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CAPACITY EVALUATION OF THE AIRPORT SECURITY SCREENING CHECKPOINT UNDER COVID-19 MEASURES: A SIMULATION STUDY[1]

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ABSTRACT

The COVID-19 outbreak that occurred at the end of 2019 has affected the whole world. The aviation industry has also been one of the most affected sectors by the epidemic. In order to prevent the spread of the virus, the country borders were closed to entry and passenger transportation came to a halt. With the resumption of flights, international civil aviation organizations and civil aviation authorities of the countries have taken various measures. In the light of these measures, new regulations were developed about processes from entrance to the airport to completion of the flight. New applications such as the use of personal protective equipment and social distance caused many changes in airport processes. The aim of the research is to determine the effect of the COVID-19 measures taken on the airport security screening checkpoint capacity. The airport security screening process of Milas-Bodrum Airport was modeled in line with these measures and capacity analysis was carried out by simulation method. While creating the model, the passenger traffic data of the airport from previous years, similar studies in the literature and expert opinions were used. As the result of the research, it was determined that the measures taken increased the usage rates of the processing units to the maximum levels. If additional security checkpoints are not used, it is anticipated that the measures taken may disrupt the passenger flow.

Keywords: COVID-19, Airport Security Screening Checkpoint, Simulation

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HAVALİMANI TERMİNAL GÜVENLİK KONTROL NOKTASI KAPASİTESİNİN COVID-19 ÖNLEMLERİ ÇERÇEVESİNDE DEĞERLENDİRİLMESİ: BİR SİMÜLASYON ÇALIŞMASI

ÖZET

2019 yılı sonunda ortaya çıkan COVID-19 salgını tüm dünyayı etkisi altına almıştır. Havacılık sektörü de salgından en çok etkilenen sektörlerden bir tanesi olmuştur. Virüsün yayılmasını engellemek amacıyla ülke sınırları giriş çıkışlara kapatılmış ve yolcu taşımacılığı durma noktasına gelmiştir. Uçuşların tekrar başlaması ile birlikte uluslararası sivil havacılık kuruluşları ve ülkelerin sivil havacılık otoriteleri tarafından çeşitli tedbirler alınmıştır. Bu tedbirler ışığında havaalanına girişten uçuşun tamamlanmasına kadarki süreçte yeni düzenlemeler yapılmıştır. Kişisel koruyucu ekipman kullanımı, sosyal mesafeye dikkat edilmesi gibi tedbirler havaalanı süreçlerinde birçok değişikliğe sebep olmuştur. Araştırmanın amacı, alınan COVID-19 tedbirlerinin terminal güvenlik kontrol noktası kapasitesine etkisinin belirlenmesidir. Araştırma kapsamında Milas-Bodrum Havalimanı'nın terminal güvenlik süreci tedbirler doğrultusunda modellenmiş ve simülasyon yöntemiyle kapasite analizi yapılmıştır. Model oluşturulurken havaalanının geçmiş yıllara ait yolcu trafiği verilerinden, alan yazındaki benzer çalışmalardan ve uzman görüşlerinden faydalanılmıştır. Araştırma sonucunda, alınan tedbirlerin işlem birimlerinin kullanım oranlarını maksimum düzeylere çıkardığı tespit edilmiştir. Ek güvenlik kontrol noktaları kullanılmadığı takdirde alınan tedbirlerin yolcu akışını aksatabileceği öngörülmektedir.

Anahtar Kelimeler: COVID-19, Terminal Güvenlik Tarama Noktası, Simülasyon

INTRODUCTION

The coronavirus 2 (SARS-CoV-2) detected in December 2019 has spread rapidly worldwide and has been declared a pandemic. With the spread of the virus, all countries have tried to take similar precautions in the fight against disease. Social activities where people come together are restricted, travel restrictions between countries and within the country have been initiated, and partial or general curfews have been imposed (WHO, 2020). Despite of all the precautions, the number of cases worldwide has reached 209 million, and the total number of casualties has exceeded 4 million in August 2021 (WHO, 2021).

