CZECH TECHNICAL
UNIVERSITY
IN PRAGUE

FACULTY OF
TRANSPORTATION SCIENCES

BACHELOR THESIS

2021

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ZADÁNÍ BAKALÁŘSKÉ PRÁCE
(PROJEKTU, UMĚLECKÉHO DÍLA, UMĚLECKÉHO VÝKONU)

Jméno a příjmení studenta (včetně titulů):

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Kód studijního programu a studijní obor studenta:

B 3710 – PIL – Profesionální pilot

Název tématu (česky): **Průzkum předkovidového a postkovidového trhu letiště Ben-Gurion**

Název tématu (anglicky): Ben-Gurion Airport and its Pre-covid and Post-covid market investigation

Zásady pro vypracování

Při zpracování bakalářské práce se řiďte následujícími pokyny:

- Cílem této práce je prozkoumat trh letiště Ben-Gurion z pohledu podílu leteckých společností, podílu jednotlivých typů cestujících, personálu letiště atd. V tomto výzkumu bude pozornost zaměřena na izraelský trh letišť s důrazem na hloubkovou analýzu informací o letišti Ben-Gurion. Práce bude prezentovat celkový obraz změn na letištním trhu a nakonec bude zakončena názorem studenta na všechny shromážděné poznatky, zejména o izraelském trhu.
- Seznámení se s letištěm Ben-Gurion - trh leteckých společností a tok cestujících
- Analýza struktury trhu před pandemií Covid-19
- Vektory změn způsobené situací během pandemie Covid-19
- Analýza post-covidové struktury trhu a její výsledky ve všech provozních a ekonomických aspektech

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Rozsah grafických prací:	dle pokynů vedoucího práce
Rozsah průvodní zprávy:	minimálně 35 stran textu (včetně obrázků, grafů a tabulek, které jsou součástí průvodní zprávy)
Seznam odborné literatury:	Kaitano, D., et. al. - COVID-19 pandemic and prospect for recovery of global aviation industry Serrano, F., Kazda, A., The futuro of airports post COVID-19 Ben Gurion International Airport - Monthly reports

Vedoucí bakalářské práce: **doc. Ing. Peter Vittek, Ph.D.**

Datum zadání bakalářské práce: **9. října 2020**
(datum prvního zadání této práce, které musí být nejpozději 10 měsíců před datem prvního předpokládaného odevzdání této práce vyplývajícího ze standardní doby studia)

Datum odevzdání bakalářské práce: **9. srpna 2021**
a) datum prvního předpokládaného odevzdání práce vyplývající ze standardní doby studia a z doporučeného časového plánu studia
b) v případě odkladu odevzdání práce následující datum odevzdání práce vyplývající z doporučeného časového plánu studia

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Potvrzuji převzetí zadání bakalářské práce.

Lidor Barkai
jméno a podpis studenta

V Praze dne 9. října 2020

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BACHELOR'S THESIS ASSIGNMENT

(PROJECT, WORK OF ART)

Student's name and surname (including degrees):

Lidor Barkai

Code of study programme code and study field of the student:

B 3710 – PIL – Professional Pilot

Theme title (in Czech): **Průzkum předkovidového a postkovidového trhu letiště Ben-Gurion**

Theme title (in English): Ben-Gurion Airport and its Pre-covid and Post-covid market investigation

Guides for elaboration

During the elaboration of the bachelor's thesis follow the outline below:

- The aim of this work is to examine the market of Ben-Gurion airports in the areas of airline share, share of individual types of passengers, airport staff, etc. In this research, attention will be focused on the Israeli airport market with emphasis on in-depth information analysis of Ben-Gurion airport. The work will present a general picture of the change in the airport market and finally the students' opinion will end with all the collected data, especially about the Israeli market.
- Introduction to the Ben-Gurion airport - airline market and passenger flow
- Pre-covid market structure analysis
- Vectors of change due to the Covid situation
- Analysis of post-covid market structure and the results in all operational and economics aspects

Graphical work range: according to the instructions of the bachelor's thesis supervisor

Accompanying report length: at least 35 pages of text (including pictures, graphs and tables, which are part of the accompanying report)

Bibliography:

Kaitano, D., et. al. - COVID-19 pandemic and prospect for recovery of global aviation industry

Serrano, F., Kazda, A., The futuro of airports post COVID-19

Ben Gurion International Airport - Monthly reports

Bachelor's thesis supervisor: **doc. Ing. Peter Vittek, Ph.D.**

Date of bachelor's thesis assignment: **October 9, 2020**
(date of the first assignment of this work, that has be minimum of 10 months before the deadline of the theses submission based on the standard duration of the study)

Date of bachelor's thesis submission: **August 9, 2021**
a) date of first anticipated submission of the thesis based on the standard study duration and the recommended study time schedule
b) in case of postponing the submission of the thesis, next submission date results from the recommended time schedule

ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE Fakulta dopravní

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I confirm assumption of bachelor's thesis assignment.

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Student's name and signature

Prague ..... October 9, 2020

ABSTRACT

The airports market is a field that includes a variety of participants such as the Airport Authority that controls and profits from passenger and aircraft movements, airlines, airport workers, shareholders, owners of contractor companies that provide services, real estate, and more.

The COVID-19 pandemic has affected the international and domestic airport market in various ways. In this study, the focus will be on the Israeli central airport “Ben-Gurion” market, with an emphasis on in-depth information analysis. The analysis will be presented for the first half of 2020 versus 2021 with the most up-to-date published reports of the year 2021. Beyond the information analysis, there are already forecasts for the trend in the airport market, both at the economic level and at the level of the physical changes that are going to bring new participants to the airport market, for example in the healthcare field. The vector of change will be presented through the information analysis of Ben-Gurion Airport. This thesis includes an exclusive interview with a senior official from the Israel Airports Authority to provide up-to-date information. The thesis will demonstrate the overall picture of the change in the Israeli airport market and finally, personal opinion will be a conclusion from all the data that was collected and in particular on the Israeli market.

Keywords: Airport market, Information analysis, Ben-Gurion airport, covid-19

DECLARATION

I hereby declare that the presented thesis is my own work and that I have cited all sources of information in accordance with the Guideline for adhering to ethical principles when elaborating an academic final thesis.

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In Prague, 05.08.2021

Signature .....

Acknowledgement

At this point I would like express my great gratitude to two kind people who supported me through the whole process of this research. The first, is my supervisor doc. Ing. Peter Vittek, Ph.D., who has led me throughout the whole thesis composing process and helped me with everything. The second, is to Ing. Sarah Van Den Bergh, who helped me with finalizing and editing at any time I needed. I appreciate both of them a lot. In addition, I would like to thank my family, that although they are far away from me in Israel, they are still in my heart and supporting me with everything they can.

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LIST OF ABBREVIATIONS

IMF	International Monetary Fund
ICAO	International Civil Aviation Organization.
IATA	International Air Transport Association.
MERS	Middle East Respiratory Syndrome.
CANSO	Civil Air Navigation Services Organization.
ACI	Airports Council International.
IAA	Israel Airports Authority.
API	Application programming interfaces.
NOTAM	Notice to airman
A/C	Aircraft
PAX	Passengers

Introduction

The Covid-19 erupted in Israel in February 2020. With the spread of the plague, many markets, as well as the airports market, were affected. The topic of the thesis is to investigate in depth the effects of the eruption of the Covid-19 on the Israeli airport, Ben Gurion.

Ben-Gurion is the main gateway to entry and exit in Israel. The study is designed to map how Israel is coping with the crisis by analyzing operational, economic, and physical data. With this in mind, the goal is to create a comparison between the years before the outbreak of the epidemic and focus in-depth on how the airport will operate in the years 2020 and 2021 when this is the time when Israel experienced lockdowns but also vaccinated most of the population at rapid rates.

The goal will be to understand how a market works in general, what an airport market is, how to map a market and what happened to the global aviation market following the crisis. Then data collection as much as possible will be done on Ben Gurion and at the same time collection of supporting articles. The results will be presented in graphical reports to show the change that has taken place within Ben Gurion Airport.

Due to current reports by June 2021, the comparison will be semi-annual between 2019 until 2021. Finally, there will be a discussion and summary with findings of the research work.

Chapter 1 - The airport market

Before going into details about the airport market it is necessary to understand the definition of economic markets in general. So, what is a market? “A market is any place where two or more parties can meet to engage in an economic transaction” [1]. Generally speaking, when one would like to understand fully the aspect of the market he may look at two fundamental dimensions embedded as explained by Khemani [2]. The first is the product market and the second is the geographic market. The product market - comprises all products and/or services that are regarded as interchangeable or substitutable by the consumer. Looking at these days, if money can be described as a “product” so the seller and the consumer are interchanging their products. The geographic market - comprises the area in which the interchange is being done. It includes also the supply and demand of products or services. The focus is now on the competition with competitors in the geographic area in which the market is working.

When describing the airports market, the geographic market can include both the geography where the costumers are coming from (Airlines mainly) for example Ryanair can be a customer of Ben-Gurion by flying there and using their services. Ben-Gurion airport competitor can be Ramon airport which is located a one-hour flight to the south of Tel-Aviv which is where Ben-Gurion airport is located [3]. In addition, Cyprus can be a competitor due to its geography. Later on, in the chapter. 3, Ben-Gurion airport geography will be described in more detail. Moreover, all passengers which are flying from/to Ben-Gurion airport will use the services located in the airport such as Parking lots, external security service, shops, and other facilities which will create a satisfied returning customer. If Ben-Gurion airport for example will provide good products (services and their price) and the location will suit the airlines, it can pull more customers to open routes to Israel and the chain keeps growing.

Ideally, the conditions of competition are sufficiently homogeneous and can be distinguished from neighboring areas. Connected to the understanding of the “Market” definition there is another term to discuss which is market segmentation. As explained by O'Connell [4] *“Market segmentation is a marketing term that refers to aggregating prospective buyers into groups or segments with common needs”.*

The concept of segmentation is a strategy that can be described as it has been written by Green and Krieger [4] upon two key assumptions:

- Consumers can be grouped into segments that display homogeneous preferences relative to other segments.
- Returns are likely to be greater if companies match their products and marketing mixes to particular segments within the market.

Companies generally use three criteria to identify different market segments within their business to identify the groups [5]. The criteria are:

- Homogeneity
- Distinction
- Reaction

Homogeneity describes what are the common needs within a segment and Distinction means to be unique from other groups. The last criteria are the Reaction which means how the consumers react to new products.

Market segmentation is an extension of market research that seeks to identify targeted groups of consumers to tailor products and branding in a way that is attractive to the group.

In conclusion of market terming, Market is any place that two parties can interchange their products. It can be segmented into groups with common needs but still will belong to the same market.

1.1 The Airport market

The main participants of the airport itself are the Airlines (Aircraft operators). But significant secondary participants are the passengers. The airport is a demonstration of the same market with two different segmentations. For airlines, the product is all relevant services to operate a commercial flight. Moreover, for the passengers, the meaning is all the services that they will use within their travel from the moment they start the interchange with their product (money) [5]. In addition, all the businesses that are working within the airport boundaries are renting the space so they consider the same as the airlines, passengers, etc. They are another segment of the airport market. Another homogenous customer with

specific needs. One new participant after the COVID-19 pandemic appeared are all the health companies that are providing services of tests for the passengers.

The airport market segmentation further maintains that segments are frequently not robust enough to withstand even small changes in their composition as said by O'Connell [4]. The opportunity to develop coherent long-term marketing strategies based upon consumer segmentation is therefore limited (Theory limitation because some things were never academicly investigated).

The limitations of the current state are the lack of economic data about airports. It is difficult to build a map of a market with a lack of revenues, expenses, etc. of airports. In this research, when investigating the operational part, we had a lack of data about the type of airplanes and economical information. There are some databases but, they are for high prices and not free to the public.

If speaking only about one airport as an area for marketing, it has its economic role. The economic role of an airport as explained by the National Academy of Sciences [6] is created through a combination of factors presented below:

- Location. This factor is created from the local demand and concerning other airports.
- Airport's physical size. Generally, it describes how much space available is for infrastructure.
- Services. The mix of (including connecting flights), CARGO operations, and general aviation services provided.
- Frequency of flights.

When multiple airport options are available, travelers, shippers, and those looking for based aircraft parking choose between airports for a variety of reasons, including [6]:

- Airport proximity to home or work, when choosing an origin airport.
- Airport proximity to the final destination, when choosing a destination airport.
- Ground transportation convenience.
- Runway length.

- Navigational aids, automated weather observing systems, and Airport Traffic Control Towers (which affect airport reliability and capacity).
- Hours of operation.
- Services and facilities at an airport (for both passengers and aircraft operators).
- Commercial services.
- Price, including the price of travel and costs incurred in accessing the airport such as parking or other tolls.

1.2 The commercialization of European airports

Airports were deregulated from government support. Smith [7] states that the deregulation of airports has been prompted primarily by the desire of governments to avoid the financial burdens associated with subsidizing airport capital investment. Airports have traditionally had to compete with other areas of public expenditure such as education, health, and defense [7]. Allowing private sector organizations, a financial interest in airport operations is argued to be an efficient and cost-effective way for the state to maximize revenue, while at the same time improving customer service and quality standards. The level of return is increased while the degree of risk is reduced as the state draws upon a specialized set of management skills [7].

There are 2 ways to maintain an airport economy [4]:

- aeronautical charges
- commercial revenues

As it was explained by O'Connell [4] and also by Lapler [8], aeronautical charges are levied on airlines by the airport operators for using their facilities and include landing and apron charges and passenger fees. Alternative ways of generating revenue are catering, car parking, money exchange, and especially retailing. All have become an integral part of the revenue-generating strategy for many European airports.

Aeronautical revenue Formula [4] - (traffic numbers X airport passenger fees) + (aircraft X landing charges).

1.3 What affects customers of the airports

Focusing on the passengers, airports are having all the passengers "*captive*" within their walls. About human spending behavior, aside from the captives which are creating an easy system for the sellers to the customers, there is also a negative factor on the airport costumers which is stress. Or time pressure. The uncertainty that surrounds many travelers when using an airport can harm spending. Some may suffer from ''gate lock'', i.e. moving to the departure gate earlier than required and avoiding the commercial offer on the central concourse [4].

As for airlines, the main factor is the attractiveness of the geographic location that will create pressure from the demand to maintain a high frequency of flights. It can be created either by passenger demand or cargo demand. In addition, in a continuation of starting a market is how do airports maintain the loyalty of the costumers. Or better say how to determine the satisfaction of the customer to achieve an effective response to the market needs. Explained in Table 1 by Bilani [9] is the loyalty spectrum of the customer.

