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Research Article

The effect of measures taken in the scope of Covid-19 on flight delays: The case of Istanbul Airport

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Abstract: Baggage handling services make up a significant portion of the airline passenger transportation system's services. Air passenger transportation, unlike other modes of transportation, allows passengers to save time. It's one of the things passengers think about when making choices. The time it takes to travel is directly affected by delays in baggage delivery or flow. This could eliminate the time savings that air transportation has provided to its passengers. Some rules have changed as a result of the coronavirus pandemic. One of them was discovered as a result of the pandemic circular. It is forbidden to take cabin baggage with passengers, and it is requested that the baggage be sent under the plane, according to the circular. This change also exposed a condition that could cause problems with baggage flow. Problems with baggage flow may have an impact on the time benefit. Due to the drop in flight frequency at several airports during the pandemic period, this study was scheduled to be conducted at Istanbul Airport, and it was conducted on international lines due to the interruptions experienced on domestic lines and the decreased number of passengers. In this study, international baggage transactions at Istanbul Airport were simulated using the Arena Trial program using data obtained through the interview method. As a result, during the Airport Pandemic Measures and Certification Circular, there was an increase in the time it took for bags to get to aircraft.

Key words: Air transport, Baggage handling system, Covid-19, Passenger baggage, Simulation

Covid-19 kapsamında alınan önlemlerin uçak gecikmelerine etkileri: İstanbul Havalimanı örneği

Özet: Bagaj elleçleme işlemleri havayolu yolcu taşımacılık sisteminde gerçekleşen işlemlerin önemli bir kısmını içermektedir. Havayolu yolcu taşımacılığı diğer ulaşım araçlarından farklı olarak yolculara zaman faydası sağlamaktadır. Yolcuların tercihlerini yaparken dikkate aldıkları faktörler arasında yer almaktadır. Bagaj tesliminde ya da akışında yaşanacak aksaklıklar ise direkt olarak seyahat süresini etkilemektedir. Bu durum havayolu taşımacılığının yolcularını sunmuş olduğu zaman faydasını ortadan kaldırabilir. Koronavirüs salgınıyla birlikte bazı kurallarda değişiklik yaşanmıştır. Bunlardan bir tanesi de salgınla birlikte yayınlanan genelge sonucunda gerçekleşmiştir. Genelge kapsamında kabin bagajları yolcuların yanına alması yasaklanmış, bagajların uçak altına göndermesi istenmiştir. Bu değişiklik de bagaj akış sürecini aksatabilecek bir durumu ortaya çıkarmıştır. Bagaj akışında meydana gelebilecek aksaklıklar da zaman faydasını etkileyebilecektir. Bu çalışma, pandemi döneminde birçok havalimanında gerçekleşen uçuşların sıklıklarının düşmesi sebebi ile İstanbul Havalimanında yapılması planlanmış, iç hatlarda yaşanan aksamalar ve yolcu sayılarının daha az olması sebebiyle de dış hatlarda yapılmıştır. Yapılan bu çalışmada İstanbul havalimanı dış hatlar bagaj işlemleri görüşme yöntemiyle alınan veriler ışığında Arena Trial programı ile simüle edilmiştir. Bunun sonucunda Havaalanı Pandemi Tedbirleri ve Sertifikasyonu Genelgesi döneminde bagajların uçaklara ulaşma sürelerinde artış yaşandığı görülmüştür.

Anahtar kelimeler: Hava taşımacılığı, Bagaj taşıma sistemi, Covid-19, Yolcu bagajı, Simülasyon

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1. Introduction

The ability to quickly transport passengers from one point to another is the most critical characteristic that distinguishes air passenger transportation from other modes of transportation. Air transportation is crucial because of this time benefit (Kiracı, 2018). The quality of service provided to passengers in air transport is determined by a variety of factors (Gerede, 2015). Check-in and baggage processing are two of the most crucial steps in terms of saving time. The benefit of the time granted by the airline may be lost if the baggage flow is disrupted. At this point, it is expected that, as a result of the circular issued during the pandemic, the number of bags travelling under the plane will increase, causing some disturbances in the luggage flow, which could result in flight delays. Due to the cancellation of flights at several stations due to limitations and passenger anxieties during the pandemic time, the low number of passengers, and the decrease in frequencies, it was felt that conducting the study at Istanbul Airport International Flights would be more appropriate.

