will therefore be the subject of further discussion and development of the current model.

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