BANDIRMA ONYEDİ EYLÜL ÜNİVERSİTESİ
AUSUD JITSA

Research Article

Security Control Process Modeling During the Covid-19 Pandemic: Example Of Esenboğa Airport

Emre Karsigil[1*], Savas Selahattin Ates[2]
[1] Department of Aviation Management, Faculty of Aeronautics and Astronautics, Necmettin Erbakan University, Konya, Turkey
[2] Department of Aviation Management, Faculty of Aviation and Space Sciences, Eskisehir Technical University, Eskisehir, Turkey
*Correspondence: ekarsigil@erbakan.edu.tr
DOI: 10.51513/jitsa.1085557

Abstract: Airport facilities are places where constantly updated measures, regulations and improvements are implemented. Simulation modeling plays an important role in ensuring the high efficiency and user friendliness of such arrangements. Especially in recent years, simulation has become an indispensable need for the aviation industry. Contrary to traditional theories, the simulation approach reveals a more realistic system behaviour analysis. One of the most important operations carried out at airports is undoubtedly the security checkpoints. Simulation of airport security checkpoints is the basis for more efficient use of these service points, improving the service level, identifying bottlenecks in the system and producing solutions. In this study, it is aimed to calculate the delay and queue data created by the precautions and regulations applied in the Esenboğa Airport terminal building after the Covid-19 pandemic, at the security checkpoint after the visa checkpoint. In the study, it is aimed to determine the problems that can be caused by the precautions and regulations taken in airport security by modeling the security control process after the Covid-19 pandemic by using the simulation method. The simulation model was created by taking expert opinions in accordance with the operation carried out at the airport. Finally, the results of the simulation model were evaluated, and suggestions were made to the airport stakeholders.

Key words: Airport Management, Simulation, Covid-19, Airport Security Screening Process.

Covid-19 Pandemisi Sırasında Güvenlik Kontrol Süreci: Esenboğa Havalimani Örneği

Özet: Havalimanı tesisleri, sürekli güncellenen önlem, düzenleme ve iyileştirmelerin uygulandığı yerlerdir. Simülasyon modellemesi, bu tür düzenlemelerin yüksek verimliliğini ve kullanıcı dostu olmasını sağlamada önemli bir rol oynamaktadır. Özellikle son yıllarda simülasyon, havacılık sektörü için vazgeçilmez bir ihtiyaç haline gelmiştir. Simülasyon yaklaşımı, geleneksel teorilerin aksine daha gerçekçi bir sistem davranış analizi ortaya koymaktadır. Havalimanlarında gerçekleştirilen en önemli operasyonlardan biri de kuşkusuz güvenlik kontrol noktalarıdır. Havalimanı güvenlik kontrol noktalarının simülasyonu, bu hizmet noktalarının daha verimli kullanılmasına, hizmet seviyesinin iyileştirilmesine, sistemdeki darboğazların belirlenmesine ve çözüm üretilmesine temel oluşturmaktadır. Bu çalışmada Covid-19 pandemisi sonrası Esenboğa Havalimanı terminal binasında uygulanan tedbir ve yönetmeliklerin vize kontrol noktası sonrası güvenlik kontrol noktasında oluşturduğu gecikme ve kuyruk verilerinin hesaplanması amaçlanmıştır. Çalışmada, simülasyon yöntemi kullanılarak Covid-19 pandemisi sonrası güvenlik kontrol süreci modellenerek havalimanı güvenliğinde alınan önlem ve düzenlemelerin yol açabileceği sorunların belirlenmesi amaçlanmaktadır. Simülasyon modeli, havalimanında gerçekleşen operasyona uygun olarak uzman görüşleri alınarak oluşturulmuştur. Son olarak simülasyon modelinin sonuçları değerlendirilerek havalimanı paydaşlarına önerilerde bulunulmuştur.

Anahtar Kelimeler: Havalimanı Yönetimi, Simülasyon, Covid-19, Havalimanı Güvenlik Tarama Süreci

* Corresponding author: Emre KARSIGIL.
E-mail address: ekarsigil@erbakan.edu.tr
ORCID: 0000-0001-6243-9746[1], 0000-0003-2462-0039[2]
Received 10.03.2022; accepted 31.08.2022
Peer review under responsibility of Bandirma Onyedi Eylul University.