A worldwide pandemic was declared in March 2020 due to the Covid-19, which first appeared in Wuhan, China, and then spread throughout the whole of China and the world shortly after. Governments started to take measures, and some of them closed their borders to prevent the spread of the virus. As a result, the air transport industry was deeply affected by all these developments (Zhuang et al., 2020; Akca, 2020).

Since international travel is associated with the spread of the virus, flight restrictions have been applied, and most of the countries have reduced or even stopped their flights to the countries where the number of the Covid-19 cases is high. According to Eurocontrol data, the number of flights in Europe in May 2020 decreased by 90 % compared to the previous year (Eurocontrol, 2020). According to the report published in November 2020, flight loss in Turkey is 0.49M (-64%) and passenger loss is 99M (-74%) since March 1 compared to 2019. However, cargo transportation increased by nearly 40% in May-June (Eurocontrol Briefing). World Health Organization (WHO) has issued many measures as the rate of spread of the virus increases. Some of those warnings include washing hands regularly, applying social distance with people who have symptoms, and avoiding crowds and unessential travel (WHO, 2020). Meanwhile, the Directorate General of Civil Aviation (DGCA) has also taken measures to prevent virus spread in Turkey. One of those measures is the restriction of cabin baggage in aircraft (SHGM, 2020).

Cabin baggage limitation inherently increased the number of baggage in the aircraft cargo hold, and as a result, baggage loading times soared, which triggered flight delays. This study examines the relationship between baggage number increase in the cargo hold because of cabin restriction and the flight delays.

The remainder of this paper proceeds as follows. A literature evaluation of the effect of Covid-19 on the aviation industry and the measures taken was conducted in the second section. The approach utilized is explained in the third chapter, as are the assumptions. While the analysis and conclusions are discussed in the fourth chapter, the results are discussed in the fifth part.

2. Literature Review

The Covid-19 is highly contagious and transmitted by saliva or droplets when an infected person coughs or sneezes. For this reason, the risk of infection increases in crowds (WHO, 2020). As a result of these reasons, countries have imposed certain restrictions on passenger transportation by air. In this context, Turkey limited its flight to England, Switzerland, Saudi Arabia, Egypt, Ireland and the UAE for the first time on March 16. International air transportation have been limited as a result of increases in the number of cases the second half of March (SHGM, 2020). While all of this is goingon, numerous actions have been made around the world to combat the Covid-19 virus. One of them is to avoid making unnecessary contacts in the airline passenger transportation sector. (WHO, 2020). The Directorate General of Civil Aviation has also published some measures under the name of ‘‘Airport Pandemic Measures and Certification Circular’’. The following are the changes that have occurred as a result of this circular:

Cabin baggage was accepted into the aircraft before to Covid-19; however, restrictions were placed on the items that would be accepted as cabin baggage during the duration of the circular. During the pre-Covid-19 time, there were no limitations on baggage delivery; however, during the circular period, it has become the standard for passengers to wait at the baggage claim area, in the area where the conveyors are placed, in line with the social distance rules. Laptops, handbags, briefcases, and baby items are the only items that qualify as cabin baggage. All additional products are handed to the luggage during check-in, according to this circular (SHGM, 2020). Airline passenger transportation is a service industry. The goal of airlines is to provide a wide range of high-quality services to their passengers. Baggage handling services are one of these services. Baggage handling services are very important for customer satisfaction, as customer satisfaction largely depends on baggage handling services. Disruptions in baggage handling services can cause delays in baggage, damaged or to be lost, which may lead to consumer dissatisfaction (Cavada, Cortes and Rey, 2017). Additionally, flight congestion may arise as a result of baggage system overload and airport population. (Savrasovs, Medvedev and Sincova, 2009).

The importance of baggage handling systems for airlines has been shown by the research in Table 1. It has been observed that a problem with the handling process has an impact on the operation's efficiency. The importance of the process is taken into account because one of the most important benefits of air transport is the time savings. The changing rules during the Covid-19 period had a negative impact on operation times, according to the findings presented in Table 1. Studies have demonstrated that using the simulation method, it is better to improve the system. The purpose of this research is to see if changes in the Covid-19 period have an impact on flight delays utilizing simulation management.

Due to the Covid-19 pandemic, it is critical to take precautions to avoid contact with passengers and to follow social distancing norms. However, as a result of these precautions, the number of pieces of luggage going under the plane increased. This resulted in a backlog at check-in counters as well as problems in luggage systems, resulting in flight delays. In this study, a simulation was used to account for the changes that occurred within the scope of the circular. The challenges that will arise as the number of pieces of luggage increases were modelled and the results were analyzed.