Pandemic has deeply affected the aviation industry as well as many other sectors. Passenger transportation has come to a halt as the country borders are closed to entry and exit. For example, the total number of flights in May 2020 in the European region decreased by 85% compared to the same month of the previous year (EUROCONTROL, 2020). It is predicted that the aviation industry will continue operating loss post-Covid-19 and will not recover in the short term (IATA, 2020). Moreover, international aviation organizations cooperated and published various handbooks that guide the aviation authorities of countries.

Various precautions in flight related processes such as check-in, passenger handling, terminal security, and etc. were taken to prevent the spread of pandemic (ICAO, 2020).

Since 1931, when the first aircraft hijacking was recorded, security has become an increasingly important element for the aviation industry. They have invested in large quantities, especially in the United States, after the September 11 attacks and increased security measures in airport security procedures (Leone & Liu, 2011). In addition to the existing security, the measures taken within the scope of the pandemic have been added, and the terminal security screening process has been reshaped. Post-Covid-19 precautions are thought to increase costs in the aviation industry and adversely affect passenger flow.

In this study, measures for terminal security screening processes after the pandemic have been introduced. Then, the airport security screening process of Milas-Bodrum Airport was modeled with simulation method and it was examined to what extent it could meet the estimated demand with the new measures.

1. AIRPORT SECURITY SCREENING PROCESS

The purpose of security measures at an airport is to determine if there is a prohibited substance on passengers and staff or in luggage and prevent illegal activities (Salter, 2007).

The first security measures in the history of aviation began to be taken between 1968 and 1972, with more than 364 aircraft hijacking actions taking place worldwide. The Federal Aviation Administration (FAA), the aviation authority of the United States, issued a rule requiring all passengers to be screened and luggage checked in early 1973 (Yoo & Choi, 2006). In 1974, Annex-17 on aviation security was published by International Civil Aviation Organization (ICAO) and requirements and standards regarding airport security screening processes were introduced for all ICAO member countries. Following these requirements, security measures implemented at airports in Turkey, the National Civil Aviation Security Program (NCASP) has become the standard across the country (ICAO, 2015).

In this section, the airport security screening process before the pandemic (Pre-Covid-19) is explained. Subsequently, what changes occurred in these processes in line with the post-pandemic measures were revealed.

1.1. Pre Covid-19 Airport Security Screening Process

The states are obliged to take measures to prevent the use of weapons, explosives or other dangerous substances in illegal acts or entry into aircraft that are not authorized to carry in Annex-17, published by ICAO and on aviation security. Therefore, passengers and hand luggage must be scanned before boarding (ICAO, 2011). The security check zone where the screening process is carried out is an important component of airport security (SHGM, 2018).

Security control areas may vary by country and airport, but security screening procedures are largely standardized. After the passengers make their check-in procedures, they go through the security screening process with their small bags known as cabin luggage and hand baggage. There are various queues and devices such as walk through metal detector (WTMD), explosive trace detector (ETD) in each queue in the airport security control area. (Naji et al., 2017).

The safety screening process should be as less "intrusive" as possible to avoid disturbing the passenger. However, the process should be completed as quickly as possible, without causing congestion in the flow of passengers (Başdemir, 2020). For example, the liquid restrictions introduced in 2006 caused delays in many airports around the world, revealing the importance of an efficient security screening process (Barros & Tomber, 2007).

Most of the airports use security lanes model, which have become the standard for security control zones. Each lane or channel is equipped with an arch-shaped magnetometer and an X-ray device. Passengers must pass through the magnetometer, which will sound an alarm when a metal object is detected. If the alarm is activated, security personnel may be asked to pass the magnetometer again or a manual scan is made. Meanwhile, passengers' portable items such as laptops and small bags are scanned by the X-Ray device. If security personnel suspect the bag contains a prohibited item, a manual review is carried out. With the completion of both processes, passenger and hand luggage come together at the exit of the X-Ray device (Naji et al., 2017). Some passengers are randomly selected for additional scanning, while other passengers leave the security checkpoint and proceed towards the boarding gates. In some countries such as the United States, Canada, a secondary screening of selected baggage can be done using an explosive trace detector (Barros & Tomber, 2007). This process is visually expressed as follows (ICAO, 2013):

