THE IMPORTANCE OF QUEUES AT AIRPORT SECURITY CHECKPOINTS

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Summary. The capacity is a critical issue at many airports today. Queues are generally rather negatively accepted. But queues at airport security checkpoints are operationally justified from a certain point of view. There are tools for capacity examining and management. This paper deals with the importance of queues at airport security checkpoint.

Keywords: Queuing theory; Efficiency; Capacity; Aviation security

1. INTRODUCTION

The growth of air traffic may in some parts of the airport leads to problematic issues in the field of capacity. Limitations may also arise at the security checkpoint. Issues associated with this area can influence directly the passenger satisfaction and airport operation efficiency. It has also impact on the level of service, demand calculation [1], airport's earnings and so on.

Queues at security checkpoints throughout the world are currently phenomenon. We can find them both at small airports and at the largest airports around the world. From the viewpoint of a passenger the waiting time in a queue and its length are the most critical parameters associated with the queue occurrence. From the viewpoint of a security control provider it involves the number of employees and technological equipment which are needed to maintain queue parameters at acceptable level. For passengers, the security control and all parts of the airport is the level of passenger satisfaction one of the most important outcomes while maintaining a high level of provided security control [2].

In optimal cases the queue parameters (its length, waiting time, etc.) are results of the optimal processes setting which consider a large number of factors [3]. The extreme on the one hand is ensuring the operations without incurring the queue and on the other hand a long term unstable process of queue growth (theoretically endless queues). This paper elaborates on the issue of queues at security checks of passengers and their cabin baggage, its importance and the significance.

2. SECURITY CHECK

The security check at airports is intended to ensure the required level of security checks on all passengers, staff and items carried into a security restricted area of airports and on board aircraft. Defined procedures and processes which are performed at the security check create another strong protective layer of overall security. The security check procedures are standardized and required by law. Reliability can be verified for instance by audits, or other non-traditional approaches such as safety indicators [4]. Individual tasks cause higher time demands for passengers and their delays in

ISBN 978-80-553-2628-3
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this stage of the airport terminal process. The local reducing of passengers flow velocity increases the requirements on the number of check stations for maintaining the total number of passing passengers.

Security threats are constantly evolving. Terrorists remain obsessed with attacking airplanes. After each new attack or attempt security measures are examined and security barriers are strengthened. At the same time passenger loads are increasing. The tolerance of passengers and their will to cooperate are slowly decreasing. [5]

3. THE QUEUING THEORY

Queuing theory is a part of applied mathematics. It is a study of system operations where the recurrence of a sequence of operations is present. The emergence time and the time of the occurrence of such operations are usually random. The aim is to specify dependencies between the entry requirement character, lines productivity and operation efficiency. For this purpose, it is appropriate to define the basic terms that are relevant to this area. Those can be found in the standard books written on this topic, see e.g. [6, 7].

Basic queuing model (Figure 1) is characterized by the following terms. The arrival process of customers describes the laws of the origin and arrival of a new requirement. The arrival rate (λ) is equal to the mean value of the number of customers entering per time. Arrival times are usually independent and have a common distribution (for example customers arrive according to a Poisson stream). The service times are usually independent and identically distributed. The service times are commonly deterministic or exponentially distributed. The service rate (μ) equals to the mean value referring to the number of customers served by one line per time.

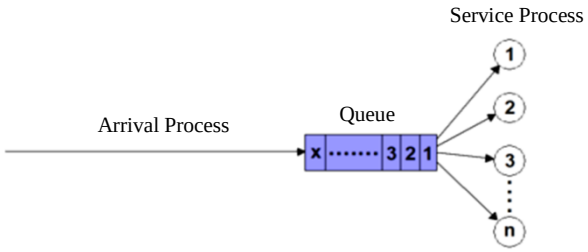

Figure 1 Basic queuing model

4. THE QUEUE AT SECURITY CHECKPOINTS

4.1. Security checkpoint design

We recognise two basic security checkpoints designs. The first is decentralised security checkpoint. In this concept is each flight (or Gate) assigned to the individual checkpoint (Figure 2).