Table 1. *Baggage studies with simulation method*

Study Name	Author	Date	Purpose	Conclusion	Reference
Simulation-based Input Loading Condition Optimization of Airport Baggage Handling Systems	Le, Creighton, Nahavandi and Member	2007	Avoiding baggage blockages due to busy check-in process	Both operation and transfer speed increased when baggage travel time decreased	Le, V. T., Creighton, D. and Nahavandi, S. (2007)
New Developments in Airport Baggage Handling Systems	Rijsenbrij and Ottjes	2007	Preventing baggage handling system failures in narrow-body aircraft	The number of lost and damaged bags has decreased. Operational costs have been reduced by 50%. Improved aircraft turnaround time Baggage monitoring has significantly improved of this technique, which has increased security.	Rijsenbrij, J. C., & Ottjes, J. A. (2007)
Riga Airport Baggage Handling System Simulation	Savrasovs, Medvedev and Sincova	2009	Process improvement	Faster delivery & acceptance of luggage	Savrasovs, M. Medvedev, A. and Sincova, E. (2009)
A Generalised Data Analysis Approach for Baggage Handling Systems Simulation	Le, Zhang, Johnstone, Nahavandi and Creighton	2012	The expected performance of the baggage handling system was evaluated.	Presented the baggage handling system's working features.	Le, V. T., Zhang, J., Johnstone, M., Nahavandi, S., and Creighton, D. (2012)
A Simulation Approach to Modelling Baggage Handling Systems at an International Airport	Cavada, Corets and Rey	2017	Improving baggage processes during periods of congestive flights	Answered questions such as how much baggage systems can handle the load; how much additional demand can be removed with these systems	Cavada, J. P., Cortés, C. E. and Rey, P. A. (2017)
Antalya Uluslararasi Havalimanı Simülasyon Modeli ile Bir Kuyruk Problemi	Öz	2017	Estimating hazardous emissions into the environment from aircraft operations and understanding the standby status of runway use	The time the aircraft waited on the runway, it is understood, did not create any delays. The passenger boarding-deboarding process causes delays. Because the engines were not functioning during the operation, there was no connection between pollutant emissions and the operation.	Öz, Y. (2017)

Table 1. *Baggage studies with simulation method*

Study Name	Author	Date	Purpose	Conclusion	Reference
Modeling and Simulation of Air France Baggage Handling System with Colored Petri Nets	Hafilah, Cakravastia, Lafdail and Rakoto	2019	The most crucial responsibility of the baggage handling system is to ensure that the cargo arrives at its destination on schedule. The reason of the problems has been simulated in this case.	Misreading of barcodes in manual scanning was shown to be the cause of the issues.	Hafilah, D. L., Cakravastia, A., Lafdail, Y., & Rakoto, N. (2019)
Uçak Çevrim Süresinin Covıd-19 Öncesi ve Sonrası Simülasyon Analizi	Öztürk and Ates	2021	Its goal is to see if the changes in aircraft turnaround time are comparable to the pre-Covid-19 and Covid-19 periods.	The turnaround time has risen by roughly 9 minutes as a result of the steps implemented during the Covid-19 phase. The cleaning crews' workload has increased.	Öztürk, A. and Ateş, S. S. (2021)

3. Methodology

The process of developing a model that can show the system is known as simulation. Due to simulation modeling, procedures that could be very costly can be completed for a low cost and in a short amount of time (Ersoz, 2019). A simulated system can be observed in various iterations, as well as the outputs and diagnostics in various scenarios (Özçift, 2010).

The qualitative research method's interview approach was utilized to obtain data on the airport baggage handling service. In qualitative research, the interviews method is the most commonly used data collection methodology. (Yildirim and Simsek, 2011).

The research is based on an Istanbul Airport ground services company. Due to etichal laws, the company name will not be disclosed. Data on baggage handling service processes were acquired throughout the Covid-19 period and during peak hours as a result of interviews with a ground handling employee who has worked at Istanbul Airport since 2019. Face-to-face interviews were performed. Transfer to the Arena Trial simulation application and simulate based on the airport information provided by the participant.