Table 3 The 4 categories of airport customers loyalty [6]

A classification of consumer loyalty towards an individual airport	
Loyalists	These represent the most important group of consumers within an airport. Based on their past experiences, they continue to choose the airport as a departure or arrival destination
Defectors	These include persons who may be satisfied with the current provision of an individual airport but are not satisfied to the extent that they will automatically choose it
Mercenaries	These consumers tend to be price or fashion conscious. They exhibit no loyalty towards a particular airport
Hostages	These consumers have no choice over the airport they use and are compelled to accept the services and facilities that are offered

Of course, that an airport would like to have as many Loyalists as possible. Working with this table it's possible to create measurements about the loyalty of the consumers. Moreover, a table which is very interesting talks about the market <–> costumers, relationship. It explains the freedom spectrum of choice that the customers have. COVID-19 pandemic entered new players to the airport market for example in Ben–Gurion there is a company that is making the PCR tests before leaving and when getting back to Israel. According to Ballini, the customers are captured in a Monopoly (Table 2) market meaning they don't have any other choice. A more in-depth overview of how the airport market looks before and after the pandemic crises started will be presented in a further chapter.

Table 4 The freedom of choice a customer has [9]

Consumer behaviour within monopolistic, regulated and liberalised markets

Monopolistic market	Regulated market	Liberalised market
The customer has no freedom of choice	The customer has limited freedom of choice	The customer can choose freely
The customer is affected by legal constraints	The customer can purchase services from a restricted number of suppliers	The customer can choose between a large number of different products and services
The customer can purchase services from one provider	The customer can only partially influence his/her own loyalty level	The customer can choose between a number of different suppliers
The customer cannot influence his/her own level of loyalty	Easy to increase satisfaction levels because market provides customer with restricted options	Loyalty gained only if consumer is satisfied
Loyalty is independent of satisfaction		
Satisfied and dissatisfied customers show the same loyalty levels		

1.4 Methods to analyze market share

There are different ways to analyze the market. It can be done by specialists which will determine the customer needs, comparing to competitors, etc. Moreover, from the government's side, although airports are only partially controlled by the government, it is important to determine the market concentration mathematically. These ways were created to indicate for the authorities to determine the market concentration. In this way either the government can attract monopolies or it could be good data for new coming customers who would like to invest in their relevant field. Such an analysis can also be in the clothing market, vehicles, and the topic which is described here, airports. To determine the

concentration of market share, the HHI way will be described as a good example. The Herfindahl-Hirschman Index (HHI) is a common measure of market concentration and is used to determine market competitiveness, often pre-and post- Mergers and Acquisitions (M&A) transactions. The HHI is a commonly accepted measure of market concentration. It is calculated by squaring the market share of each firm in percentages competing in a market and then summing the resulting numbers. It can range from close to zero to 10,000. The U.S. Department of Justice for example is using the HHI for evaluating potential monopolies.

The formula for the Herfindahl-Hirschman index as explained by Hayes [10] is:

$$HHI = S1^2 + S2^2 + S3^2 \dots Sn^2$$

A market with an HHI of less than 1,500 is considered to be a competitive marketplace, an HHI of 1,500 to 2,500 to be a moderately concentrated marketplace, and an HHI of 2,500 or greater to be a highly concentrated marketplace. The primary disadvantage of the HHI stems from the fact that it is such a simple measure that it fails to consider the complexities of various markets. Speaking about airports an HHI calculation can help other airports to be created if there will be found a monopoly. Moreover, looking on today when an airport is an area for buying and selling many things and services a potential can be founded for investors or companies such as airlines who would like to get involved in the airport business. To conclude, markets were created for trade. This is a setting that allows two or more participants to interchange their products. Regarding the airport market, it can be described in terms of markets in general such as market segmentation, supply, and demand, etc. Pointing on the airport, this is a captive place whose service provider is the airport and the recipients of the service are the airlines as the main customer, the passengers themselves as the most important secondary customer and then anyone who chooses to act in the form of trade within the airport or transfers through it. Some factors affect customers adversely and favorably for example the time pressure to make it to the flight and the fear of missing out. Markets are something that can get out of control as we have seen in some economic crises in the world [11] so regulation and monitoring of companies and their ratio of control in the market should be created. For this purpose, the HHI method was invented, which allows the authorities to easily identify monopolies.

Chapter 2 – The global impact of COVID-19 on airports

COVID-19 pandemic impact on the aviation sector was significant for various reasons. The earlier studies of pandemics showed that a respiratory disease (SARS for example) can be spread exponentially within hours [11]. Due to that, routes from countries had to be closed or minimized their operation to prevent the spread of the pandemic. Later on, an analysis of Ben-Gurion airport statistics will demonstrate it. As for investigating the effect of the pandemic on airports, research by many academies was initiated including this one that tried to get familiar with the pandemic and understand the vector of change that the pandemic has on the airport market. The main questions that have been looking for answers such as how does the pandemic are getting spread? What it will create within the airport ecosystem dynamic? What airports should expect? and How to manage and deal with the pandemic in the aviation sector to recover as soon as possible from the crisis that was followed by the pandemic eruption. It is like fighting with an unknown enemy.

Nhamo [12] explains that due to this extreme scenario, unlikely to other situations, many organizations opened up access to some restricted data in the public interest and to foster an understanding of how the COVID-19 pandemic was affecting various sectors. Data from the COVID-19 Airport Status was used to track daily departures of aircraft across the world. The data was gathered from the COVID-19 NOTAMS and could be accessed via application programming interfaces through ICAO's API data Service. The COVID-19 cases per day were sourced from the European Centre for Disease Prevention and Control, and this was updated daily. The data were obtained from a collation made by EUROCONTROL and archived on their database. The data excluded military aircraft, circular flights, unknown operators [12].

In Figure 1 the trend in departures before and after COVID-19 erupted is presented as a reference to how does the pandemic function the departures rate. This conclusion has a huge effect on all the airport market. The main customer (Airlines)

can’t work with their normal operation. In addition, it affects all the participants within the airport (Passengers, Retailing, Employees of the airport, etc).

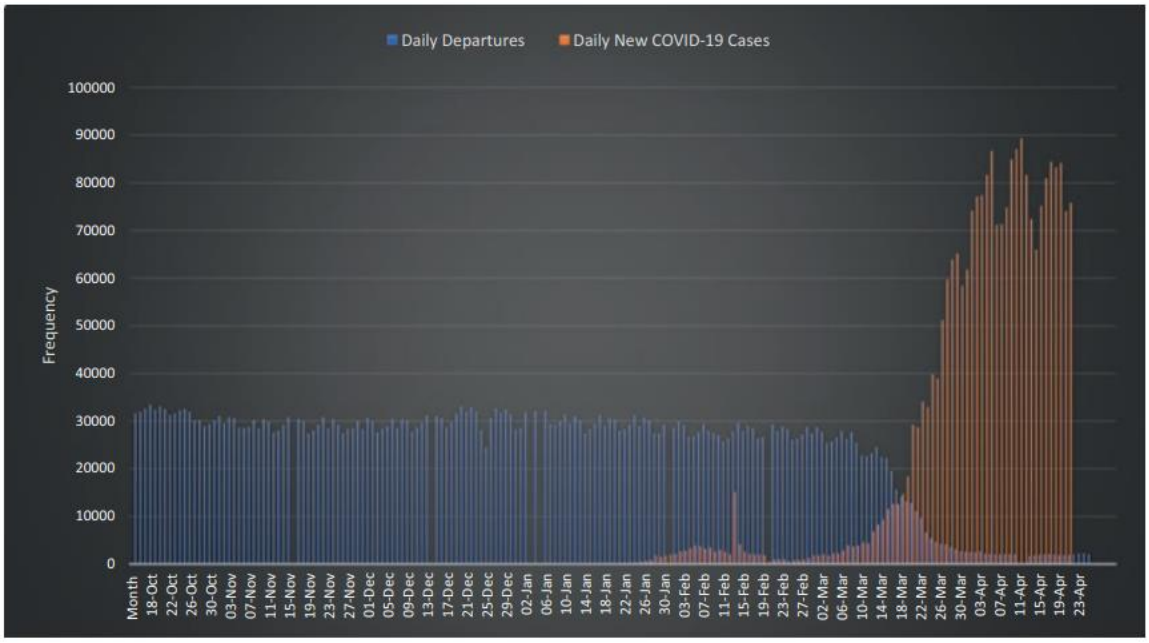


Figure 1 Statistics of daily traffic departures at all the airports and statistics on daily new COVID-19 infections [13]

The outbreak of COVID-12 or its announcement resulted in a decline in global departures, with impacts starting to show at the end of January 2020. The impacts were more pronounced in early February 2020. The hardest knock was observed on 12 March 2020 from the ICAO database [13], as reflected in a marked global downward of departures. This resulted in a decrease of about one-third of aircraft departures. In about 10 days after the pandemic declaration on 11 March 2020, departures plummeted to less than 10,000 aircraft globally. On Nhamo research [12] they found that by the end of April 2020, there were fewer than 2,000 departures on average. Globally an estimated 95% of the departures were lost.

The bulk of aircraft departures and landings at airports mainly comprised cargo and domestic flights [13]. Primarily, cargo aircraft was delivering medical supplies across the world, and the few passenger flights were as a result of slight relaxation-imposed travel restrictions, which also resulted in poor demand for air transport services. The few departures that were observed later on show that few airlines

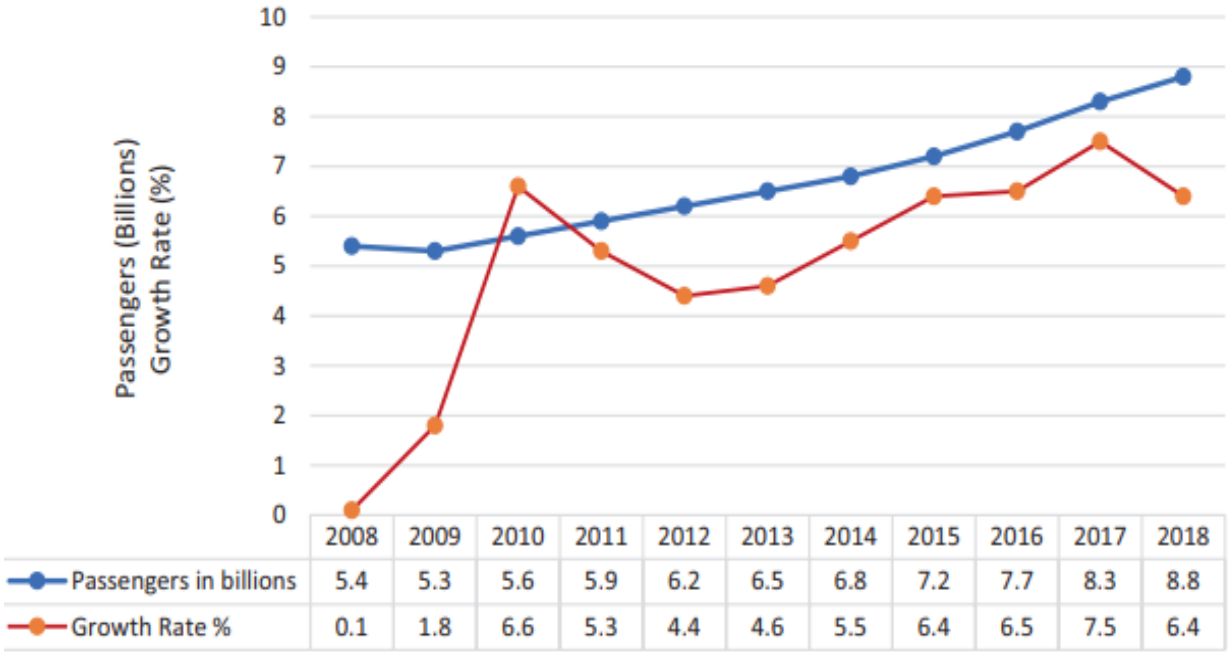
were conducting stranded citizen rescue and relief missions as was found by Nhamo and his group [12]. Israel was part of this kind of operation as well, especially at the end of March and early April 2020 as Lapler said [8] in his interview with us.

In Israel, as it was found from the database of Ben-Gurion airport [14], the majority of flights were largely cargo aircraft medical supplies, and other essentials that were needed. This chapter will provide a better understanding of airport market change before and after COVID-19 erupted. We will see the economical aspect that has been followed when the restrictions started to be effective on the airports.

2.1 Airport status pre covid-19

Airports have witnessed increased use and function over the past decades [15]. This is as a result of increased global air traffic mainly driven by increased levels of tourism development. Besides acting as important transport nodes in the past, airports have become economic hubs offering additional services, including shopping malls, car rental facilities, conference facilities, lodging, and logistics for exports and imports. A record of 8.8 billion travelers passed through the world's airports in 2018, marking a 6.4% increase from the previous year (International Airport Review 2019) [15]. During that time, before the COVID-19 pandemic erupted, there was an increased demand for air travel. From the IATA database of the year 2019 [16], indications were that the trend was likely to continue in the forecastable future as the demand for business and leisure travel increases.

Figure 2 shows how traffic at airports grew and evolved over the past decade, with some significant events impacting aviation such as the economic recession and outbreaks of avian flu, Middle East respiratory syndrome (MERS), and Ebola. Data from the International Air Transport Association (IATA) show that the distance between travels is becoming shorter and shorter [15]. Hence, people are traveling more frequently today than ever before. As a consequence, there is a higher demand for airport usage, and the demand was expected to grow in the short and long term until the COVID-19 pandemic has changed the whole story.



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Passengers in billions	5.4	5.3	5.6	5.9	6.2	6.5	6.8	7.2	7.7	8.3	8.8
Growth Rate %	0.1	1.8	6.6	5.3	4.4	4.6	5.5	6.4	6.5	7.5	6.4

Figure 2 Number of travelers making use of airports and annual passenger growth rate (2008–2018) [17]

Airports are a significant source of economy-system. There are many people and companies involve. According to the Airports Council International (ACI) reports of 2020 [17], globally airports made 178.2 billion US$, of which 59.9% came from aeronautical services, 39.2% from non-aeronautical services, and the further remainder from non-operating revenue. The data is presented in Figure 3.

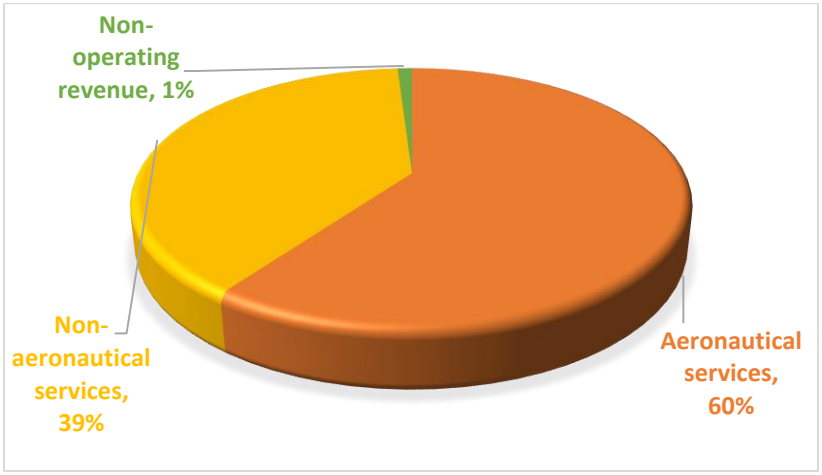


Figure 3 Airport revenue distribution 2020, [18]

The non-aeronautical revenue is the income of the airport which is arriving from services and business that is being traded within the airport eco-system. We can see updated data in Figure 4 about this non-aeronautical income distribution as well from ACI reports [17].