In the figure gates are indicated by letter and number (for example: A4). The red part is SRA (Security Restricted Area). All passengers, luggage, personnel and other equipment must be security checked before entering to this area. The purple part is a transit area and gray par is a public area. There are lots of security checkpoints in the figure. Each security checkpoint is between transit area and SRA.

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The boarding pass validation point or the border control is used depending on terminal processes. For flights between schengen countries the border control is unnecessary. For these flights is the boarding pass validation considered to be sufficient.

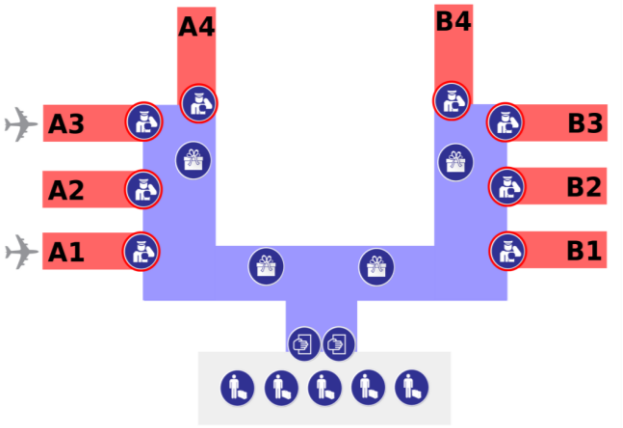

Figure 2 Decentralised security checkpoint concept

Nowadays the modern trend is in creating centralised security checkpoints. In this mode all passengers (or most of them) pass through only one security checkpoint (Figure 3). This paper further deals with the concept of the centralized checkpoints.

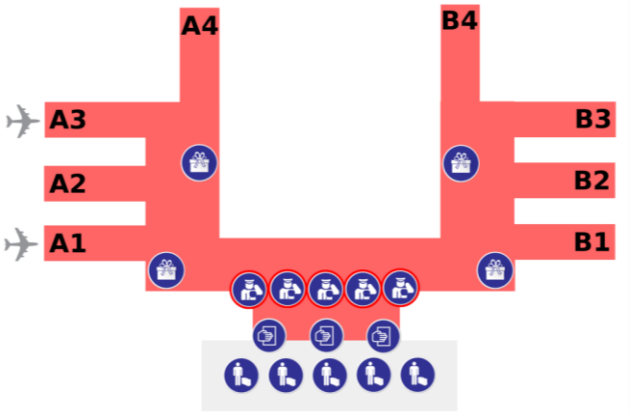

Figure 3 Centralised security checkpoint concept

4.2. Security queuing process

Passengers come to the centralised checkpoint usually after the boarding pass validation. It is performed at the boarding pass validation point or at the border control depending on terminal processes. Passengers arrive here from check-ins, self-service kiosks, directly without using airport check-in, etc. The arrival intensity of passengers is to a certain extent reliably predictable [8]. Based on a flight schedule, load factors and arrival curves the arrival rate of passengers (λ) can be determined with relatively high accuracy. The service rate (μ) is also possible to determine by monitoring the number of handled passengers at each checkpoints. The more parameters calculations include, the more accurate estimates and predictions can the system provide.

Currently, the passenger's arrival rate (λ) and the service rate (μ) are negatively influenced from queuing point of view. The srrival rate (λ) is constantly growing. It is caused by changes in the European aviation market where the aviation is accessible for wide range of passengers and their

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numbers are constantly growing. The operation intensity still increase in peak hours as well as during troughs hours. On the other side the average numbers of handled passengers at security checkpoints (μ) are still dramatically reducing. Especially after September 11 when the new security procedures were applied. The security procedures were stricter and stricter under the influence of new terrorist attacks and threats until today. The proper understanding of the behaviour of λ and μ, the possibilities of their influencing and passengers flow controlling are absolutely crucial parameters for wider understanding of these issues nowadays – the efficiency of security checks, quality of provided service and especially the customer satisfaction.