The Arena Trial simulation program was used to model the intensity at the airport during the circular period in this investigation. During the circular period, the impacts of an increase in the number of bags carried under the plane and the duration the plane spends on the ground were simulated. Discrete event simulation was used in this research. Variables in a discrete system change only at certain sites and at specific times (Ersoz, 2019). Here are a few examples of discrete systems: Arriving at the airport, bags arriving at the distribution area, and passengers waiting at the airport check-in line.

3.1. Assumptions

The application was carried out in this study based on an increase in the number of bags given under the plane by passengers flying internationally through Istanbul Airport during peak hours in a single day. The Arena Trial simulation tool was used to model the data collected from the interview. Figure 1 depicts the technique in question.

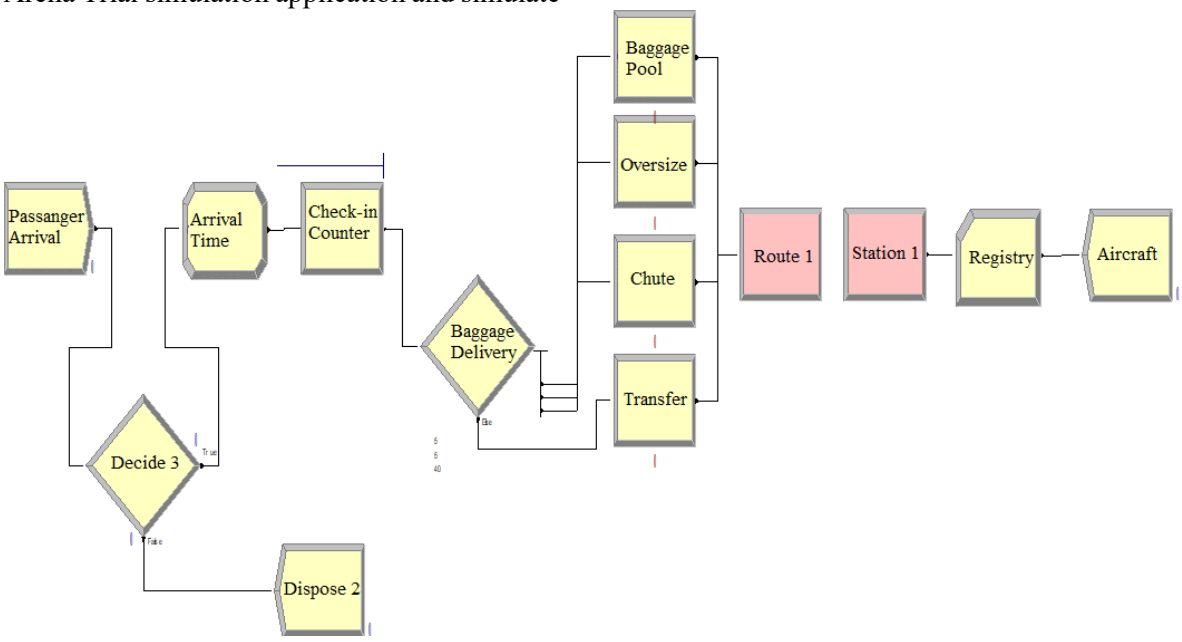

Figure 1. *Baggage Delivery Process*

Due to an increase in the number of bags moving under the plane, the baggage delivery process, which is part of the check-in process, has been simulated in line with the circular that came before Covid -19 and within the scope of Covid-19 measures. The scenario prior to Covid-19 was referred to as the first situation, whereas the current situation as a result of the Covid-19 circular is referred to as the second situation.

H1: The circular, which came under the ban, increased the time it takes for planes to stay on the ground.

H2: There have been disruptions in baggage flow due to density.

4. Analysis and Findings

When looking at Istanbul Airport's air traffic statistics as of the end of December 2020, it was discovered that it served a total of 185,424 aircraft, including 59,572 domestic and 125,672 international flights. In terms of passenger traffic, a total of 23,410,380 individuals were served by 7,473,875 domestic lines and 15,936,505 foreign lines (DHMI Annual Report, 2021). Istanbul Airport is a big facility. On special days, the airport, which is packed at all times, becomes even busier. However, as a result of Covid-19, the number of flights has fallen and the number of flights has decreased. Following the conference, the following statements about the circular period were made: ‘‘There is a general congestion at the new airport in summer and winter months. However, this intensity decreased slightly due to the pandemic effect. Despite this, flights to USA began in June and the planes flew at a 98% occupancy rate.’’