1. Introduction

In former times, the aviation industry has been affected by viruses that spread regionally among humans. However, COVID-19 pandemic unexpectedly had such a large impact on the functioning of air transport. When large clusters of COVID-19 cases in Europe were identified as of March 2020, initial restrictions were placed on crossing borders, followed by the suspension of international and intercontinental flights (Kierzkowski and Kisiel, 2020). With the impact of the pandemic, compared to year of 2019, there was 50% decrease in the number of seats offered by airlines in 2020 compared to 2019 (66% in international flights, 38% in domestic flights), 60% in the number of passengers (1.38 billion passengers on international flights, 1.3 billion passengers on domestic flights) and therefore, there was a loss of 371 billion dollars in airline revenues (251 billion dollars in international flights, 120 billion dollars in domestic flights) (ICAO, 2020). On a global scale, there was a 60% loss in the number of passengers, 64.2% in airport passenger traffic and 65% in revenues. Moreover, according to ICAO (International Civil Aviation Organization) (2020), there was a decrease of 9.2% in the trade volume and around 4% in the gross national product (GDP). In Turkey, compared to 2019, the decrease has taken place on 45% in the number of flights, 58% in transit flights (Overflight), 50.5% in the number of domestic passengers, 70.5% in the number of international passengers and 90.7% in the number of direct transit passengers. A loss of 40% was experienced in the cargoes carried on domestic lines and 41.6% on international lines (GDSAA, 2020). It is stated that the recovery in the aviation sector will be in the second quarter of 2021 in Europe and its upward trend will be in the third quarter (ICAO, 2020).

Since the first known hijacking in 1931, the aviation industry has been the target of terrorist attacks. Especially in the past two decades, aviation security has become a high priority issue of national concern and concern. The events of September 11 led to fundamental changes in many operational and aviation security policies at all commercial airports (Nikolaev et al., 2011). Skorupski and Uchronski (2016) stated that transport systems adopted from critical infrastructure parts are constantly at risk of terrorist attacks and airport terminals are a frequent target for these attacks, despite being closely protected. In addition, it was stated that airports are the only places to detect and prevent the carrying of explosives or weapons to aircraft. Besides, the attempt to actively respond to the terrorist threat takes place at security checkpoints carried out at airports. The tools and equipment used during the control of personal security, which is one of the most basic methods of preventing illegal acts, is very important to prevent the methods used by all terrorists in the world. Wang (2016) emphasized that the increase in terrorist attacks in recent years has made the security screening of airline passengers an important feature of air travel. Additionally, the primary purpose of passenger and baggage screening within the aviation security control system is to prevent prohibited substances from entering the airport terminal and boarding a commercial aircraft, and that it is important that security screening procedures must have a high degree of reliability, as the potential loss of life and aircraft is substantial. Pendergraft et al. (2004) stated that security measures allow community to continue their lives normally in an increasingly dangerous world. It has been highlighted that while security measures have become a standard part of daily life due to increasing dangers, they also return to society as discomfort and delay in terms of airport operations. In response to these concerns, it was stated that the passenger control process should be designed to minimize inconvenience to community.

A pre-screening system is used to help quantify the risks to passengers in aviation security operations. This risk information is then used to make decisions about how each passenger and their baggage should be screened within security checkpoints. Due to limited budget and scan device resources, only a fraction of passengers can be screened at the highest security levels. The reason for this is that it requires more time and cost for existing identification systems to identify high-risk objects (Wang, 2016). Also, Pendergraft et al. (2004) mentioned the necessity of adequate number of personnel and checkpoint equipment such as X-ray devices required to carry out standard procedures at control points. It was stated that the need for additional personnel to distribute the density and the queue at the busiest times and the waiting time at the check-in counters affect the required time and waiting time at the security checkpoints. In this study, first of all, additional measures, and practices regarding the scanning processes at the security checkpoints in the airport terminal buildings after the Covid-19 pandemic were put forward. In the next stage, the security control process after the passport control point at the international terminal of Ankara Esenboğa Airport was modelled with the simulation method, and it was

examined whether the existing capacity at this point was met with the new measures and applications put into effect.

2. Literature Review

Pendergraft et al. (2004) aimed to create analytical support for the airport by focusing on resource requirements, process performance, customer satisfaction and cost aspects for the simulation, which was rapidly developed and put into practice for the airport after the September 11 attacks. It has been observed that a change in any of these areas significantly affects other areas. It has been stated that all these policies have a cost effect, and that policy evaluations have both cost and operational effects. The created simulation has succeeded in adequately describing and predicting the effects of system changes. No formal verification process is used to validate the model, depending on the allowed timeframes; however, the simulation has been noted to be able to accurately imitate the checkpoint performance under several different scenarios. The overall successful checkpoint process of the model was observed to be crucial to the redesign, providing valuable insights into policy development.