5. THE SIGNIFICANCE OF QUEUES

When thinking about queues at security check the issue of providing enough efficient service comes into conflict with the issue of high level of passenger satisfaction and the quality of provided security measures. From the viewpoint of operating efficiency during the peak hours it is the most effective to have long queues which are caused by operation fewer security control lines (lower cost of the technological equipment and personnel). On the other hand and from the passengers perspective the best option is in using theoretically unlimited number of security lines in order to ensure high comfort without waiting times.

Operationally optimal is not a single solution. The balance between maximum efficiency and customer satisfaction ensure optimum numbers of security lines in operation. The optimal number of security lines (μ) is, for example, possible to determine as a reaction on passengers arrival rate (λ). Because λ is predictable, it is possible to ensure effective personnel and technological resources planning (μ) in the longer term.

λ and μ are based on the average values in a certain time interval. For example these include information λ = 15 incoming passengers per five minutes and μ = 20 handled passengers per five minutes. The arrival process is driven by Poisson flow. It is assumed that the intervals between arriving passengers are independent variables with exponential distribution. At very short time intervals the intensity of the arrival process and the service rate may vary considerably. An example might be the behaviour of passengers before security check, when they wait for their groups and then continue together at one moment.

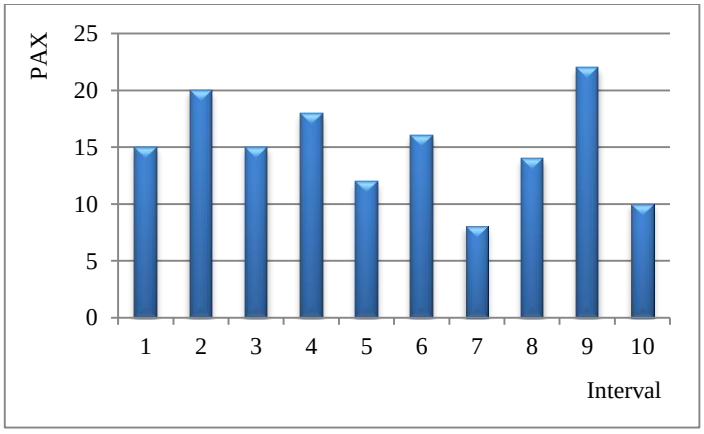

Figure 4 The number of incoming passengers

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To ensure sufficient service rate and appropriate arrival rate is necessary to maintain a certain queue capacity. This is exemplified in a model at figure (Figure 4). λ will be determined on (average) 15 incoming passengers per 5 minutes. As it is shown, it is evident that the real number of incoming passengers is very different for each time interval.

The queue must have sufficient capacity to ensure alignment flow of incoming passengers. For the same reason is the queue important for the service rate – in some time periods more passengers are handled than in others.

Determining the appropriate service rate level to maintain optimum queue length is challenging and very complex discipline. With the refinement of the calculations and the implementation of other influences the complexity of the mathematical model greatly increases. From a certain level of complexity it is more appropriate to use simulation models based on Markov chains and probability theory to determine the appropriate level of service rate.

6. CONCLUSION

Especially in the sharp peak periods there may be longer waiting times in the queue before security check for passengers. However, to a certain extent is the queue necessary from operational point of view. Without the possibility of using queues it would be practically almost impossible to ensure system stability in real conditions in terms of queuing theory. The queues significantly reduce operating cost for security providers. With appropriate information flow and influencing the passenger's perception the queue may not have a significantly negative impact on customer satisfaction.

6. ACKNOWLEDGEMENT

This paper was supported by the Grant Agency of the Czech Technical University in Prague, grant No. SGS16/189/OHK2/2T/16.

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