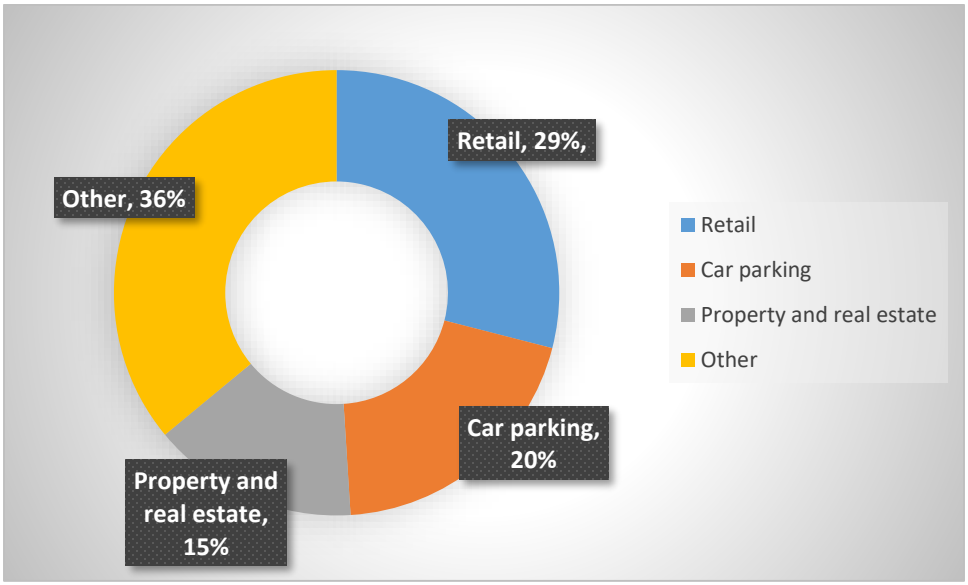


Figure 4 Airport non-aeronautical revenue distribution [17]

Given the number of people who use airports daily, the establishments are also part of the global disease transmission and control channels, with some of the biggest airports facilitating millions of tourists per annum. In research made by Chung [19], it was found that the rapid commercialization of the aircraft industry paved the way for disease proliferation at a faster rate. Given the history of pandemic and infectious diseases, the world has learned over time that the only plausible measures of controlling such diseases are screening, quarantines and isolations. As was explained earlier Airports make the bulk of their money from landings and departure fees, and airport taxes charged to customers. The travel limitations included ground, water, rail, and air travel restrictions. A disruption in

air traffic has implications for traffic flow, which affects revenue collection for airports.

As this chapter explains the status of airports pre-COVID 19 eruptions it is also necessary to present other crises that airports had been affected by in history. These several historical events [12] had an impact on the aviation industry, including:

- 1973 - Oil crisis
- The 1980s - Iran–Iraq war
- The 1990s - Gulf War, the Asian crisis
- 2011 (9/11) - September terrorist attack in the USA
- 2003 - Severe Acute Respiratory Syndrome (SARS)
- 2008 and 2009- global financial crisis
- 2013 - *Avian flu outbreak
- 2016 - **MERS outbreak

Avian Flu - Bird flu [20], or avian flu, is an infectious type of influenza that spreads among birds. In rare cases, it can affect humans. Not all cases are humanly infected. Bird flu is spread by close contact with an infected bird (dead or alive). Markets, where live birds are sold, can also be a source of bird flu. About our topic, traveling to countries that have had an outbreak of bird flu can lead to a quick spread of the disease. Therefore, the aviation market had a deduction within its value because people were afraid to travel and get infected.

MERS [20] - Middle East Respiratory Syndrome (MERS) is a viral respiratory illness that is new to humans. It was first reported in Saudi Arabia in 2012 and has since spread to several other countries, including the United States. Most people infected with MERS-CoV developed severe respiratory illnesses, including fever, cough, and shortness of breath. Many of them have died. MERS looks more or less the same as COVID-19 in its way to be spread among humans.

The impact of some of the outbreaks is presented in Figure 2 but still, the mean value of the graph is showing a positive slope. Looking at the trend, it appears that the number of shocks affecting the travel industry is increasing. Of interest is the

increase in the frequency of outbreaks, epidemics, and pandemics. The COVID-19 pandemic did not only threaten public health and wellness but also had an impact on the global economy. The International Monetary Fund (IMF) [12], officially announced in March 2020 that the world had entered a recession. An economic recession harms economic performance in every sector, including the aviation industry, and indeed traffic at various airports. Generally, airport status was on the rise. Economically speaking the revenues got higher and more airlines were starting their business.

2.2 Status of airports post COVID-19 eruption

While the IMF declared that the COVID-19 pandemic had triggered the worst economic recession in history, projections were that the recovery would assume a "U recovery shape" – with a decline followed by some flattening at the bottom before upward growth – as opposed to a V-shaped recovery (a sharp drop and a sharp rise). The study made by Nicola [22] predicted that most of the impact would be felt in the tourism and aviation industries. Looking at what happened in Figure 1, when focusing on the departures as a source of statistics to how COVID-19 eruption affected airports we can observe a slight decline in departures in January and February 2020 could be attributed to the ban on people to leave or enter Wuhan during which is the busiest travel period in China. As investigated by Chua [23], the travel bans led to a sharp decline in traffic at several airports, with airlines reporting traveler declines of between 85% and 90% for the 2 months year on year comparison. The Wuhan ban resulted in the cancellation of many flights.

The slump in departures presented challenges for airports that generate up to half of their revenue from landing and departure fees. Gathering data from ACI reports [17], ordinarily, airports make close to half of their revenue from the following revenue streams:

- Landing fees (determined by weight and origin)
- Aircraft parking fees (determined by duration and aircraft size)
- Passenger service charges (in most cases, these are charged only on departures).

One thing that was interesting to see is that while airports rely on landing and departure fees, it has other revenue sources that are linked to landing and departure. Most notable is revenue from aviation fuel surcharges. Revenue from this source was not affected by reduced sales, relevant losses compounded by notable lower fuel prices because of an oil price slump emanating from squabbles within the relevant countries that provide petrol.

2.2.1 Airport parking challenges

In as much as the grounding of many airlines presented a huge financial blow from declining departure and related fees overall, there was an unforeseen opportunity for airports to generate revenue from parking fees. With many grounded flights, most airports struggled to find parking space, with some ending up using part of their runways as parking space. Moreover, as it was explained by Lapler [8] "Airplanes parking shall be in as much dry as possible. Israel has few airports in the desert so we had an advantage with this function". This situation was found as well when Boeing 737 MAX 8 type was grounded. There is a struggle both for the airport and the aircraft operators to ground so many airplanes. From an airport maintenance point of view, this led to pavement damage and for airlines of course it led to a stop from their main source of income said Nhamo [12]. Moreover, for the operator as well, he should pay for the parking and other services required for the airplane maintenance. Lapler explained [8] that parking fees are determined by the weight, size of the airplane, which facilities does it require, and for how long it is going to park in the airport apron. The airplane is not generating any income for the operator when staying on the ground. For example, parking fees for a wide-bodied aircraft at Heathrow Airport [24] are £59.35 (1,773 CZK) and that for narrow-bodied aircraft £24.73 (734 CZK) for every 15 minutes, with the costs waived between 22:00 and 05:59 UTC. While the parking costs could have been reduced by government and airport authorities through concessionaries and waivers, there were serious financial implications for airlines with wide-bodied aircraft and those with a large fleet. We can say that in such a crisis there are advantages for some participants such as the airport parking fees for example. The airport is getting revenue from the parking space occupation.

Focusing on Europe, aircraft were piling up at various airports since February 2020, with the most significant number of parked aircraft witnessed in mid-March 2020. (Figure 5). Ryanair, Lufthansa, and Turkish Airways had the highest number of parked aircraft, with a total of 915. The airports with the highest number of parked aircraft were in Madrid, Istanbul, London, and Vienna (Figure 6). On 17 April 2020, there were 5,472 parked aircraft at 303 airports across Europe.

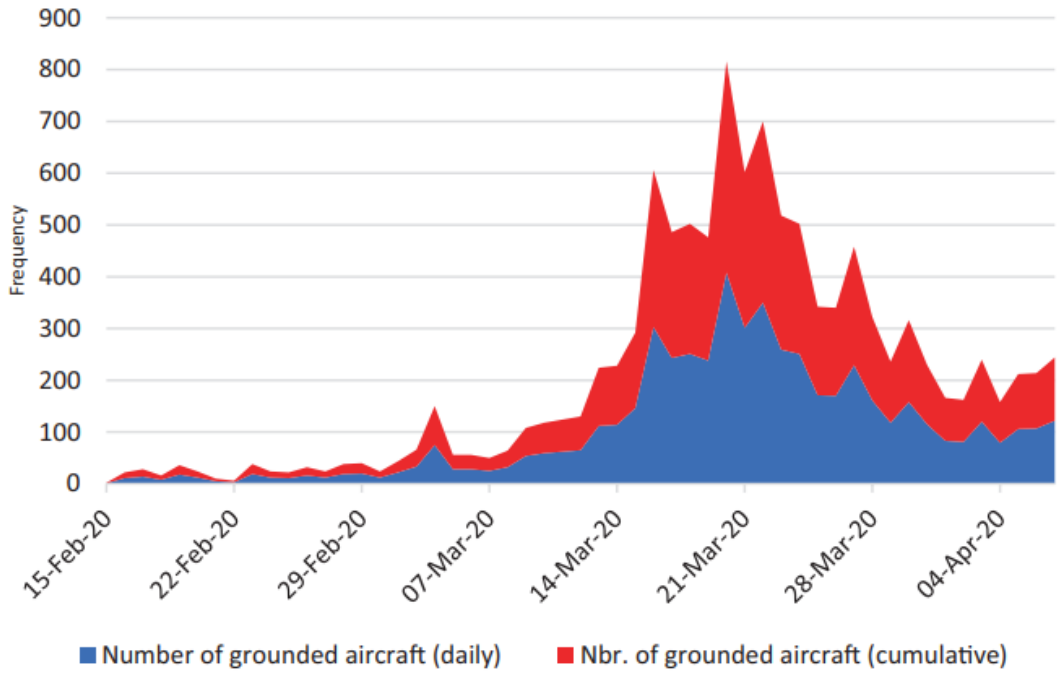


Figure 5 Trend in airport parking due to COVID-19 in Europe [25]

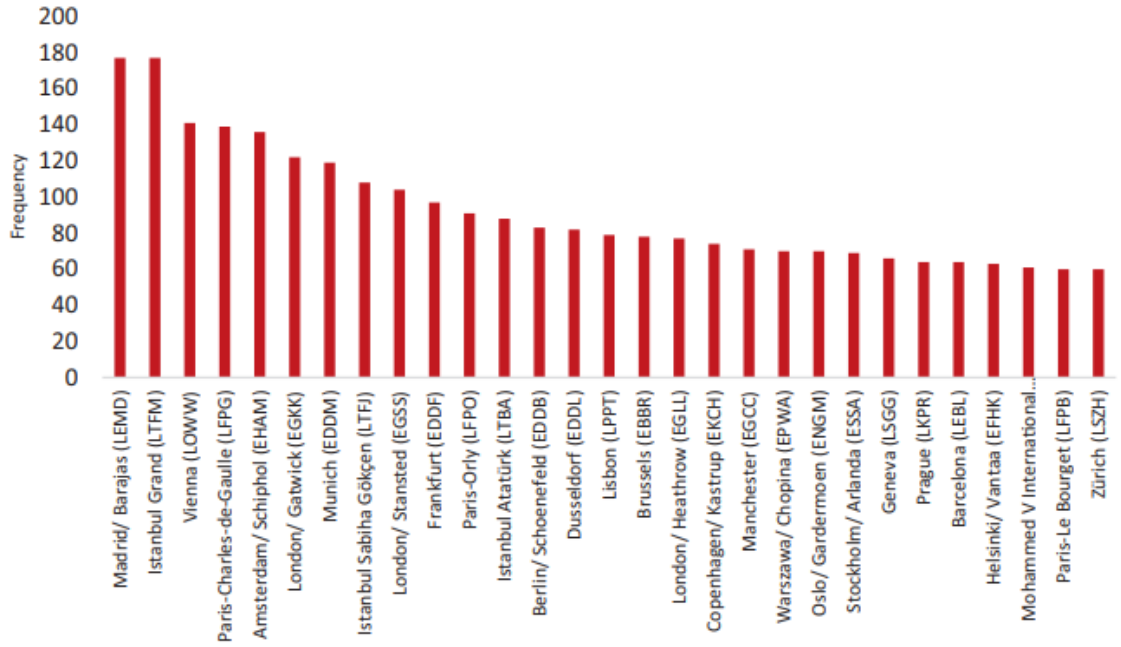


Figure 6 Airport with more than 60 parked aircraft due to COVID-19 [25]

In the USA, airports resorted to using closed airports or airports not frequently used as parking sites for grounded aircraft [12], some of the airlines that used this less frequented airport, probably evade the high cost at other busy airports. The airport is also advantageous in that it has sub-humid conditions. The dry conditions ensure that aircraft are rust-free, which helps in lowering maintenance costs. Faced with substantial parking costs, probably for a more extended period, some airlines decided to retire their bigger aircraft. Airlines such as Lufthansa retired a sizeable number of wide-bodied aircraft. In Europe, there was a call to cut airport parking fees, which effectively reduced revenues [12], as such, the airports were also incapable of cashing in on the troubled airlines.

2.2.2 Impact on retailing market of the airport

Apart from getting revenue from aeronautical services, several airports get substantial revenue from retail, car rentals, property leases, and ground transport. Taking data from Sydney airport reports of 2019 [26], for example, they made 1,637.9 million AUS$. Figure 7 shows the contribution of each airport business unit to the total revenue collected by the airport.