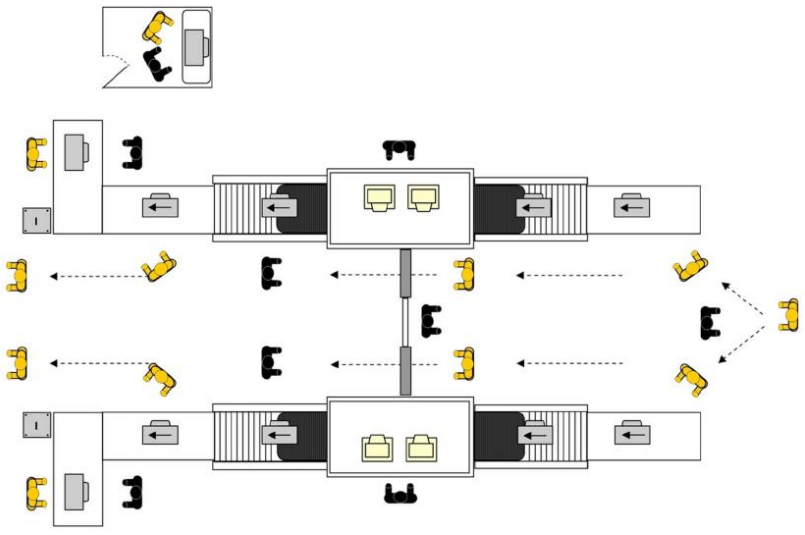

Figure 1: Airport Security Scanning Process *(ICAO, 2013)*

1.2. Measures Taken Under the Scope of Covid-19

Pandemic has affected every area of life and various measures have been taken by countries. The precautions taken, especially the use of personal protective equipment and the protection of social distance, have also shown their effect in the aviation industry as the passenger transportation started to operate again. In this context, it was tried to monitor whether passengers show any signs of high fever with thermal cameras at airports of some countries, quarantine was applied to people whom entering the country for 14 days and border gates were closed to some countries (IATA, 2020).

Many organizations in the civil aviation industry, especially ICAO, that have international regulatory and advisory characteristics have set up guidelines that include measures to be taken while transporting passengers during the pandemic process. These precautions, aimed at protecting the health of passengers and employees, include practices that do not compromise safety and security standards (ACI, 2020). "Airport Pandemic Measures and Certification Circular" released by Directorate General of Civil Aviation (DGCA) under the coordination of the Ministry of Health and Ministry of Tourism in Turkey. With this certification, the measures to be taken to prevent the spread of COVID-19 and the operations of the airports in line with these measures have been declared (SHGM, 2020):

Table 1: Differences in Terminal Processes Pre and Post-COVID-19

	Pre-COVID-19	**Post-COVID-19**
Airport Entry	Security check	Social Distance Mask control Fever control Thermal scanning Cleaned / disinfected trays in X-ray areas Those who do not travel are not taken to the terminal building
Security Zone	Take out electronics Remove fluids Remove metal items	Social Distance Wear a mask Cleaned / disinfected trays in X-ray areas Contactless boarding pass and identity check
Departure Passenger Lounges	Control of boarding cards	Social Distance Final check of flight availability

Some methods such as manual scanning, Explosive Trace Detector (ETD) scanning, vehicle search, and aircraft security search, which are among the security scanning processes, require contact with people or surfaces that contact with people. Since the contact is thought to increase the risk of virus spread, application details of these methods have been changed with the "Aviation Security Bulletin" published on May 18, 2020 by DGCA. Some of these changes are: (SHGM, 2020):