Skorupski and Uchronski (2016) aimed to create a decision support system that can draw conclusions and make decisions, which includes showing a solution (in equipment and operating technology at the passenger safety checkpoint) with the highest evaluation. In the created system, the knowledge base was used which provided by the experts, expressed in the form of fuzzy rules. In the study, a computer tool called Fuzzy Passenger Security Control Assessment (FUPSCA), which is a practical application of the expert system that supports the management of the airport security system, was created based on the presented theoretical concept. It has been observed that it is possible to make a quantitative assessment of the effectiveness of the passenger safety check in relation to the selected frequency of the additional checks and the quality of the manual check identified in the experiments performed. In the other experiment, it was stated that the practical applicability of the theoretical and software solutions developed for the organizations managing the airports was verified and the management method could be designed from a psychological point of view. It has been seen that the method applied in this study enables better management of aviation security to evaluate the effectiveness of passenger security control at an airport. Also, the human factor was taken into account in the evaluation of the effectiveness of passenger control as an approach.

Kierzkowski and Kisiel (2020) drew attention to the need to maintain social distance between people due to the pandemic and stated that this situation caused congestion at the airport security checkpoint and the performance decreased dramatically. In order to minimize this effect, it is stated that different configurations have been developed to ensure passenger flow on the way to the security checkpoint. Moreover, it was stated that the advantages and disadvantages of these configurations were determined, and performance measurement was made. It has been stated that if the necessary clearance is not provided on the way to the checkpoint to ensure the passenger flow, the required instructions should be given to the passengers in order to maintain the distance after the checkpoint and the performance can only be achieved in the entrance area.

3. Airport Terminal Building Security Scan Process

Security screenings, which started due to many attacks in the history of aviation industry and have been developed since the terrorist attack on September 11, 2001, implemented more strictly at all airports around the world, have become one of the most important factors in ensuring passenger and flight safety. These control scans started with the rule enacted by the Federal Aviation Administration in the USA in 1973. According to the "Annex-17" published by the International Civil Aviation Organization (ICAO) in 1974, standards related to security processes have been determined for ICAO member countries around the world. Turkey, on the other hand, largely implements the security screening standards determined by ICAO.

In this part of the study, the security control processes in the terminal building at the airports before the pandemic were specified and additional measures and practices introduced after the pandemic were explained.

3.1. Pre-pandemic Airport Security Control Process

In recent years, security checkpoints have taken the lead in processes that have become a necessity in airport terminals. At security checkpoints, passengers and their luggage are checked through a channel. Each channel is equipped with an arch-shaped magnetometer and X-ray device. Passengers are checked by magnetometers and baggage is checked by X-ray devices. If a metal object is detected on the passenger and/or in their luggage, the security officer can manually check the passengers and their luggage. Some passengers may be randomly selected for additional screening. (Naji et al., 2017, cited by Özkan and Ateş, 2020).