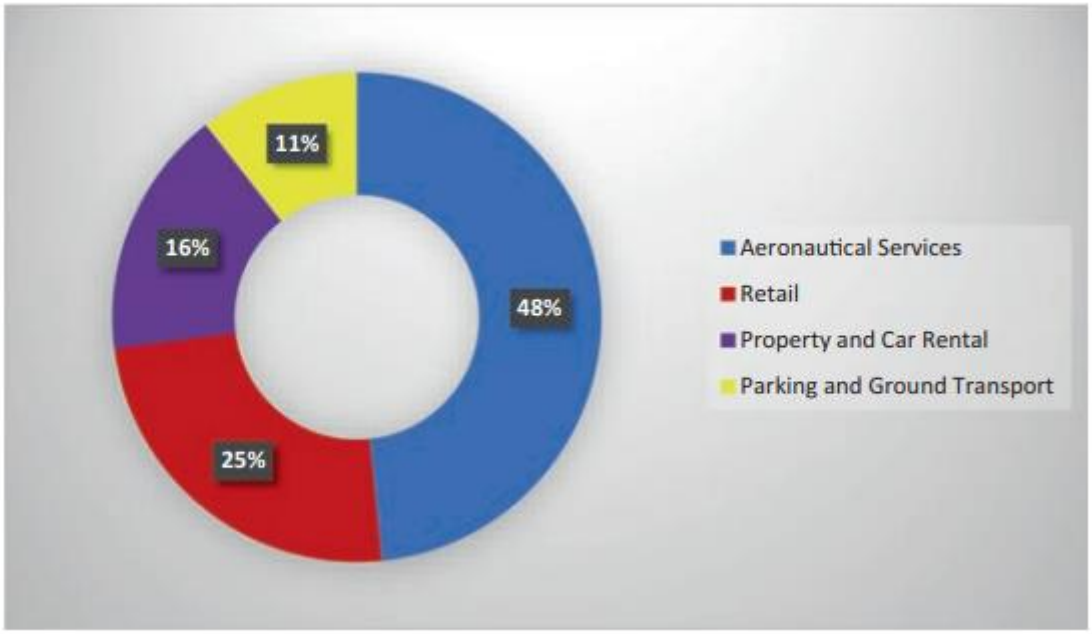


Figure 7 Revenue collection by airport business units at Sydney Airport in 2019 [26]

With millions of passengers using the airports and using various services and facilities, the closure of various retail units as a result of the grounding of airlines as was explained in the global airport retailing market report of 2018 [27], led to a loss of substantial revenue from various business units. Closed services in the space include airport restaurants, bars, airport lounges, and car rental, and ground transport facilities, all of which generate significant amounts of revenue for airport-owning companies.

Besides retail, some airports rent or lease hotel space all adding another revenue stream. The global airport retail value in 2017 was pegged at 40 billion US$, with

the figure expected to reach 58.4 billion US$ by 2022 [28]. Generally, airports retail was rising together with the growth of flights. In 2019, the global retail market grew by 5%, with profit margins at 5.6 %. It is estimated that a loss of over 5 billion US$ is predicted. Together with this loss, retail employees are suffering [29].

2.2.3 Employees

Airports are an independent market. It indirectly employs a lot of people who provide cleaning services for airlines and airport facilities, security services, and ancillary services such as baggage handling and airport shuttle services.

Given that most of these employees are either semi-skilled or employed temporarily, indications were that the bulk of them was furloughed or dismissed due to reduced operations or the closure of airports across the world.

Table 3 shows some of the cases where airport employees were either furloughed or dismissed.

Table 3 The impact of Cov19 on the airport employees [12, 30, 31, 32]

Name of airport	Number of dismissed/furloughed employees
Leeds Bradford Airport	250 people directly employed by the airport were laid off
Houston Airport	Swiss port temporarily laid off at least 50 full-time employees of its airport staff
Charlotte Douglas Airport	112 airport workers lost their jobs
Heathrow Airport	Security guards and firefighters accepted a 10% reduction in their pay for 9 months. Other airport staff were forced to take a 15 % salary reduction after business fell by 90 %

Bristol Airport	Furloughed 80 % of staff
Ben-Gurion Airport	Most of the workers have been furloughed. The Airports Authority has 4,500 employees, of whom about 2,600 were furloughed, and about 220 retired.

Another physical change that the COVID-19 pandemic brought under the spotlight is the effectiveness of thermal scanners in the screening of infected passengers. Thermal scanners were often used previously to control the outbreak of diseases such as SARS [33]. Quilty [34] observes that out of 100 COVID-19 cases, an estimated 47 % was not detected, 44 % was detected at exit screening, 1 % was detected as severe on the flight and 8 % was detected at entry screening. This points to the need for continuous research and innovation to improve the efficiency and effectiveness of thermal scanners at airports.

To conclude, it can be seen from the data that the airports market has been directly affected due to the COVID-19 pandemic. The traffic flow reduced, and the revenue of airports were directly affected from it. They responded by reducing salaries, employees were either furloughed or dismissed.

There is a parking challenge for the airplanes. Due to the large number of planes that were on the ground, the damage was caused to both the pavement on which the planes were standing and to the airplane frame itself, which was not intended to remain on the ground for such a long time. In the economic aspect, the airports could take advantage of this situation to use the airlines as a source of income for parked planes but the airlines got into financial distress as well so this situation was not ideal for either party. Some of the airports used this time to make renovations and some of the airports as well as Israel chose to stop projects to take care of their employees first [12].

Airports and national airlines have received financial support from the state to continue projects aimed at making the airports more efficient and greener. Because the trend of economic recovery from the crisis will be in the U-shape and not in V-shape, countries with poor traffic will suffer a longer period from the crisis. The ACI [17] called for support for airports and aeronautical companies across the world in

the form of providing financial relief packages to enable service sustainability post-COVID-19 or when the economy is restarted. There is a need to support the sector to ensure the continued existence of affected airports and associated operations. There is also a need to protect airport employees from the impact of the COVID-19 economic shock, the magnitude of which had never been seen in history.

Chapter 3 – Ben-Gurion Airport

This part of the thesis will be an introduction to Israel's Ben-Gurion International Airport. At the beginning of the chapter, it will be explained about the establishment of the airport from its history, its geographical location, and operational information which is accessible. Further in this work, in chapter 4, data analysis of the information gathered about the effect that the COVID-19 pandemic had on Ben-Gurion Airport will be presented.

Explanations will then be presented explaining the analysis of the graphs and hypotheses based on articles, an interview with a senior airport official Mr. Lapler [8], and minor information gathered from the news.

It is important to declare, there are graphical phenomena that have no precise explanation and it should be taken into account that this is a combination of a pandemic outbreak, immediate economic damage as well as accompanying psychological effects on humans that are affecting all movements of aircraft and passengers.

3.1 Description of Ben-Gurion airport

Ben-Gurion International Airport, named after Israel’s first prime minister, David Ben-Gurion. It is located in the heart of the country, 40 kilometers from Jerusalem and around 15 kilometers from Tel Aviv. In Figure 8, the airport is presented with its ICAO letters (LLBG) from a point of view concerning its neighborhood competitors.

As it was explained in chapter 1, there are competitors which are having the same product or sharing the surrounding area. Professionally expressed as geography market. Ben-Gurion doesn’t have a significant competitor due to the location. As it was said by Lapler [8] due to the political-geography relation.

Figure 8 Ben-Gurion airport general location [35]

The airport was built by the British Mandate authorities in the 1930s. In the late 1970s, the Israel Airports Authority (IAA) was established as a statutory corporation and since then, the airport has been developed and thrived as a passenger and air traffic has seen a consistent increase in volume. In the 1990s, IAA management realized that the old Terminal 1 could no longer accommodate the increasing passenger traffic and together with the then Minister of Transportation Israel Keisar, a decision was made to build a new terminal, Terminal 3, with the capacity to take Ben-Gurion Airport into the category of international airports with a volume of over 25 million passengers. Ben-Gurion Airport is the gateway to the State of Israel [36].

The airport has two main terminals:

- Terminal 3 for international flights
- Terminal 1 for both domestic and low-cost international flights.

Ben-Gurion Airport is a modern airport equipped with some of the most advanced technology in the world [18], with operational flight facilities meeting international standards, it provides accessible services for passengers in need of assistance, and provides high-level passenger services, and special VIP services. Safety and security at the airport are among the most stringent in the world and air safety is the top priority.

Operational responsibility lies with the director of Ben-Gurion airport. Ben-Gurion airport is operated by four main divisions subordinate to the airport director. Presented below are the divisions [36]:

Ground Operations Division

The Division consists of five main departments that coordinate most of the Airport's routine activity and core services in routine and in times of emergency.

- Ground Operations Department
- Ground Services Department
- Cargo Handling Department
- Coordinators and Equipment Operating Department
- Baggage Handling Department

Maintenance Division

The Division is responsible for the maintenance of equipment, buildings, mechanical and technological systems at Ben-Gurion Airport.

Passenger Service Division

The Division is responsible for services for incoming and departing passengers. Moreover, it is for state and private ceremonies, and the maintenance of terminal facilities, including passenger information, signs and directions, taxi services, shuttle services in airport grounds, and more.

Security Division

he division has a strict and unique structure that only partial facts are published to civilians which are not part of their security structure. It is divided into designated

units responsible for specific issues, that encompasses the entire field of personal and general security at the airport, both visible and concealed, including security checks of hand luggage and checked baggage, spatial protection of the airport peripheral area, security within the terminals and more.

Given everything written here, it can be understood that this airport is unique. It is located in the State of Israel. This country is a focal point for all people who believe in religions such as Islam, Christianity, Judaism, and other streams of religions that see Israel as a holy place. It is also the main airport for departure and arrival to Israel but, there is also Ramon airport which is much smaller than the Ben-Gurion. Because there is a constant security threat the airport must work in cooperation with government security bodies whose activities are highly classified. It is important to add that when a security threat such as a war against one terrorist organization or another appears, this affects the movement of airplanes arriving or departing from Israel.

It happened in the past that due to rockets being shoot in the direction of Tel Aviv caused a complete stop of the airport operation. In addition, tourists who watch the news from abroad are also influenced and influence the tourism statistics in the State of Israel.

3.2 COVID-19 timeline in Israel

On February 22, it was reported that South Korean pilgrims who visited Israel between February 8 - 15 were diagnosed as carriers of COVID-19 after returning to their country. The next day, the first infection was diagnosed in Israel, the wife of a citizen who had returned from Italy [37].

On March 5, 2020, it was announced that a group of pilgrims from Greece traveled to Israel infected with the virus from February 20 - 27. Following the group's visit to Bethlehem, the IDF imposed a closure on the city.

According to researchers from the Institute for Biological Research in Israel [38], Purim celebrations (Holiday in Israel) and parties held on March 10 and 11 without any restrictions or social distance created the mass infection.

1st Lockdown [39]

On March 14, the Ministry of Health and the Prime Minister announced the abolition of all leisure culture, studies in universities, schools, and kindergartens, and a ban on more than ten people staying in the same area.

On March 16, in a joint statement with Finance Minister Moshe Kahlon, Netanyahu announced that the public sector would be transferred to an emergency format, the private sector would reduce its employees by 70 % and the essential services would continue to exist in full format.

On March 17, the Ministry of Health issued new guidelines under which no one should leave the house except in situations that require it. Thus, public transportation was canceled every evening from 20:00 LCL until early morning, as well as on Friday and Saturday (Jewish weekend days).

On the night of March 19, the government approved emergency traffic restrictions that determine when it is allowed to leave the house - and allow police to enforce them.

On March 20, the government approved additional regulations according to which the number of employees in the business and public sector will be reduced to 30% and stipulate which businesses are allowed to continue operating - and in what format.

On March 25, leaving the house was restricted.

The end of the 1st Lockdown

On April 18, the number of patients began to decline, and the number of newly verified recoveries was higher than the number of newly verified patients It was found that there were 209 recovered cases compared to 158 infected.

From then until May 29, the number of new patients did not exceed the number of recovering patients, and the number of active patients decreased.

On May 4, the distance limit was canceled, and a routine exit strategy was published in the “shadow” of the plague.

During the month, restrictions on public transportation and businesses gradually diminished.

These were opened on May 27, just before the original date.

Hotels and other tourist attractions were gradually opened under the guidance.

During these weeks there was a slow increase in newly infected cases, which caused a delay in relief, and yet in mid-June happy and cultural events resumed, under instructions.

At the end of June, the rate of morbidity increased.

By mid-July, the number of infected cases had risen sharply.

In the end, the increase was halted by Mr.Gamzo who was appointing as a leader who is a hospital CEO and in the past was in government in the health sector.

Use the "traffic light" approach which classifies localities on the level of their morbidity, isolation, and local treatment rather than putting the whole country under lockdown. [40]

2nd Lockdown [41]

In August, there was an increase in the number of patients hospitalized continued.

The daily number of infections remained around 2000.

In early September, a sharp rise in morbidity began.

At the cabinet meeting that took place, Mr. Gamzo recommended that a local lockdown is to be imposed on the red cities, which were all -Orthodox and Arab localities.

After pressure and opposition, it was decided to settle for a night lockdown only.

On September 11, Mr. Gamzo recommended to the cabinet a "three-step plan":

- Tight restraint
- Partial restraint
- and a return to the “traffic light” program

As of September 18, the government approved a 21-day lockdown and returned to the "traffic light program" afterward [41].

On September 25, the tightening of the second lockdown took effect.

Except for the restriction of demonstrations that required a change in legislation, and went into effect on September 30th.

The end of the 2nd Lockdown [42]

During the lockdown, 3 different plans for an exit strategy were presented.

On October 17, the lockdown ended except in the red cities.

In November, various reliefs were added in green and yellow cities.

The 3rd Lockdown

On December 3, 2020, the coefficient of infection rose above 1, and the average number of infected was about a thousand. The government has developed a dispute over the existence of a nocturnal Lockdown on the Hanukkah holiday. The law requires a lockdown only if given a clear benefit, but since the Ministry of Health did not show support during, the lockdown was not carried out. It was decided to wait and perform tight restraint when there will be 2,500 infections (weekly average) or an infection factor of 1.32, and if after 3 weeks there is no decrease, perform a lockdown. After a long delay, the government decided on a lockdown as of December 27, 2020. Unlike its predecessors, educational institutions continued as usual with private sector work at a rate of 50 %, and a distance limit of 1,000 meters. The target to the end: a drop along with less than a thousand contagious a day [41, 42].

The end of the 3rd Lockdown

In February 2021, about a month later talks about ending the lockdown began. Hospital load was high, as were morbidity: 7,397 infected, infection coefficient: 0.99. On February 15, it was determined that on the 21st of the month, a green

passport[1] will start operating in the leisure culture. The crowd limit was eased. At opening: morbidity - 3,041, infection coefficient - 0.83. On March 30 there were no red cities - for the first time since the launch of the traffic light program when the coefficient of infection was 0.53. On April 23, zero daily mortality was reported. On June 1, the restrictions on the purple[2] and green characters were canceled [43].

Current status

As of August 3, 2021, the number of verified cases was 878,931, 217 in critical condition, 6,486 died, and 852,007 recovered [44].