- If the passenger caused the device to alarm while passing through the metal detector (WTMD), all metal items should be removed and passenger should re-pass. If the security personnel suspects that the passenger may be carrying the banned substance, they can be searched by hand so as not to face the passenger directly. New gloves should be worn after each hand search.
- Searching for passengers who do not want to pass WTMD due to various reasons (pregnancy, wearing a pacemaker, ethnic clothing, etc.) can be done with a hand-held metal detector and ETD.
- Scans of other passengers as well as passengers that cause the WTMD to alarm should likewise be subject to manual search or ETD scans with WTMD.
- Although all screening process has been carried out for the passenger, the passenger may be rescanned or may not be allowed to pass because of the suspicion that he / she still carries a banned substance.
- It may be of a size and structure that can allow the banned substance to be stored in surgical masks worn by passengers. The removal of these masks should be requested by the security officer. In case of doubt, masks should be screened like cabin baggage.
- The safety officer should maintain limited contact with the passenger during ETD scans. ETD should be made by taking the sample from the object such as wallet, passport or clothing accessories instead of the hands of the scanned passengers.

In this study, it is aimed to make capacity analysis for the airport security screening point of Milas-Bodrum Airport in line with the measures mentioned above.

2. METHODOLOGY

2.1. Simulation Method

Simulation is a tool to evaluate the performance of an existing and proposed system under different arrangements and in the desired time interval (Maria, 1997). In airports, simulation is mostly used for modeling airport processes with capacity and delay estimation (Horonjeff et al., 2011). There are various studies related to processes such as check-in, registered baggage, security screening, arrival or departure processes in the literature.

In this study, discrete event simulation was used. It was concluded that Law and Kelton (2000)'s simulation definitions and studies conducted in the literature were evaluated by analyzing airport security scanning processes with the best discrete event simulation.

The system is dynamic in nature. In other words, it has a structure where events occur on the timeline and one event affects the other. The events between logging in and out of the system occur in discrete (discrete) times and the fact that these events are greatly affected by the human factor causes some situation variables to be random. Because of that, the process is stochastic.

2.2. Collection of Data

In the step of collecting the data required for the development of the model, the passenger traffic data of Milas-Bodrum Airport for 2019, related studies in the literature, the airport security screening process observations and expert opinions were used. The table below shows the distribution of passenger traffic for 2019 monthly (DHMİ, 2020):

Table 2: Distribution of 2019 Milas-Bodrum Airport Passenger Traffic by Monthly

Months	Domestic	International	Total
January	96,171	0	96,171
February	88,648	0	88,648
March	101,992	262	102,254
April	153,244	56,209	209,453
May	190,393	194,311	384,704
June	330,950	317,798	648,748
July	405,406	373,746	779,152
August	411,732	415,963	827,695
September	311,102	335,841	646,943
October	194,723	176,823	371,546
November	97,977	2,382	100,359
December	82,060	0	82,060

As seen in the passenger traffic data in table 3, Milas-Bodrum Airport is a seasonal airport and hosted the most passengers in August in 2019. In addition, a meeting was held with the officials of Milas-Bodrum Airport and "peak-hour" passenger traffic data for 2019 were provided. It was revealed that August 18th, 14 p.m. was the peak hour for Milas-Bodrum Airport. While analyzing the capacity before the pandemic (Pre Covid-19), peak hour passenger traffic data were taken as basis.

2.3. Simulation Model

Similar studies conducted in the past have been used in determining the distributions for passenger arrival, processing times and alarm rate. In line with the studies and expert opinions in the literature, the following model was created:

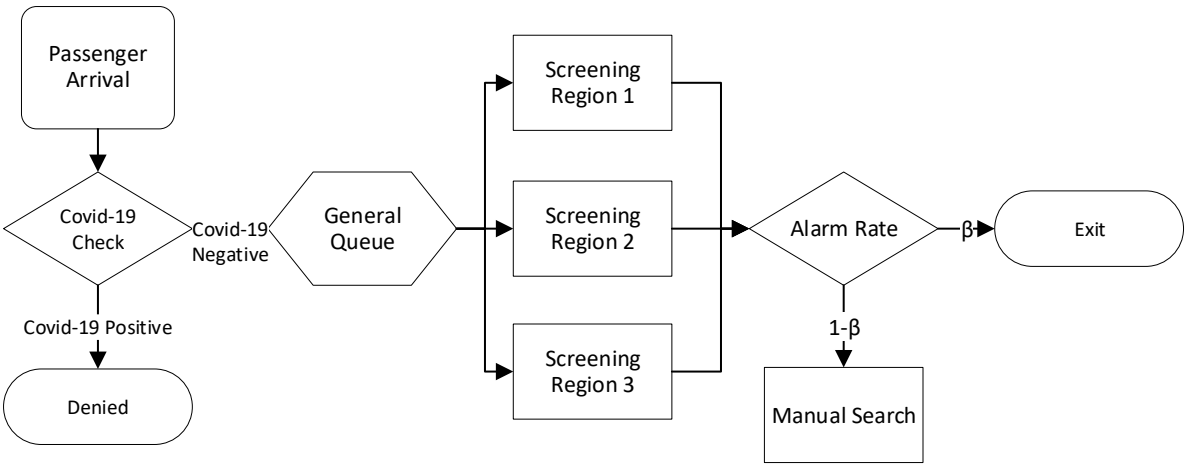

Figure 2: Airport Security Screening Process Model

Law and Kelton (2000) stated that a model should only be detailed enough to evaluate relevant variables and accurately reflect the system with available data. Considering the data available and the simplicity that will accurately reflect the system, some assumptions and limitations have been put forward. These assumptions and limitations are given below:

- Multiple related studies only simulated the peak hours because it is assumed that the airport security screening point can handle less than peak hour traffic (Lange et al., 2013). Only the peak operational time of 14 pm to 15 pm was simulated.
- Factors related to security personnel were not considered. While modeling the security screening process, a fixed personnel planning was made.
- Passengers who cannot be scanned in the Metal Detector, such as wheelchairs, prostheses or pacemakers, are not included in the model because they are few in number. These passengers who stayed longer in the system were ignored as in similar studies (Dorton, 2011).
- Passenger travel times between transactions are ignored.
- Trays and hand luggage used for personal belongings are handled as standard and with the same processing time distribution as in similar works (Leone & Liu, 2011).
- "First in, first out (FIFO)" rule is taken into consideration for all transactions and queues.
- Dorton (2011) stated that close to 98% of the recorded times for screening zone operations are suitable for a triangular distribution in seconds (1, 4, 20). In this study, the same distribution was used for screening region operations.
- In similar academic studies and data from the Transportation Security Agency (TSA), an agency of the United States operating in transportation security, it has been demonstrated that manual searches fit uniform distribution. Within the framework of the information received through the interview method, a uniform distribution of 30 to 120 seconds was determined for the manual search operation.
- The alarm rate was determined as 9% in line with the sample of Leone and Liu (2011). In other words, 91% of passengers pass without causing the device to sound an alarm.

3. RESULTS

The airport security screening process of Milas-Bodrum Airport was modeled using simulation software in the one-hour time when the airport passenger traffic was highest. Two simulations were carried out as before and after the pandemic. Variable values of the model before the pandemic are given below:

Table 3: Variable Values of the Model Before the Pandemic

Model Variable	Variable Value
Passenger Arrival Rate	7.05 passengers / minute
Scanning Process	TRIA [1,4,20] seconds
Manual Search Operation	UNIF [30.120]
β (Alarm Rate)	%91

In post-pandemic simulation, changes were made in the processing times due to reasons such as increasing passenger distances in the queue and changing manual search procedures (SIHAGUVDER, 2020). According to the simulations carried out, the average time spent by the passengers before and after the pandemic is shown in the table below:

Table 4: Average Time Passengers Spend in the System (Minutes)

	Pre-Covid-19	Post-Covid-19
Service Time	0.1901	0.2357
Wait time	3.4061	7.1244
Total Time in the System	3.5963	7.3601

With the measures taken under the pandemic, it is predicted that both the average service times given to the passengers and the average waiting times of the passengers will increase dramatically. Therefore, the total time that passengers will spend in the system will increase.