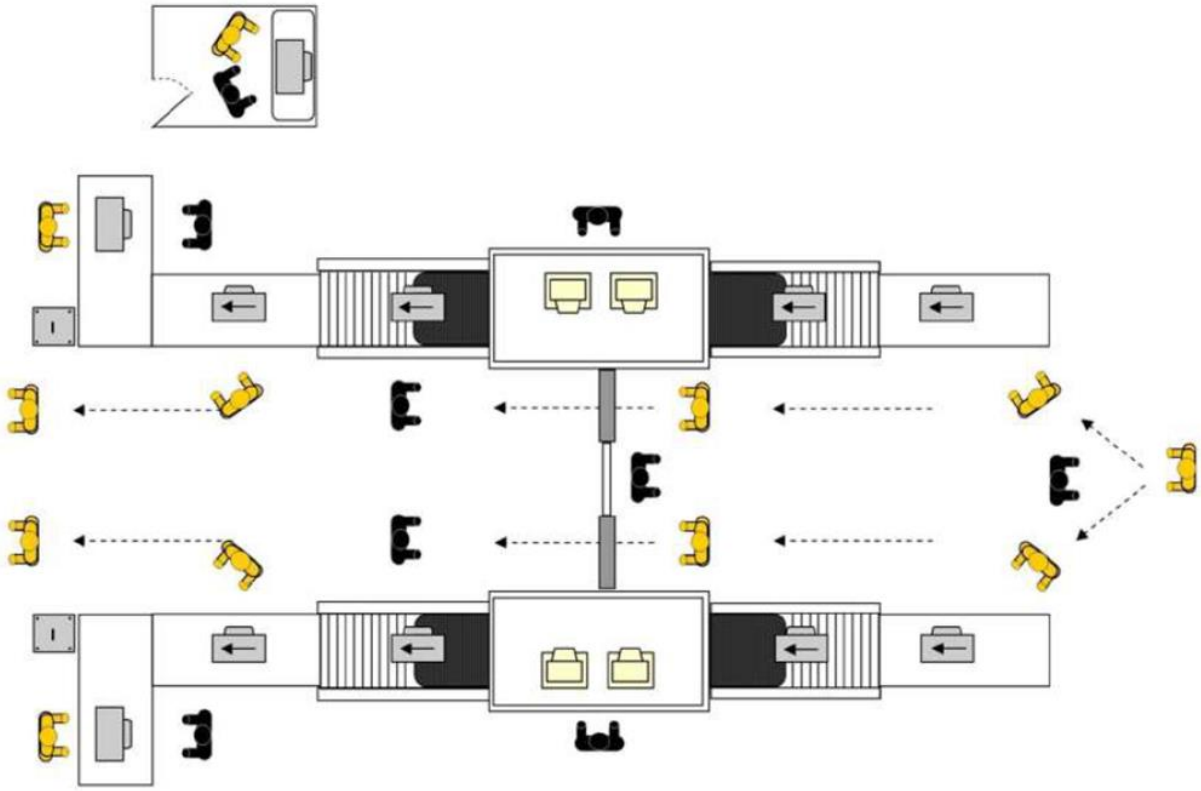

Figure 1. Terminal Security Scan Model (ICAO, 2013).

Besides that, many negativities are encountered in security scanning processes. Paul et al. (2009, 66) lists the barriers to effective passenger screening in aviation security as follows:

1- Due to the large number of personnel changes, the recruitment of the controllers takes place in a short time.

2- Inadequate education.

3- Mental and physical wear and tear of employees due to high labour force at busy times.

4- Low wages given to those working at checkpoints.

5- Insufficient number of personnel.

6- Low quality screening equipment.

7- Insufficient space at screening control points.

8- Over carriage procedures for some restricted items.

9- Uneven distribution of passengers sent to security checkpoints.

10- Pressure from airlines and airport management departments to avoid delays at security checkpoints.

Another disadvantage of passenger safety control is that it is costly to plan the process and make it sustainable. Furthermore, the congestion at the checkpoints and the delays caused by the queues. As a consequence of all, the airport's security control causes workforce loss for the airport and passenger dissatisfaction could be occurred on the basis of airport service quality. In fact, national economies are seriously affected by their operational efficiency, as airports play an important role in passenger and cargo transport (Wang, 2016). Also, it has been stated that security checks at checkpoints that are passed through metal detectors on foot do not provide full efficiency since they can only detect metal items (Skorupski and Uchronski, 2016).

3.2. Post-pandemic Measures and Practices

After the pandemic, preventive measures have been taken at airports, which are among the largest public places. ACI (2020) listed the advisory measures to be implemented at the security checkpoints at airports during the pandemic as follows:

- If passenger traffic permits, it is recommended to maintain a gap of at least 1.5 meters between checkpoints.
- Additionally, checkpoint managers should note that creating queues before the checkpoint should be avoided.
- For cleaning and disinfection of hands, hand disinfectants and gloves should be distributed to the scanning personnel.
- At regular intervals, screening personnel should perform routine cleaning and disinfection of frequently touched/exposed surfaces in the security checkpoint and baggage areas.
- Employees are advised to wash their hands after cleaning and after removing gloves. (ACI, 2020).

In addition, DGCA (Directorate General of Civil Aviation) (2020), the measures applied before and after the pandemic at the security checkpoints in the airport terminal building before the flight are indicated in the table.

Table 1. Precautions applied at airports before flight (DGCA, 2020)

	Before Covid-19	**After Covid-19***
Security Checkpoint	- Removal of electronic items - Removal of liquids - Removal of metal items	- Social Distancing (at least 1 meter) - Wearing a mask - Maintaining cleaned/disinfected trays in X-ray areas - Contactless boarding pass and ID check

* The measures specified in the "After Covid-19" column are in addition to the measures specified in the " Before Covid-19" column.

4. Methodology

4.1. Simulation Method

Simulation, also known as reproduction or learning, is technically simulating the operation of a real event or system over time. While the simulation allows the observation of the past, it also allows the production of the artificial history of the system and making inferences about its properties. In another definition, simulation is the modelling of the system so that the behaviour of the system can be observed under different conditions (Aydın, 2010). Başlıgil (2016) defines modelling with simulation as “It is a trial and application methodology in the form of defining the behaviour of the system, establishing a theory or hypothesis, using the established theory to predict the future behaviour of the system”.

Currently, simulation models have turned into systems that can be used at every stage of design and prevent errors in advance, with the advancement of technology. By applying simulations of human movements according to the purpose of use of buildings, human behaviour can be analysed in the face

of different types of places and conditions. For this reason, it makes it possible to measure not only theoretical capacity but also practical capacity (Arusoğlu, 2010).

For a long time, airport simulation models are created, and capacity is measured. In this study, it is aimed to analyse the differences in capacity usage after the pandemic by creating a simulation model of the security checkpoint scanning process in the terminal building of Ankara Esenboğa Airport.