[1] Green Passport – A passport which is provided only to vaccinated people who got 2 dozes. As well as the opening of trading places, other parts of the education system, etc.

[2] Purple character – it is approved to certain businesses that can operate under restrictions of the people inside should have either green passport or heal from COVID-19.

Chapter 4 - Data analysis of LLBG

This section presents an analysis of the information that was available for this work about Ben-Gurion airport ICAO Letters LLBG. The data [14], was collected from the airport reports published by the Israeli Aviation Authority. The information contained types of flights, types of passengers, and cargo between the years 2019, 2020, and 2021, when 2019 is presenting the situation before COVID-19 eruption and, 2020-2021 presenting the crisis era. Also, more information was collected from *flightera.net* [45] and from *flightaware.com* [46]*, which* are two sources that contain statistics on global airports, as well as on LLBG to support the analysis. The information was entered into Excel software with which we could create comparison charts, calculate the rate of change in percentage and present it. The rate is the trend in % between the values of 2020 compared to 2021. The comparison is distributed by months from January – June. The selection of only half a year was made due to a lack of reports from June 2021. In the part of presenting the vector of change in LLBG airport, thorough the operational part, we accumulated the data gathered from 2019-2021 and made charts that present the trend that happened. The explanations of the data analysis were supported with aviation articles and news collected from published sources of Israel news during the crisis. The goal was to investigate how the COVID-19 crisis have changed Ben-Gurion airport market operation.

4.1 International activity

A/C movements mean, accumulated arrivals and departures. According to the IAA database [14], in January 2021 there were 2,224 aircraft movements compared to 11,374 aircraft movements that were noted in January 2020. A decrease of 80 % in international traffic from Ben-Gurion. But when looking at the rate of change during this half-year, an increase of 47 % was observed in the international traffic movements at Ben-Gurion. In June 2021 there were 6,119 movements compare to June 2020 which captured only 1,849 a/c movements. When making compression of just month-to-month, that is present a rate which is positive by 70 % above the 0 % point but, the accumulated amount of the international flights until June 2021 were 20,866 which is still lower values compering to the accumulated international

flights noted during 2020 which was 31,556. The bottom line is, there is an improvement in the rate of change for 2021 but the values are still negative below the 0 % due to the pandemic. Below see Fig. 9 depicting total aircraft movements from Ben-Gurion airport.

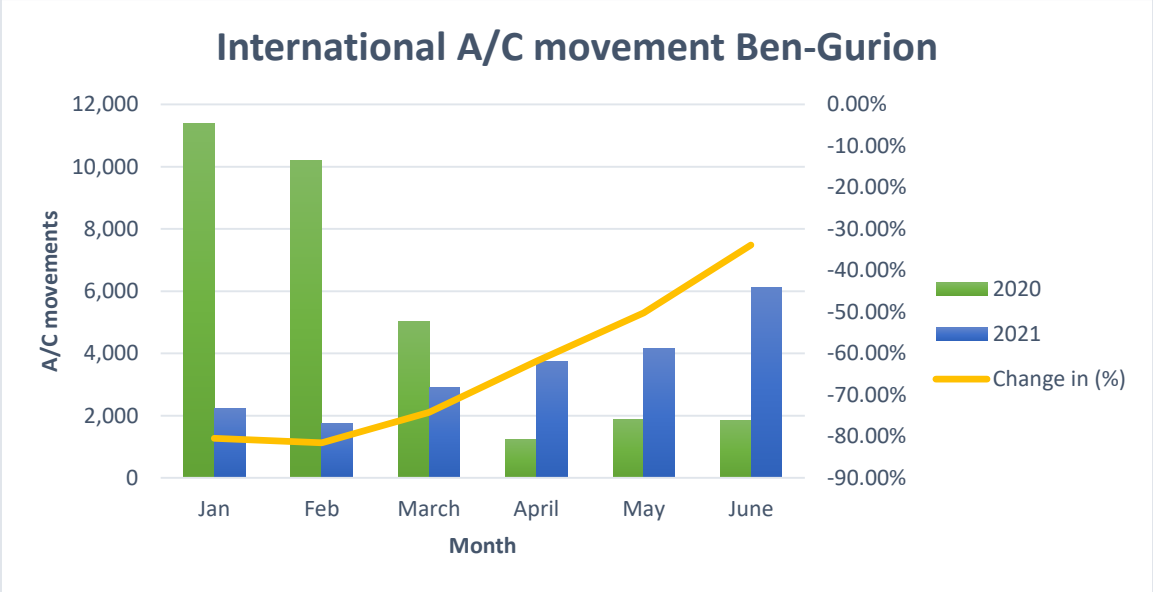


Figure 9 International Aircraft movement in total from LLBG [14]

Figure 10 presents the corresponding chart of Figure 9 but, it shows the number of passengers that were noted within these flights. As it is possible to observe from January-April on both charts trend looks more or less parallel and the reason is the pandemic eruption in February 2020 in Israel. In April the trend is starting to be positive dramatically. Explanations will be in the discussion chapter.

Aircraft movement can be any type of aircraft. For example, it can be charter, cargo, private, etc. In the next figures the distribution of the international flights, by their type will be presented. A/C movements mean, accumulated arrivals and departures. According to the IAA database [14], in January 2021 there were 2,224 aircraft movements compared to 11,374 aircraft movements that were noted in January 2020. A decrease of 80 % in international traffic from Ben-Gurion. But when looking at the rate of change during this half-year, an increase of 47 % was observed in the international traffic movements at Ben-Gurion. In June 2021 there

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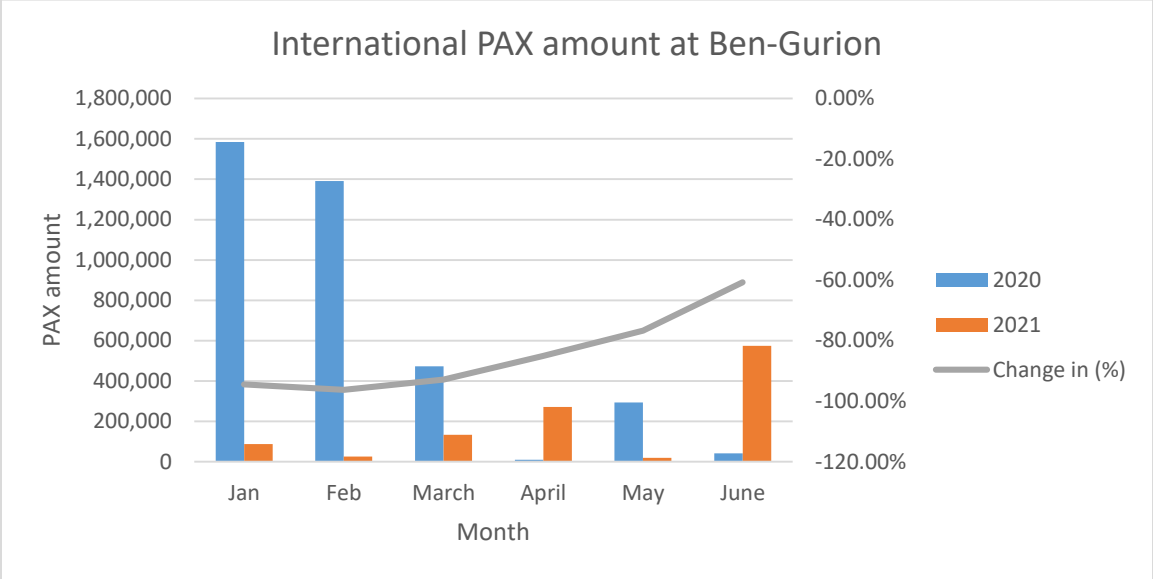


Figure 10 International passengers movement at LLBG [14]

In figure 11, we can observe a significant decrease in the year 2020, from February. Later on this year, the number of international charter flights was still low. Later on, according to the data, in April 2021, we can see a recovery path, 269,109 passengers were transported via charter flights compare to April 2020 which had only 9,089 passengers transported. March 2021 was the first month that a positive rate of change was noted.

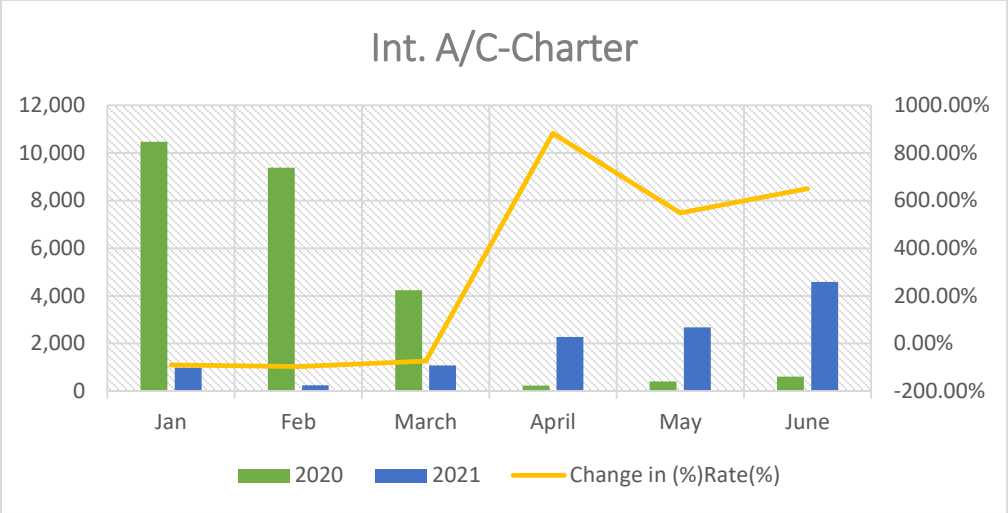


Figure 11 International Charter flights from LLBG [14]

As we can see, in figure 12 the number of international passengers who flew with charter flights decreased significantly from February 2020. The continuous year (2021) presents a positive slope which is rising sharply in March 2021. Percentages show a trend of thousands due to the absolutely dramatic positive change in April 2021.

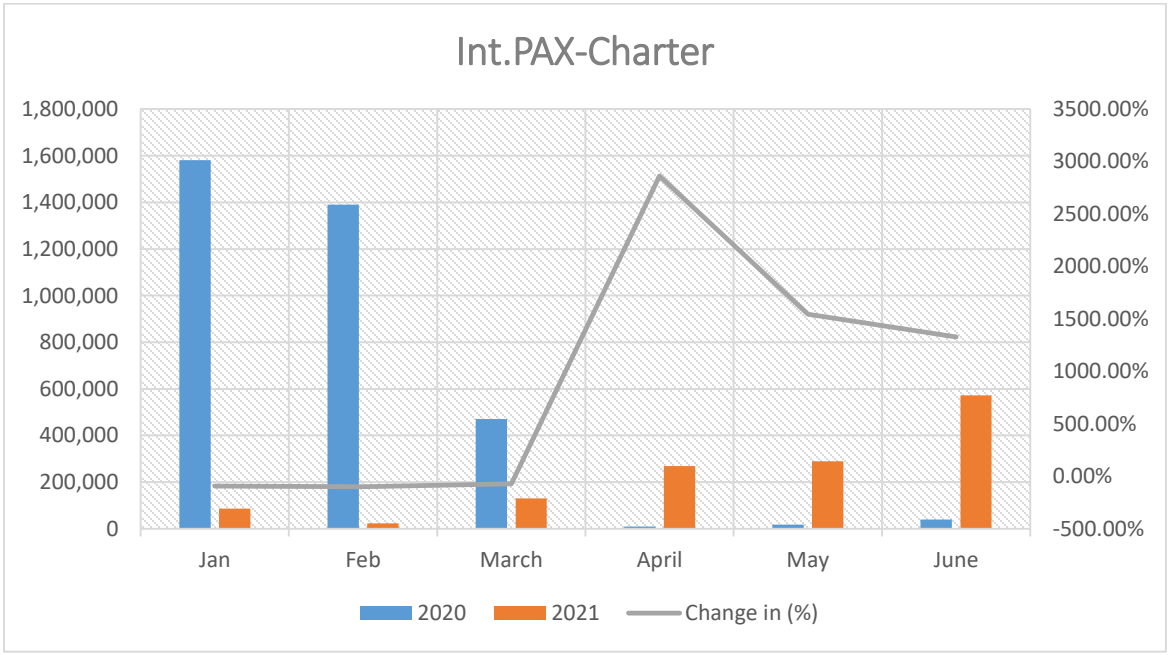


Figure 12 International PAX amount in CARGO flights from LLBG [14]

Aside from Charter flights, an increase of 145 % in international private flights was noted from 2021 compared to 2020. Figure 13 presenting graphically the data about the international private flights, aircraft movement, and Figure 14 shows the corresponding details but with the number of passengers transported. We can see that January and February were almost the same results but during Mach and April, it is observable that there were many more international private flights. In March 2021 there were 797 flights compare to March 2020 which had only 279 flights, an increase of 185 %.

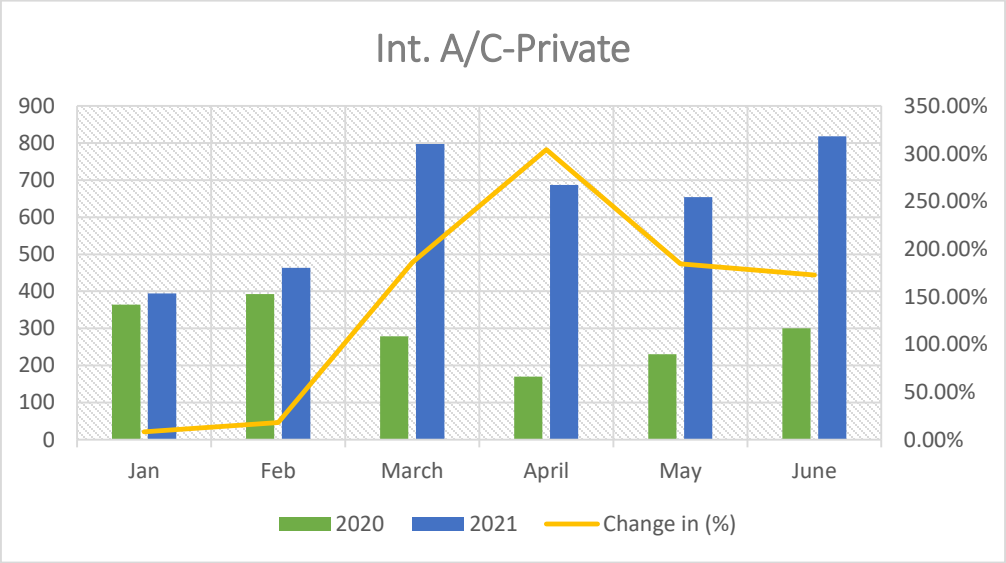


Figure 13 International private aircraft flights movement at LLBG [14]

Figure 14 shows the corresponding private flights but, presents the passengers transported. As we can see the trend looks more or less the same between these 2 figures. (Fig.14 and Fig.15). In February 2020, a decline in the number of passengers transported due to covid-19 eruption but from April 2020 a positive slope starts. In the year 2021, there is a slight drop from March to April but still, better results than 2020.