Findings related to the queues at the screening regions and manual search points before and after the pandemic are as follows:

Table 5: Average Waiting Time and Average Number of Passengers in Queue by Process Units

	Pre-Covid-19		Post-Covid-19	
	Average Waiting Time (minutes)	Average Number of Passengers in the Queue	Average Waiting Time (minutes)	Average Number of Passengers in the Queue
Screening Region 1	3.7352	28.0915	8.5947	65.8204
Screening Region 2	3.6615	28.4308	5.8778	41.6376
Screening Region 3	1.2393	8.6399	5.3730	36.7558
Manual Search	15.6448	26.2354	18.3839	21.9566

It is concluded that the average waiting time for each process unit and the amount of queue in front of the process unit will increase. Due to processes such as changing gloves and disinfecting the equipment after each manual search, the expected increases in the waiting time and number of passengers in the queue are remarkable. The usage rates of the process units are given in figure 3 below:

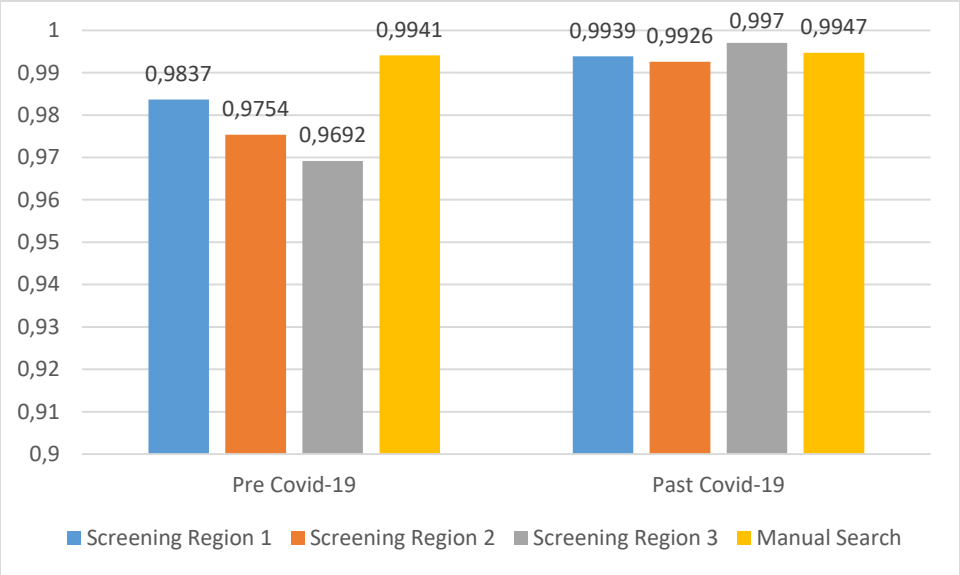

Figure 3: Usage Rates of the Processing Units (%)

Simulation has revealed that the measures taken under the pandemic will increase the usage rate of each process unit. However, it can be said that the rate of increase in use in manual search is insignificant.

CONCLUSION

The aviation industry has been affected by the COVID-19 outbreak significantly and passenger transportation has been stopped in many countries. New regulations have been introduced to take various measures to prevent the spread of the virus. Milas-Bodrum Airport security screening process was modeled by taking the measures taken within the scope of the pandemic into consideration, and it was examined how much it would respond to the anticipated demand in the study. Since the measurements for the airport security screening process before the pandemic (Pre Covid-19) could not be made, the passenger traffic data of the airport, similar studies in the literature and expert opinions were used while developing the model. In the simulation studies carried out, the measures taken under the pandemic will extend the waiting and service periods of the passengers. Therefore, it is predicted that it will affect the flow of passengers negatively. If the airport passenger traffic is the same as 2019, both screening regions and manual search points will operate at almost full capacity and disruptions to the passenger flow may occur.

If the measures continue and the same number of passengers are reached, an additional screening region may be required. For further researches, the real values of variables can be measured when number of flights increases; thus, it is thought that healthier capacity estimates can be made.

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