4.2. Data Collection and Model Building

In this study, it is aimed to simulate the intensity that may occur within the scope of Covid-19 measures at the security checkpoint after the passport control of the Ankara Esenboğa Airport international passenger terminal, and to provide suggestions to the stakeholders by determining the necessary measures to avoid queues. The main goal is to identify if there will be congestion at the security checkpoint as the passenger statistics are reached peak numbers before the Covid-19 pandemic, while the measures taken after Covid-19 pandemic still continue. Within the scope of the study, the Arena Simulation program was used. The research questions (RQs) to be examined within the scope of the research can be listed as follows:

RQ_1: Do the measures taken during the Covid-19 pandemic cause a queue at the security checkpoint?

RQ_2: Does it cause mental and physical exhaustion since the work intensity of the personnel at the security checkpoints is high in the busiest time zones of the airport?

RQ_3: Does the increasing the number of employees and scanning devices reduce the density at the security checkpoint?

There are some assumptions and limitations for the data to give accurate results in the simulation to be carried out in the study. These can be lists as follows:

- The results obtained by keeping the number of employees at the security control point constant were compared with the results obtained by increasing the number of employees according to the probability predicted in the RQ_3.
- While modelling the security screening process, fixed personnel planning was applied, and personnel-related factors were not taken into account.
- It is accepted that trays and hand luggage used for personal belongings show the same processing time distribution as passengers.
- While determining the busiest time of the airport, the 8-hour time frame in the month with the heaviest passenger and airplane traffic was simulated, since no information could be obtained on the day and time zone with the busiest passenger traffic.
- The “first in, first out (FIFO)” rule has been taken into account for all transactions and queues.

In the selection of the data to be used for the creation of the model, the passenger graph data of Ankara Esenboğa Airport for the year of 2019, the scanning processes at the security checkpoints during the pandemic process and the opinions of the experts were used to determine the operational inputs. The airport passenger traffic data is based on the international outbound passenger traffic data for December 2019, when the heaviest passenger traffic, to observe that there is sufficient capacity to meet the demand.

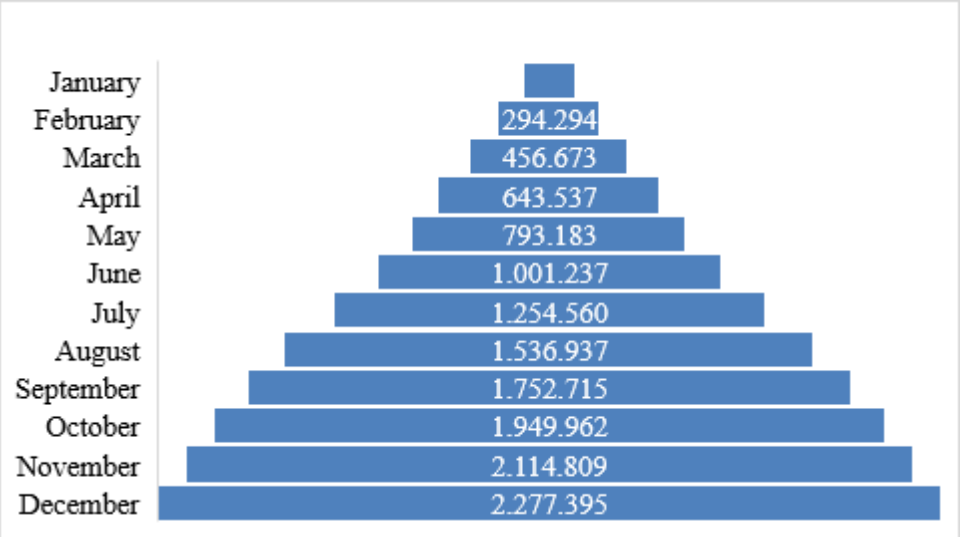

Figure 2. Ankara Esenboğa Airport international monthly passenger traffic in 2019 (Author (2021), based on GDSAA (General Directorate of State Airports Authority) database).

During the model creation phase, flights in the 8-hour shift timeframe were included in the simulation based on the busiest day in December 2019. In that time period, the international flights are carried out by types of Boeing 737-800 and A320-200 commercial aircrafts. In addition, the number of passengers was determined by considering the passenger load factor of the airline companies operating the flights in that period. Furthermore, two different simulation models were created, as the hand luggage (or items) of passengers and passengers will pass through separate X-ray devices. The model, which was created by using the expert opinion, was simulated in the Arena Simulation program. The following information based on expert opinion and assumptions have been adopted to simulate the process at the security checkpoint after passport control in the terminal building where international flights are made:

1- The measures to be taken against the pandemic have been determined in accordance with the "Airport Pandemic Precautions and Certification Circular" published by DGCA. These are;
   - Measures are taken to maintain social distance of at least 1 meter in all airport facilities and terminal building.
   - Obligation to wear a mask.
   - Cleaning the security checkpoint with disinfectant.
2- It is assumed that all passengers included in the simulation have a hand luggage and/or bag with them.
3- There is only one security checkpoint after passport control.
4- After the passport control, the walking distance to the security point is determined as a minimum of 15 seconds and a maximum of 45 seconds based on the expert opinion.
5- At the security checkpoint;
   - A staff member to inform and direct passengers,
   - A staff member near the X-ray machine to manually check the passengers,
   - In order to provide computer-based control of X-ray device, a staff member is for a personnel hand luggage,
   - Lastly, one staff member is there to manually check the hand luggage.
6- Based on expert opinion, it is determined that the transit times of the passengers from the X-ray devices are distributed in a triangle (15, 30, 45 seconds). In addition, 30% of passengers can pass without any warning during this first check.