Interviewer, 50% of the luggage was transfer baggage, 5% was oversized baggage, and 5% of the luggage on flights fell into the communal pool because it could not be read," he said. "In addition, there has been an average increase of 50% of baggage coming under the aircraft."

In addition, it was stated that no additional counters were opened for VIP and CIP and that all check-in and baggage transactions were made jointly (common check-in). It is stated that the counters are always open and that on international flights, an average of 3 hours 15mins in advance, passenger intake has started.

All data received by the interview method were evaluated as average data. The scenarios created to be implemented in the simulation program are as follows;

Scenario 1: Current working conditions before the Covid-19 period will be simulated.

Scenario 2: It will be simulated during the Covid-19 period, especially when the circular is in effect. In this process, the staff was reduced due to flexible working and this variable were added to the simulation according to the data obtained from the interview. In this context, the results and comparisons obtained will be evaluated in the findings section.

2 scenarios were operated with the Arena Trial application with the specified assumptions. The findings of the study with the Arena trial program are as follows.

The number of bags travelling under the plane increased by 50% as a result of the circular content and expert opinion obtained during the Covid-19 period (Table 2), and this condition was recreated.

Table 2. *Baggage Times for the First Scenario*

VA Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	3.2826	(Correlated)	0.00	14.1178
NVA Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	0.00	0	0.00	0.00
Wait Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	0.00	0	0.00	0.00
Transfer Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	0.3351	0,004776428	0.2502	0.4166

Other Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	0.00	0	0.00	0.00
Total Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	3.6176	(Correlated)	0.3276	14.4259

The processing time for baggage is 3.25 minutes, according to the table above. The longest time for baggage is 14.11 minutes. When we look at the entire duration, we can see that each baggage takes an average of 3.61 minutes and a maximum of 14.42 minutes. The period outside the circular is reproduced in Table 3, and the results are expressed.

Table 3. *Baggage Times for Scenario Two*

VA Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	2.3304	(Correlated)	0.00	14.0620
NVA Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	0.00	0	0.00	0.00
Wait Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	0.00	0	0.00	0.00
Transfer Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	0.2374	0,015256093	0.00	0.4162
Other Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	0.00	0	0.00	0.00
Total Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	2.5679	(Correlated)	0.00	14.3467

According to the data revealed in Table 3, the processing time for a baggage in the time period outside the circular was 2.33 minutes, while a maximum time of 14.06 minutes was observed. When we looked at the total time, it was observed that there was an average waiting time of 2.56 minutes for each baggage and a maximum of 14.34 minutes.

When baggage processing times are compared, it is seen that the time it takes for luggage to

reach the plane increases during the circular period. At the same time, it has been observed that there are occasional blockages in the luggage going to the shot in this process. It is also among the observed data that there are much more queues especially in transfer baggage. Within the scope of all these data,

H1: The circular, which came under the forbidden, increased the time it takes for planes to stay on the ground. There is enough evidence to reject the null hypothesis. When the simulation analysis findings are analyzed, it is discovered that the loading times of the aircraft have increased during the circular period. This refers to the length of time the aircraft spends on the ground.

H2: There have been disruptions in baggage flow due to density. There is enough evidence to reject the null hypothesis, but it was observed that this could be solved with a slight increase in the number of counters. The time spent at the counter increased, according to the simulation analysis results.

5. Conclusion

Baggage handling is an integral aspect of the overall passenger transportation service provided by airlines. There are numerous issues with this situation. While luggage handling disruptions can cause plane delays, it is a crucial step that impacts passenger happiness.

The scenarios and data gleaned from the interviews were reproduced in this study, and the challenges encountered during that time were attempted to be articulated. According to the findings, the time it took to get the luggage from the counter and onto the plane was stretched, and there were some difficulties. In order to avoid the problems that develop, the number of counters and staff can be raised. The study's epidemic period introduces numerous constraints. A significantly better study can be produced if these restrictions are overcome. Because of the limitations imposed during the pandemic, airports are only authorized to accept passengers. As a result, no observations were made throughout the research. Due to the low number of flights and airline cancellations, there were some restrictions. This research could be utilized as a starting point for further research. It can be identified what kind of problems there are in the baggage handling procedure if a study comparable to this one is conducted at an airport that is fully operational. These issues can be resolved, and better service can be offered. Moreover, comparable studies will be valuable in the implementation of air transportation in many types of services.

Researchers' Contribution Rate Statement

The authors' contribution rates in the study are equal

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