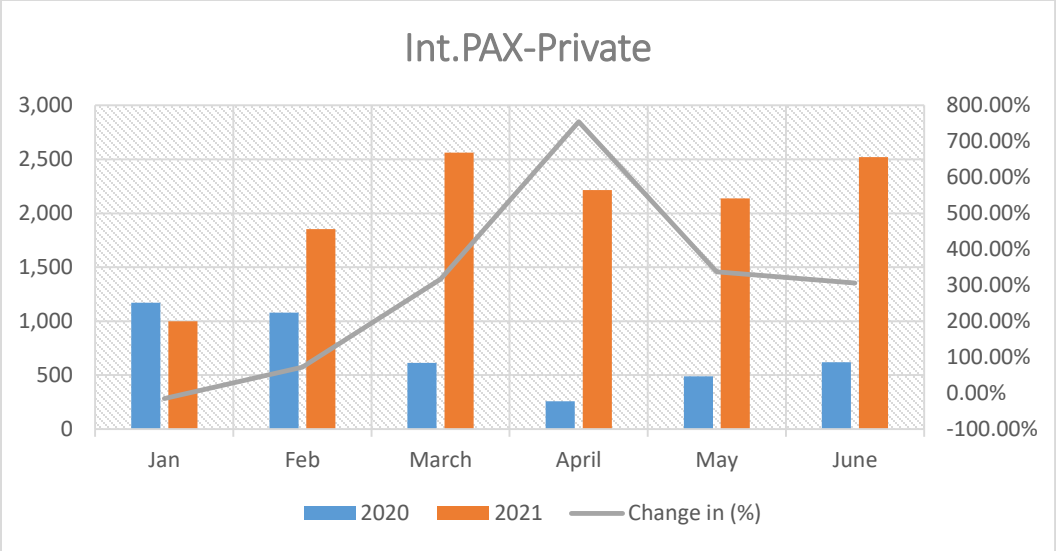


Figure 14 Passengers amount in international Private flights at LLBG [14]

The last details representing the movements in LLBG are internationally noted as "Other" flights. That could be any General Aviation (GA) flights, testing flights, training flights, or classified flights. Figures 15 represent it. According to the data [25], private flights were starting to improve in 2021. As it is possible to see the first half of 2021 were higher results in every month compared to 2020.

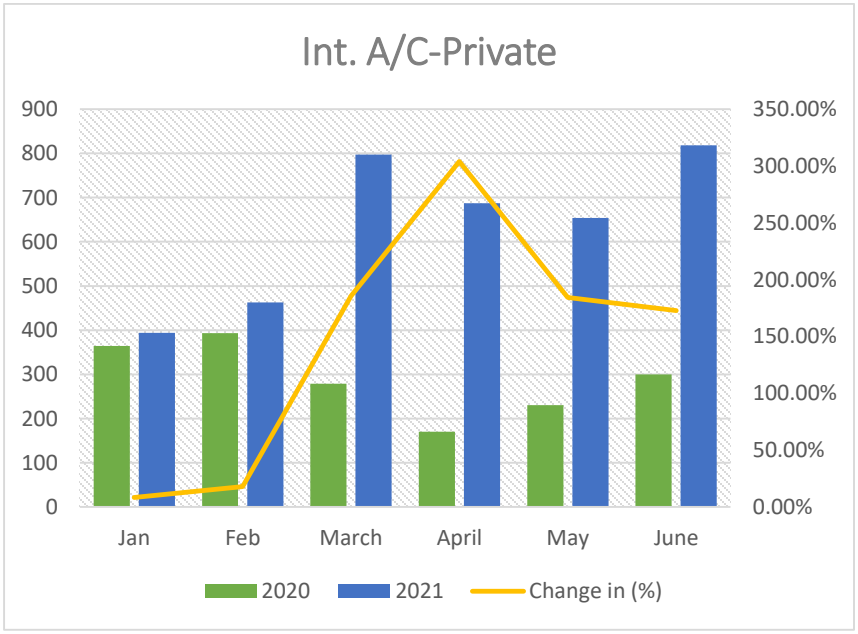


Figure 15 International other a/c movements at LLBG [14]

Figure 16 represents the international “other” flight type with the number of passengers transported. The rate of change is cut due to the significantly high increase of values in April 2021 compared to April 2020. According to the data, in April 20201 there were 491 flights noted as other compare to 2020 which had only 1 flight noted. This is the reason for the significant MAX point on the rate of change.

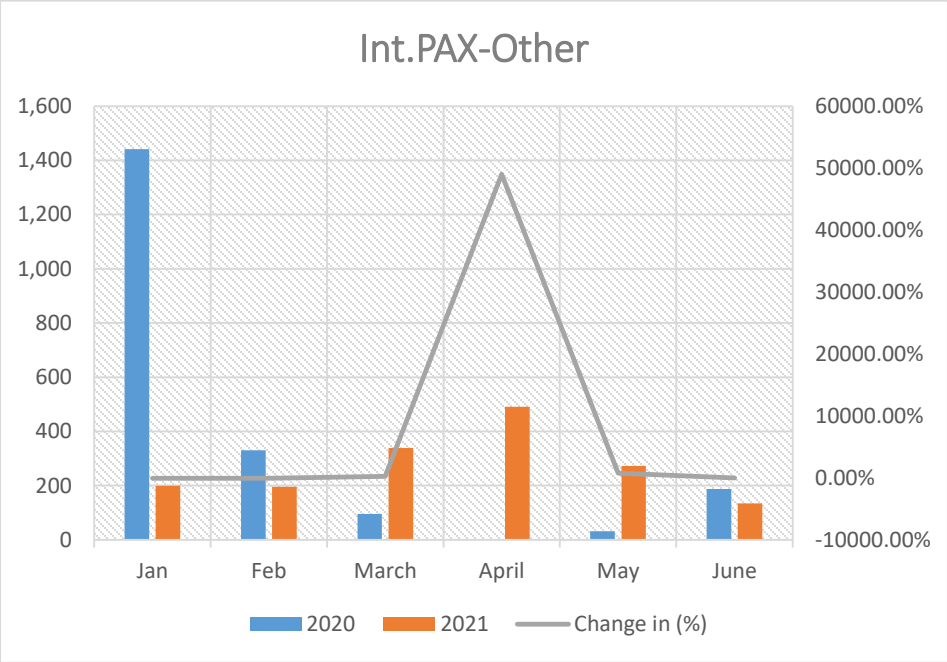


Figure 16 Passengers amount in international “other” flights at LLBG [14]

4.2 International cargo

Figure 17 represents the total amount of cargo (mail and cargo), that was transported via LLBG. We can observe a slight downward trend in the amount of cargo transported at the year of 2020 from January to April and then an increase. For 2021 we can see that generally, cargo transportation had better results for Ben-Gurion in the first half-year. According to the data from the Israel Airports Authority [14], there were accumulated 178,993 tons of cargo until June compare to 2020 which was 159,272 tons, an increase of 13 %.

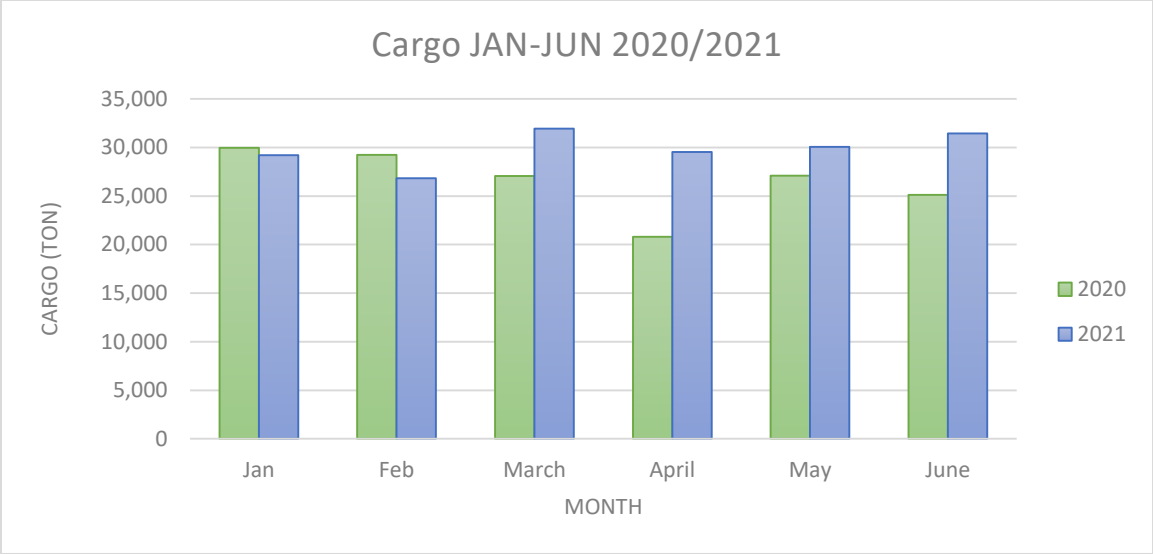


Figure 17 CARGO JAN-JUN 2020/2021 LLBG [14]

In figure 18, we can observe a sharp decrease in cargo transported via passenger's a/c in the year 2020.in April 2021 for example - 6,683 tons of cargo entered passenger flights compared to the corresponding period April 2020 - 1035 tons (an increase of 80 %). Later on, we can observe not a better result but a positive slope from February 2021 until June.

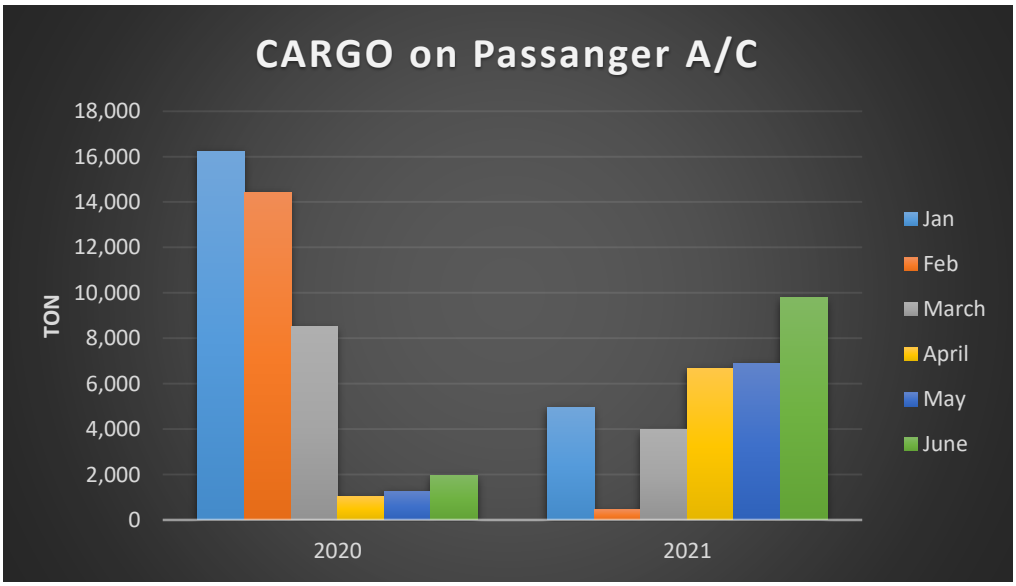


Figure 18 CARGO entered to passenger airplanes 2020/2021 [14]

Figure 19 represents the cargo amount in tons entered cargo a/c, distributed by months. In this chart, we can see that 2020 was on a positive slope but a lower amount of cargo. According to the data, the accumulated tons of cargo in 2021 was 147,420 tons compared to 2020 which noted 115,797 tons, an increase of 28 %.

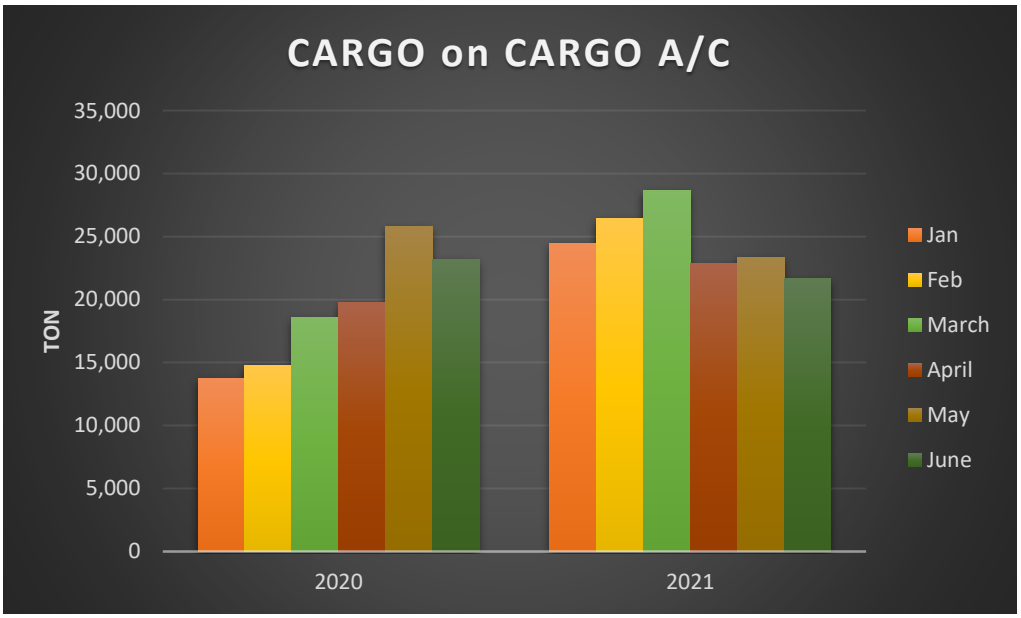


Figure 19 CARGO entered to CARGO airplanes 2020/2021[14]

Figure 20 represents the international amount of cargo flights. Is it possible to observe, cargo flights were less affected by the covid-19 eruption compare to charter flights. In the first quarter of the year 2021, there were 2733 cargo flights compare to 2020 which had 1290, an increase of 111 %. In the second quarter of 2021, there were 2196 movements of international cargo flights compare to 2937 flights at the same period but in 2020, which represents a decrease of 34 %.