7- Passengers' passing through the X-ray device for the second time is also considered to be between "15, 30 and 45 seconds". During this control, it was assumed that 70% of the passengers passed without warning, referring to expert opinion.

8- The third check is considered to be done manually and it is assumed that this check is completed between “15, 30 and 45 seconds”, referring to expert opinion.

9- Based on expert opinion, it is accepted that the hand luggage belonging to the passengers is checked at the same time and at the same time as the passengers. It is determined that 85% of the checked baggage in the X-ray device passes without warning.

10- The second check of the hand luggage of the passengers is carried out after the detection of a prohibited substance from the X-ray device. This control is done manually, showing a triangular distribution (between 2, 2.5 and 3.5 minutes), this control is completed based on expert opinion.

The simulation model was created for passenger and passenger hand luggage as seen in Figure 3.

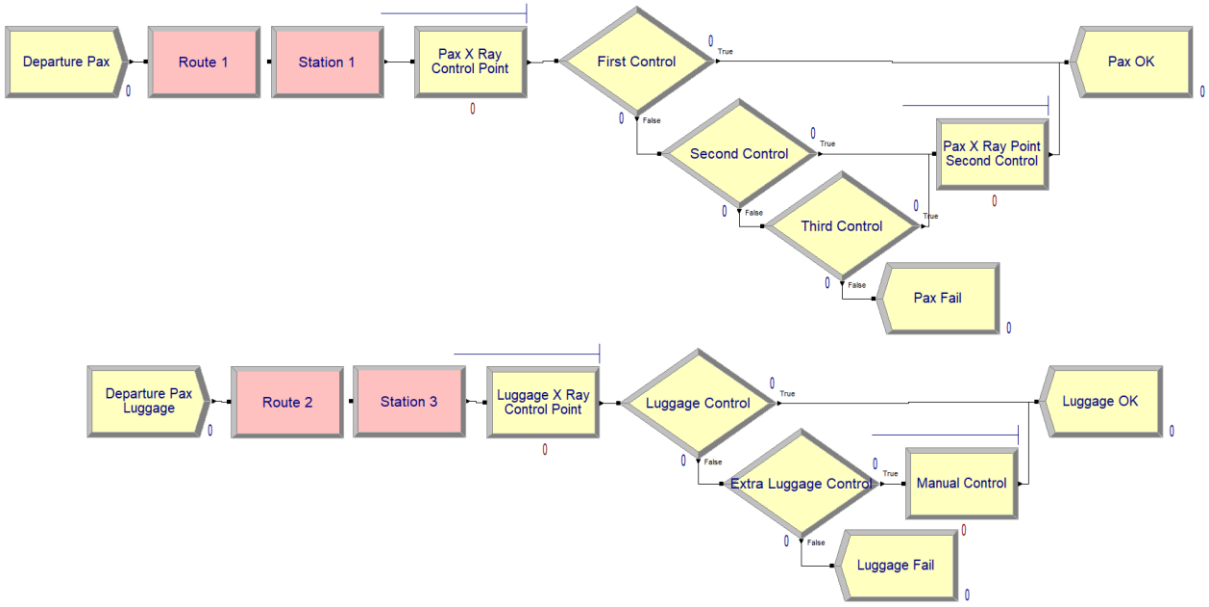

Figure 3. Security checkpoint simulation model (Author (2021), compiled from Arena Simulation software).

5. Results

The simulation model was created to simulate the security checkpoint after passport control in a shift zone (8 Hours) with the busiest day of the international passenger traffic. As the number of passengers, the 8-hour period during the busiest day in December 2019 was determined. It has been seen that the aircraft types served for the flights in this time period are namely Boeing 737-800 and Airbus A320-200. The number of passengers was calculated according to the average load factor of the airline companies at that period. Additionally, it is accepted that all passengers have purchased economy class tickets as airline companies do not put any other ticket option upon the market.

