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A model of check-in system management to reduce the security checkpoint variability

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ABSTRACT

This article presents a model of dynamic management of the check-in desk system at an airport. The elaborated model enables the obtainment of time limits ensuring a uniformly distributed stream of passengers reporting to the security checkpoint on the basis of a schedule of check-in desk operations. The model also allows for the creation of a check-in desk operation schedule for an assumption of the longest acceptable time in queue and the maximum acceptable length of a queue. The model of dynamic management of the check-in desk system at an airport was implemented in Flexsim software. A significant advantage of the developed algorithms is that they consider the stream of passengers report for security control, which is generated by the check-in operating system. The developed model was verified and implemented for management of the check-in system at the Wrocław Airport. For input data obtained in the course of research conducted in 2014 (characteristics of the system and the stream of passengers reports - flight schedule), system efficiency measures were determined: the average queuing time for the check-in, number of work-hours of check-in operators and characteristics of the number of passengers reports for the security control. The developed model can be used in existing check-in systems, and it can also be used to evaluate the operation of a system being designed.

1. Introduction

Passenger handling (PH) includes check-in as a subprocess. In accordance with regulations [1], the check-in process can be performed using a departure control system (DCS) or manually. Manual check-in, however, is usually used as an alternative if a DCS system failure occurs. Check-in with the use of DCS is performed in the traditional manner, i.e., using a check-in desk, where the entire process is performed by ground handling agent (GHA) representatives. Self-service methods include performance of the process using the web or check-in apps, kiosks, and text messages. Passengers using self-service methods can check-in their baggage at specially dedicated desks (baggage drop-off). In reality, mixed methods can also be used, in which passengers can use self-service methods; however, this is not obligatory, and they can check-in free-of-charge at the airport terminal.

GHA performs the check-in process in accordance with the requirements of a given carrier. Regarding requirements, the carrier defines possible check-in methods, time frames for check-in opening for specific connections, and the number of check-in desks for the process. Detailed procedures conducted by GHA are contained in the Ground Handling Manual im-

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plemented for a given company and approved by national authorities, which supervise the air transport process. In the traditional check-in process, carriers usually assume the common system for their own operations. This means that a minimal number of check-in desks is intended for a given carrier, at which the check-in is performed for all of the carrier's flights.

During the day, the number of PH processes performed in the parallel manner for subsequent aircraft operations [2] changes in accordance with the flight schedule and it makes it necessary to conduct the process at the airport terminal using dynamic management. It should also be noticed that PH subprocesses are interdependent. Inappropriate management of one of them may have a disadvantageous effect on another. In general, it can be assumed that the entire check-in process is directly related to the security control, which is the bottleneck of the system at many airports and generates the highest number of delays [3]. This results from the fact that some passengers can perform check-in online while each passenger must go through security control. Therefore, the number of passengers served by the security control system is much higher than in the check-in process. As shown by research [4], a non-uniform stream of reports for the security control causes numerous peaks, which require a temporary increased demand for human and technical resources to guarantee the timely performance of the process. By non-uniform stream of reports, we understand varying quantity of passengers reporting to the security checkpoint in the subsequent intervals Δt. A uniform stream of reports, on the other hand, means that in the next Δt intervals, the same quantity of passengers report to the security checkpoint.

The output stream from the check-in process influences the input stream of passengers reporting to security checkpoint. Current research work focuses on check-in as an independent system. This can have a negative impact on the operation of a security checkpoint. In this paper, we present a model that allows for management of the check-in process in such a way that significant peaks in the streams of passengers reporting to the security checkpoint can be avoided. We treat those systems as dependent. However, we also take into account the level of service (LoS) during the check-in process. By maintaining the LoS adopted, we make the intensity of passengers reporting to the security checkpoint uniform.

The remainder of the article is organized as follows. Section 2 presents the current state of knowledge for the check-in operation. Section 3 presents our model of dynamic management of the check-in system. Section 4 presents the application of the developed model for the check-in system at the Wrocław Airport. This section also presents input data of the model of the check-in system obtained as a result of research conducted at the Wrocław Airport. The results obtained from static and dynamic management of the check-in desk operation in the check-in system are presented. The paper is closed with the conclusion containeds in Section 5.

2. Overview of the state of research

The problems related to PH have been discussed as aspect of many factors since before the 1980 s. These considerations allowed for the introduction of a multi-criteria analysis for passenger flows at the passenger terminal [5]. The issue of process optimization was discussed on numerous occasions in terms of minimum queuing time with minimal use of technical resources [6–9]. [10] presented a comprehensive overview of the literature on the model of the comprehensive management of airport operation systems. It was shown that the research being conducted included: capacity planning, operational planning and design, security policy and planning, and airport performance.

The issue of passenger experience resulting from the method of implementation of individual stages of PH at the airport is very important. In [11], the authors evaluated the "level of service" (LOS) for the airport passenger terminal. The necessity of research was indicated, and the methodology of research was identified. It was based on determining relationships between LOS and quantities influencing its assessment. In [12], the authors presented the results of their research at the Guarulhos Airport, which were aimed at showing the passengers' experience in various subsystems of the airport using Cronbach's alpha. Check-in desks, the security control system, etc. were analyzed. [13] presented a simulation model used to allocate check-in desks to optimize the LOS index that takes into account other elements of the problem, such as physical locations, queue policies, arrival profiles of the passengers, and efficiency of the personnel. Thus, it can be said that a measurement for assessment of the PH operation is the Level of Service, and that is exactly how it is. Articles on optimization of the check-in process apply the wait time in a queue and the probability that the passenger will be checked in within the established time limits as a measure of assessment. Such assumptions are present in all papers referred to in the article. However, the main issue here is process management. In traditional systems, the management of the availability of check-in desks for chosen flights is important. In [14], management of the check-in system was proposed to balance operation costs and the time of waiting in a queue. The authors clearly indicate that the optimization process can be conducted only by dynamic process management. This view is shared by other authors. [15] proposes a knowledge-based simulation system to predict resource requirements at an international airport used by a check-in desk allocation system. Here, the authors focus on minimization of the use of resources while maintaining compliance with the requirements set by the level of service. The authors rightly state that airports base their actions mainly on their own experience and allocate the resources manually. [16] also adopts the same assumptions as the aforementioned articles. All of them take into account the level of service and minimization of the use of resources at the same time. The authors indicated that the process is simple to manage if the desk capacity is constant. Unfortunately, this is not the case in real life, and that is why models need to be created to support the process management. These models should be complied with by simulation models so that they can be implemented in a real-life system. The most important criteria that should be fulfilled by the solutions developed are user-friendliness and usefulness in the decision-making process [17]. Methods applied in models must represent the