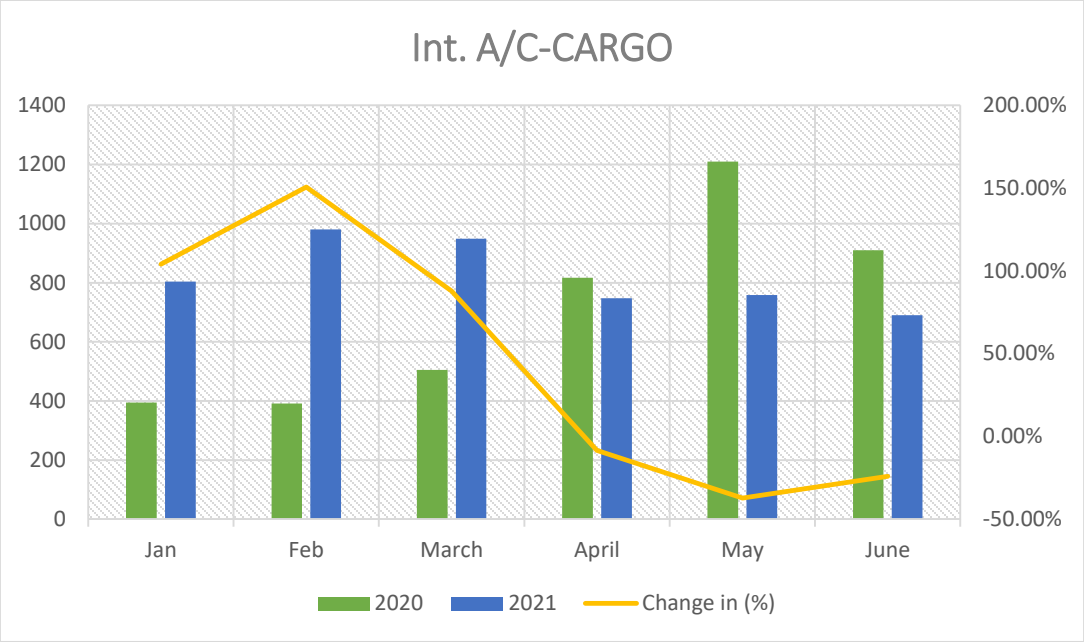


Figure 20 Amount of international cargo flights from LLBG [14]

Figure 21 represents the passengers that were onboard the cargo flights. It is relatively lower numbers compare to charter flights but, that is the kind of data that is accessible to the public. We can observe a general decrease in the number of passengers flying on cargo airplanes. For example, accumulated until June, there were 230 passengers transported on cargo airplanes throughout this half-year compare to 2020 which had 492 passengers transported on the same type of airplanes, which is a decrease of 113 %.

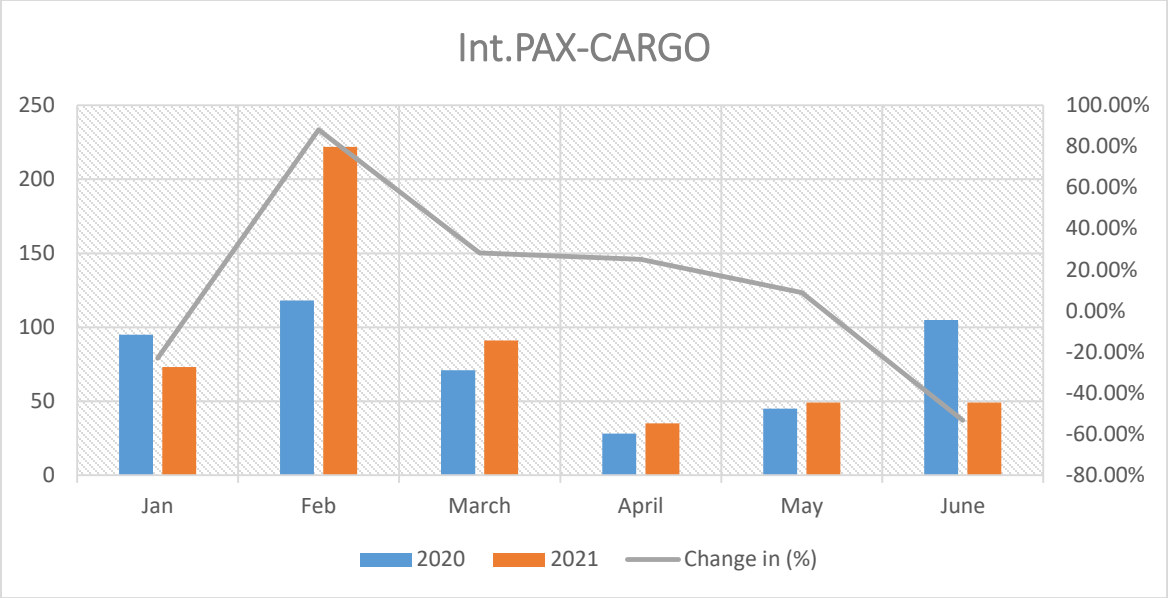


Figure 21 International Pax amount in cargo flights from LLBG [14]

4.3 Domestic activity

Figure 22 represents the graphical distribution of domestic a/c movements from Jan-June of 2020 and 2021. According to the IAA database [14] in January 2021 there were 230 aircraft movements compare to 1,033 aircraft movements that were noted in January 2020. A decrease of 77 % in domestic traffic from Ben-Gurion. From March 2021 the rate of change is becoming positive. In March 2021 a slight increase of 20% in aircraft movement was observed. We can see that also domestic movements were affected by the covid-19 eruption in February 2020 in Israel. March 2021 is the month that amount of domestic flights increased beyond 2020. In April 2021 there were 757 flights (from all types) compare to April 2020 which noted only 141 movements. An increase of 436 %. The rate of change in the chart is not presenting this trend because the rate in the chart was calculated by the accumulated flights until each month.

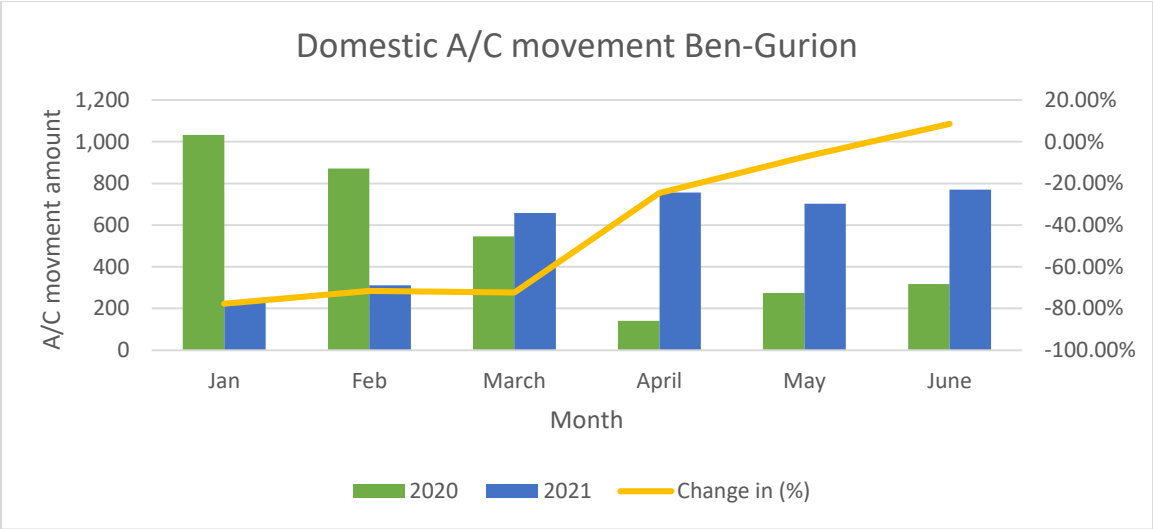


Figure 22 Domestic Aircrafts movement in total from LLBG [14]

Figure 23 represents the corresponding data to figure 22 but with the passengers transported within and not the number of flights themselves. The main difference is the slope chart 23 which is in a more or less constant increase from February 2021.

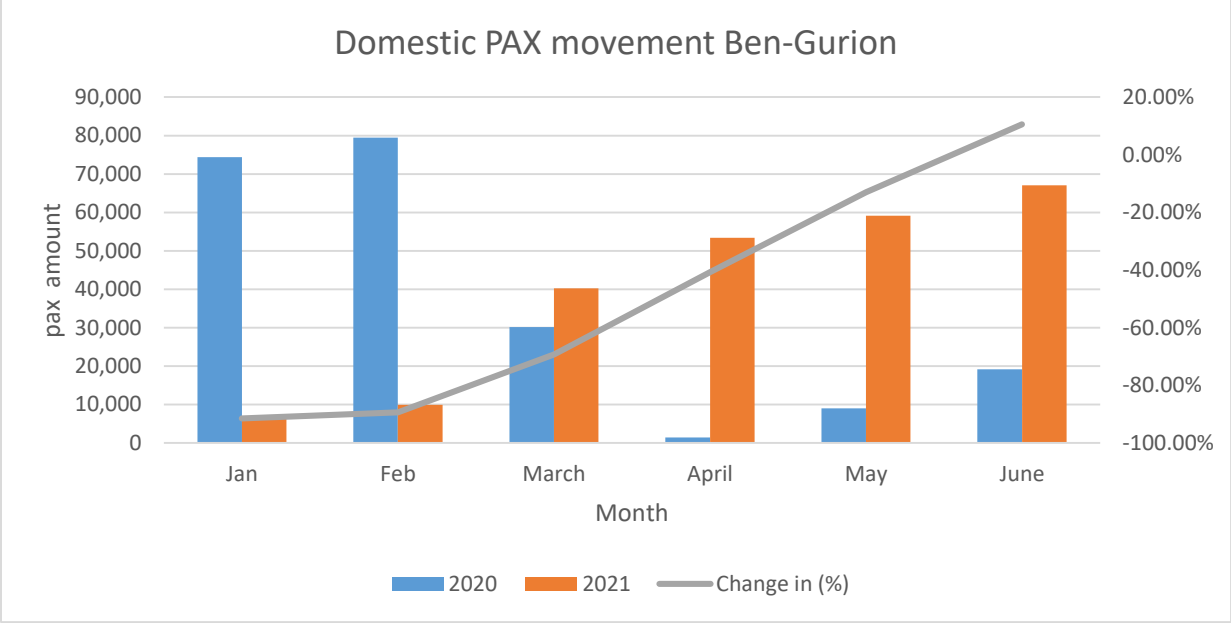


Figure 23 Domestic passengers transported in LLBG [14]

Figure 24 represents the domestic scheduled flights inside Israel. We can observe in 2020 a significant decrease due to the Covid-19 eruption and, from April slight increase. In 2021, there is only an increase. In Jan 2021 there were 123 a/c movements compare to June 2021 which had 663 a/c movements, an increase of 440 % (not accumulated but, comparison of month-to-month).

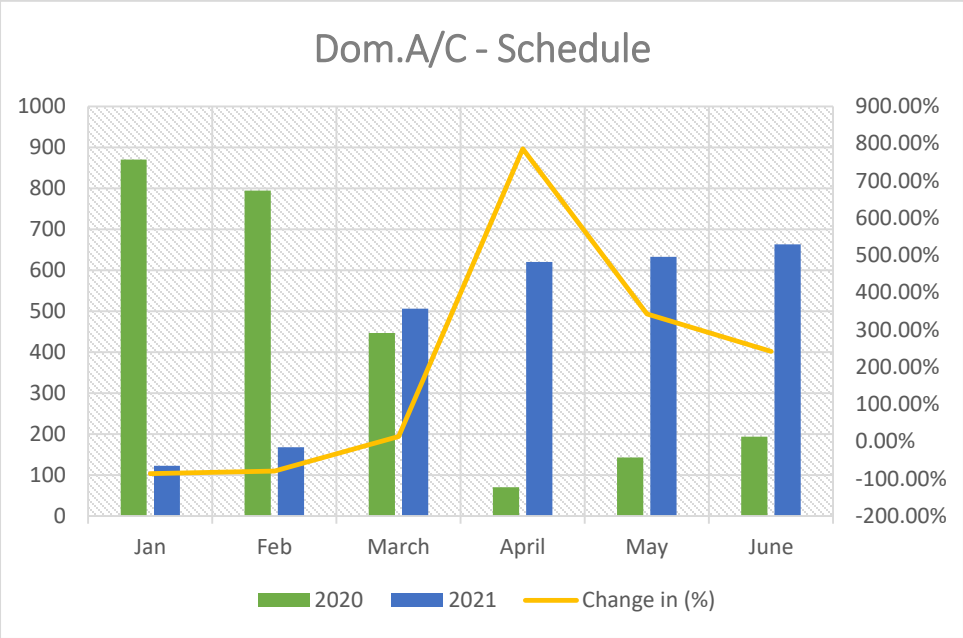


Figure 24 Domestic scheduled flights at LLBG [14]

Figure 25 represents the corresponding amount of passengers to the scheduled flights as shown in figure 24. As we can see, there is a downward trend from January 2020 where the most significant decreases were observed between February to March. Total of 79,435 passengers in February 2021 to 30,109 passengers in March 2021 and 1,412 passengers in April 2021. March 2021 was the first time after the winter period when 40,094 Passengers were moving inside Israel in the scheduled flights compare to the previous year there were 30,109 passengers, an increase of 33 %.

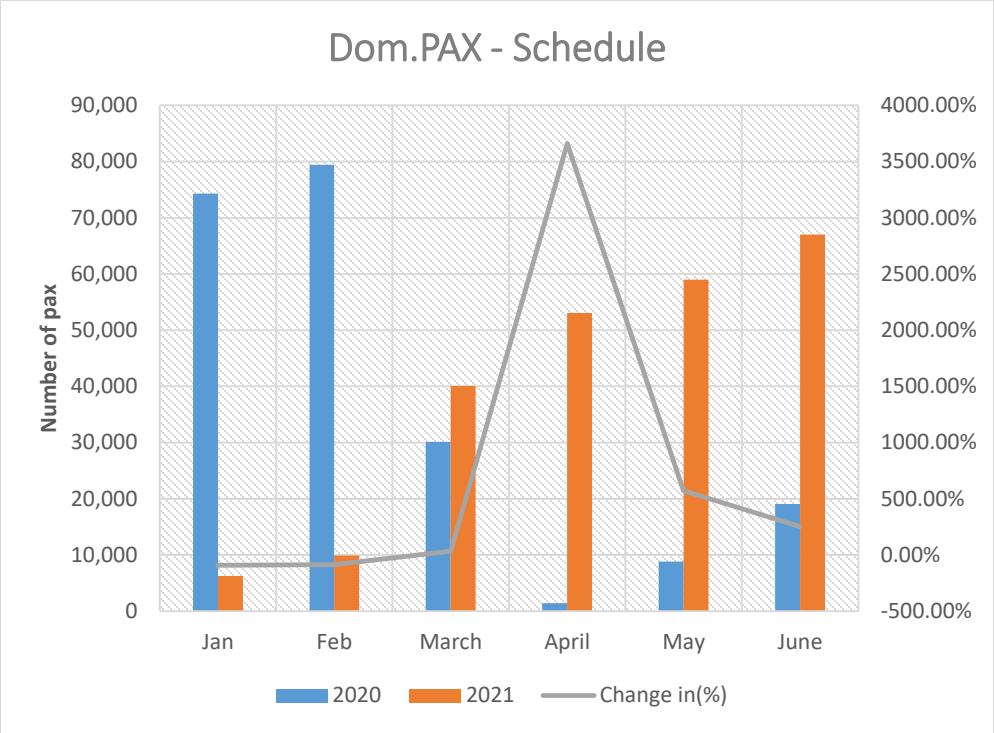


Figure 25 PAX amount on Domestic Charter flights from LLBG [14]

Figure 26 represents the domestic private flights that LLBG had during the crisis era. In 2020 we can see more or less the same pattern through all the a/c movement charts, a decrease in the number of flights from February and, an increase from March. In 2021, we can see an increase from January to March and then a decrease of 211 % until May. From May we can see an increase in private a/c movements.