Table 2. Data for flight, aircraft and passenger (Author (2021), compiled from the websites and reports of airline companies)

Name of the Airline	Aircraft Type	Seat Capacity	Load Factor	Number of Flights	Total Number of Passengers
X	B737-800	189	%72,4	3	408
X	A320-200	159	%72,4	3	345
Y	B737-800	189	%81,6	1	154
			Total	7	907

The average time spent by passengers in the system from simulating the model is shown in the table below:

Table 3. Average time passengers spent in the system (Author (2021), compiled from Arena Simulation software)

	Average Time (minute)
Service Time	0,881
Transfer Time	0,493
Waiting Time	10,32
Total Time Spent in the System	11,694

According to this result, it is seen that the waiting times of the passengers are much longer when compared to the time they receive service.

Average wait times and queue data at the sources (scan points) of the simulated model are shown in the table below:

Table 4. Average waiting time and queuing data at scan points (Author (2021), compiled from Arena Simulation software)

	Average Time (minute)	**Average Number of Waiting Passengers**
Baggage X-ray Device	6,312	11,9295
Baggage Manual Check	9,81	2,7585
Passenger X-Ray Device	7,53	12,1522

In addition, the usage and occupation rates of the personnel used in the simulation model at the scanning points are shown in the table below.

Table 5. Usage and occupancy rates at scan points (Author (2021), compiled from Arena Simulation software)

	Usage Rate (%)	**Occupancy Rate (%)**
Baggage X-ray Device	88,36	88,36
Baggage Manual Check	93,72	93,72
Passenger X-Ray Device	84,94	84,94

Considering the simulation model findings, service, and transfer times within the system, it is seen that the waiting time is much longer. This indicates that the waiting time is high if the pre-pandemic density is restored. In addition, it is seen that the number of passengers waiting at these scanning points is high. Moreover, since there is only one security checkpoint after the passport at the airport terminal, it is seen that the usage rates of the devices at the scanning points are high.

Besides results mentioned above, in order to observe changes on resources (whether number of staff members or devices), different scenarios and the changes in the duration of resource usage and the number of waiting passengers can be observed in the Process Analyzer (PAN) section of the Arena simulation software. It can be stated regarding results obtained by producing different scenarios on the simulation model, increasing the number of devices at the scanning points and/or increasing the number of personnel does not create any change on the system.

Table 6. Queuing data for different senarios on PAN (Author (2021), compiled from Arena Simulation software)

		Controls						Responses	
	Iteration	Length (hour)	Number of Personnel #1	Number of Personnel #2	Number of Personnel #3	Number of Personnel #4	Number of X-Ray Devices	Average Number of Waiting Passengers (at Baggage X-Ray Device)	Average Number of Waiting Passengers (at Manual Baggage Control)
Scenario 1	1	8	1	1	1	1	1	11,93	2,758
Scenario 2	1	8	1	1	1	1	2	11,93	2,758
Scenario 3	1	8	2	2	2	2	1	11,93	2,758
Scenario 4	15	8	1	1	1	1	1	14,67	3,437
Scenario 5	1	8	2	2	2	2	2	11,93	2,758

6. Conclusion and Discussion

The Covid-19 pandemic has adversely affected the aviation industry and almost all flights have been stopped in many countries. With the measures and regulations taken, the rate of spread of the virus has been reduced and passenger transport has entered the recovery process. In this study, it is aimed to investigate whether the regulations put into practice due to the pandemic have an effect on airports if the passenger numbers would reach pre Covid-19 pandemic level. In the study, Ankara Esenboğa Airport has been selected as the study area. After the passport control in the airport terminal building, a simulation model was created based on the security control point. In the model, which was created using expert opinion, it was desired to observe the control times and whether the passenger queue formed at this point increased if the current regulations were repeated in 2019. Using the findings, it has been observed that it will work with a high capacity due to the fact that the control point is single. In addition, it was observed that the waiting times of the passengers were much longer than the service and transfer times, and it was understood that this situation was not dependent on the personnel and/or scanning devices within the different scenarios.

What is more that the research questions put forward were compared with the results obtained. As a result of this comparison, it is observed that the findings supported the RQ_1 and RQ_2 of the study. Within the scope of the data obtained, it is seen that the measures and regulations taken during the pandemic create a queue and increase the waiting time. On the other hand, it is seen that the RQ_3 was not supported by the data obtained from simulation model. The reason for this is that it has been observed that there is no change in the waiting time and the number of passengers waiting in the queue, obtained by creating different scenarios in the Process Analyzer (PAN).

It is seen that an additional scanning point should be put into service if the current pandemic measures are continued. By adding an additional point, waiting times and queues can be reduced. In addition, passenger flow management can be more stable and comfortable by preventing the scanning devices from operating at almost full capacity. Thus, any human error can be prevented by reducing the mental and physical wear and tear of the personnel working at this control point due to the high labour force at peak times. Furthermore, creating multiple security points instead of single security checkpoint will reduce the load on the system of passenger flow at that point, especially at peak times. The cost of additional security points to be built will be less than the cost after suffering losses in the number of passengers in the long term, as passenger satisfaction is directly affected and accordingly the airport reputation is damaged. As a result of this study, it is seen that the suggestions about insufficient space at the screening control points and the mental and physical wear of the employees are supported in the study conducted by Paul et al. (2009, 66).

Researchers' Contribution Rate Statement

The authors' contribution rates in the study are equal.

Acknowledgement and/or disclaimers

There is no support for this work.

Conflict of Interest Statement

No conflict of interest was declared by the authors.

References

Arusoğlu, Ö. (2010). *A Model Proposal for Simulation of Airport Terminal Passenger Movements* [Master's thesis, Institute of Science and Technology]. ITU Academic Open Archive. Retrieved May 11, 2021, from https://polen.itu.edu.tr/bitstream/11527/703/1/10915.pdf.

Aydın, İ. (2010). *Lecture notes on Introduction to Simulation and Modeling* [PDF]. Fırat Üniversitesi. Retrieved May 11, 2021, from http://web.firat.edu.tr/iaydin/Introduction_to_simulation_and_modeling_lecture_1.pdf.

Başlıgil, H. (2010). *Lecture notes on Modelleme ve Simülasyon* [PDF]. Department of Industrial Engineering, İstanbul University. Retrieved May 11, 2021, from http://auzefkitap.istanbul.edu.tr/kitap/endustrimuhlt_ue/modellemevesimulasyon.pdf.

DGCA (2020). *Havaalanı Pandemi Tedbirleri ve Sertifikasyonu Genelgesi.* Ankara: Directorate General of Civil Aviation. Retrieved May 11, 2021, from https://web.shgm.gov.tr/documents/sivilhavacilik/files/mevzuat/sektorel/genelgeler/2020/Havaalani-pandemi-tedbirleri.pdf.

GDSAA (2021). *Statistics*. Retrieved June 21, 2021, from https://www.dhmi.gov.tr/Sayfalar/EN/Statistics.aspx**.**

ICAO (2013). *Module 3: Passenger and Hand Luggage Screening Measures*. Montreal: International Civil Aviation Organization. Retrieved May 11, 2021, from https://www.icao.int/MID/Documents/2013/capsca-mid3/ICAOHealthRelatedSARPsandguidelines.pdf.

Nikolaev, A. G., Lee, A. J., and Jacobson, S. H. (2011). Optimal Aviation Security Screening Strategies with Dynamic Passenger Risk Updates. *IEEE Transactions on intelligent transportation systems, 13*(1), 203-212. Retrieved May 11, 2021, from shorturl.at/hxH69.

Özkan, B., and Ateş S. (2020). Covid-19 Kapsamında Havaalanlarında Alınan Tedbirlerin Terminal Güvenlik Süreçlerine Etkisi: Muğla Dalaman Havalimanı'nda Bir Uygulama. *Pandemi Döneminde Yönetim & Strateji & Liderlik. Akademi Titiz Yayınları*, sf 175-192. Retrieved May 11, 2021, from shorturl.at/eDNZ6.

Paul, J. A., Lin, L., Batta, R., and Drury, C. G. (2009). Airport Security System Design: Passenger Flow Analysis and Simulation Modeling. *Protecting Airline Passengers in the Age of Terrorism, 66*. Retrieved May 11, 2021, from https://trid.trb.org/view/919916.

Pegasus. (2021). *Annual Reports*. Retrieved June 21, 2021, from https://www.pegasusinvestorrelations.com/en/operational-information/annual-reports.

Pendergraft, D. R., Robertson, C. V., and Shrader, S. (2004, December). Simulation of an Airport Passenger Security System. In *Proceedings of the 2004 Winter Simulation Conference, 2004.* (Vol. 1). IEEE. Retrieved May 11, 2021, from https://ieeexplore.ieee.org/abstract/document/1371402.

Rockwell Automation (2021). *Arena Simulation* (Trial Version) [Software]. Retrieved May 15, 2021.

Skorupski, J., and Uchroński, P. (2016). Managing the process of passenger security control at an airport using the fuzzy inference system. *Expert Systems with Applications, 54,* 284-293. Retrieved May 11, 2021, from https://doi.org/10.1016/j.eswa.2015.11.014.

TAV Airports. (2021). *Ankara Esenboğa Havaliamanı, Departures.* Retrieved June 21, 2021, from http://www.esenbogaairport.com/en-EN/flights/departure-flights.

Turkish Airlines. (2021). *Presentations*. Retrieved June 21, 2021, from https://investor.turkishairlines.com/en/financial-and-operational/presentations**.**

Wang, C. H. (2016, November). Arena Simulation for Aviation Passenger Security-Check Systems. In *International Conference on Genetic and Evolutionary Computing* (pp. 95-102). Springer, Cham. Retrieved May 11, 2021, from https://link.springer.com/chapter/10.1007/978-3-319-48490-7_12.