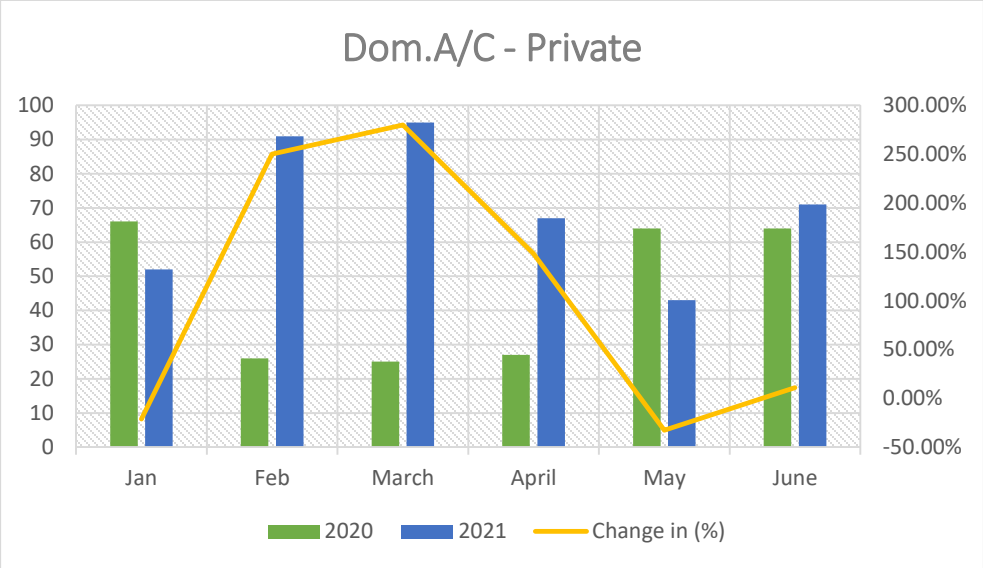


Figure 26 Domestic private flights from LLBG [25]

Figure 27 represents the corresponding passengers transported via domestic private flight. In April 2020 there was 0 passenger reported compare to April 2021 which noted 88 passengers. Due to the 0 number, a trend in percentage couldn't be presented because it can't be calculated mathematically (it is aiming to infinity).

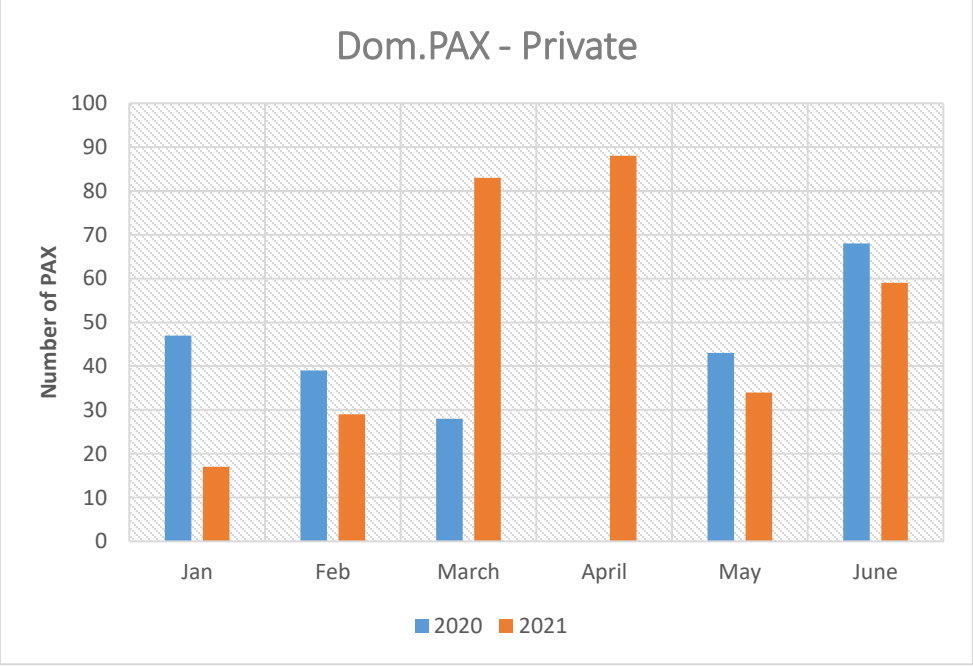


Figure 27 Number of passengers in domestic private flights [14]

Figure 28 represents domestic “other” a/c movements from LLBG. Flights that note as “Other” in the annual reports of Ben-Gurion are not specified. According to the database, April 21 was the busiest month of the “other” flights. There were 70 flights during this month with 236 passengers compared to the previous year which was 44 flights and it was written, zero passengers. We can see that 2020 had generally more “other” flights compare to 2021. It was noted at the 2020 year; 393 flights compare to 297 flights that were accumulated from Jan-June 2021.

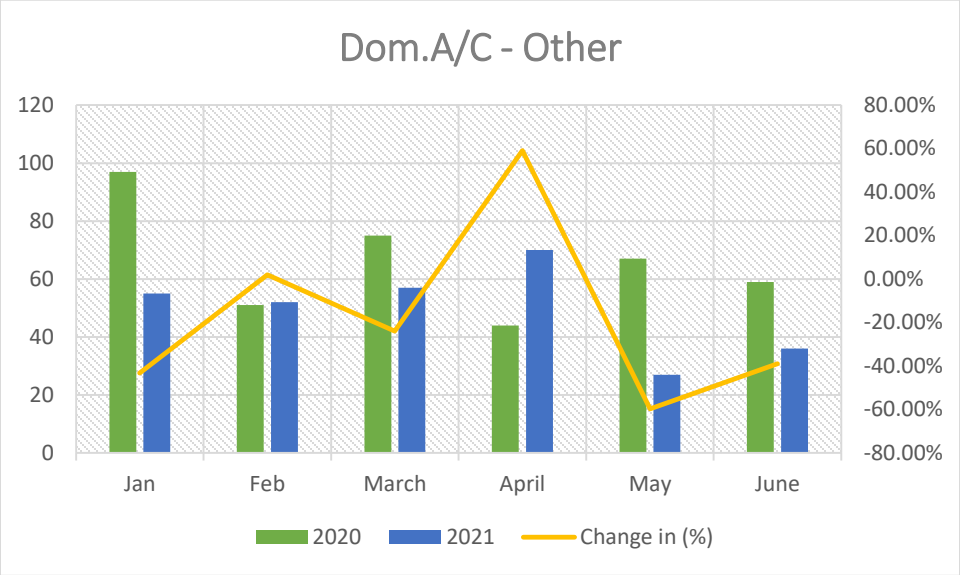


Figure 28 Domestic “other” flights from LLBG [14]

Figure 29 represents the domestic passenger transported in the “other” flight type. We can see there are not significant numbers but, generally, we can see a significant increase since March 2021 and another decrease from April to June. The reason for not presenting the rate of change is because there are 0 values and it can’t be calculated mathematically.

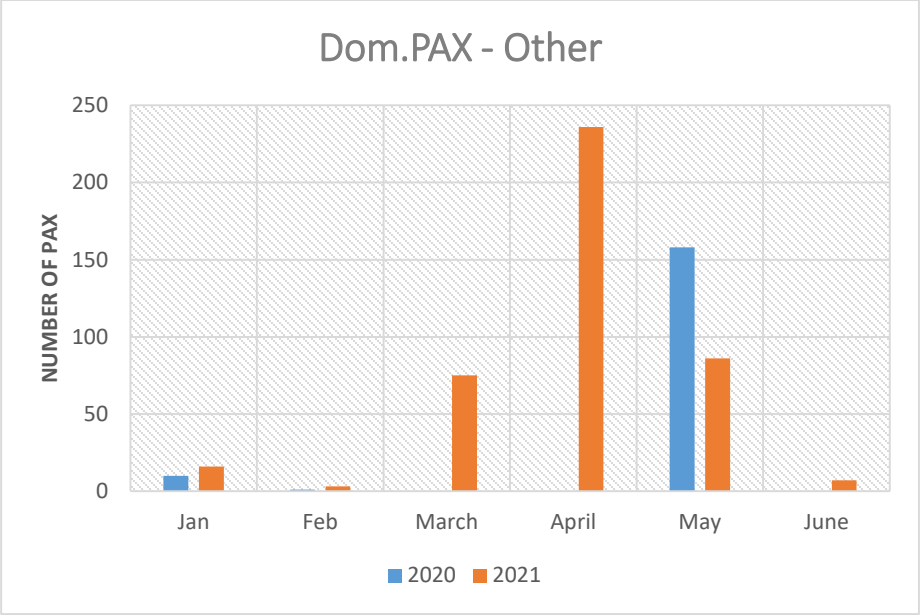


Figure 29 Domestic passengers transported in "other" flights from LLBG [14]

4.4 Vector of economic change at LLBG

Ben-Gurion airport income is managed by the Israeli Airport Authority. Due to freedom of information, IAA is obliged to publish its financial statements. Ben-Gurion's direct financial data is not available to the public. We were able to collect the revenue that LLBG had entered into the IAA during 2019 and 2020 only. Figure 30 is presenting this data. We can see a decrease in all types of revenues from 2019 to 2020. The report of 2021 will be published by the end of this year.

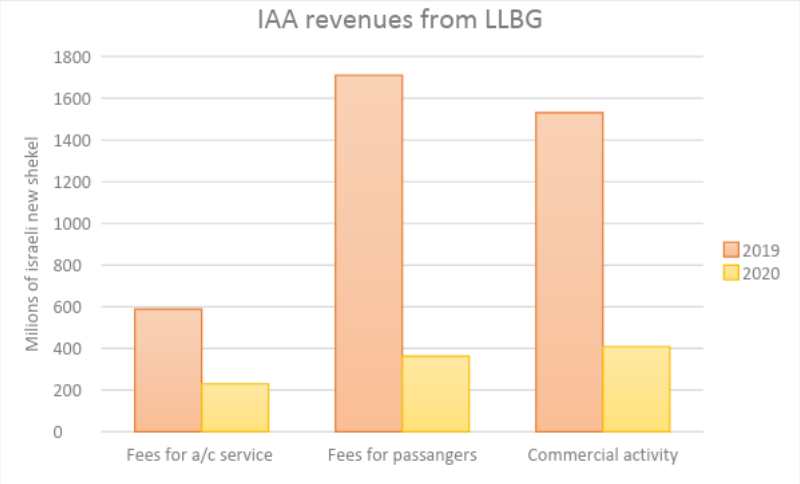


Figure 30 IAA revenues from LLBG [53]

The Authority's main source of revenue is from international operations at Ben-Gurion airport. The source of income is distributed to passengers, aircraft, cargo, parking, from the various commercial activities, and from the activities that the authority provides in the course of fulfilling its functions to the airport [53].

4.5 Vector of operational change at LLBG

Figure 31 represents the vector of change in international flights from 2010 until 2020 (data of 2021 can’t be summarized yet). We can see that Ben-Gurion has increased their

international activity through the years until 2020 which presents a Covid-19 impact on international flights

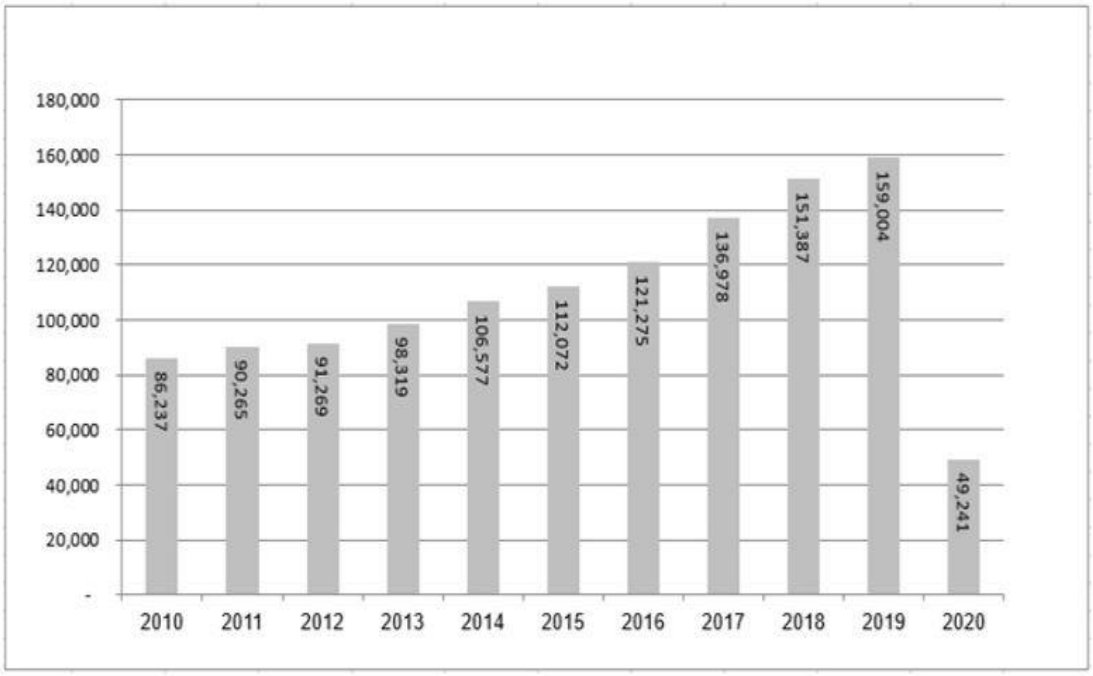


Figure 31 LLBG International a/c movements 2010-2020 [47]

Figure 31 represents the passenger traffic flow of LLBG through the years 2010-2020. We can see an exponential increase in international passenger traffic flow that is moving through LLBG airport. Then from 2019 to 2020 a significant drop of 438 %.

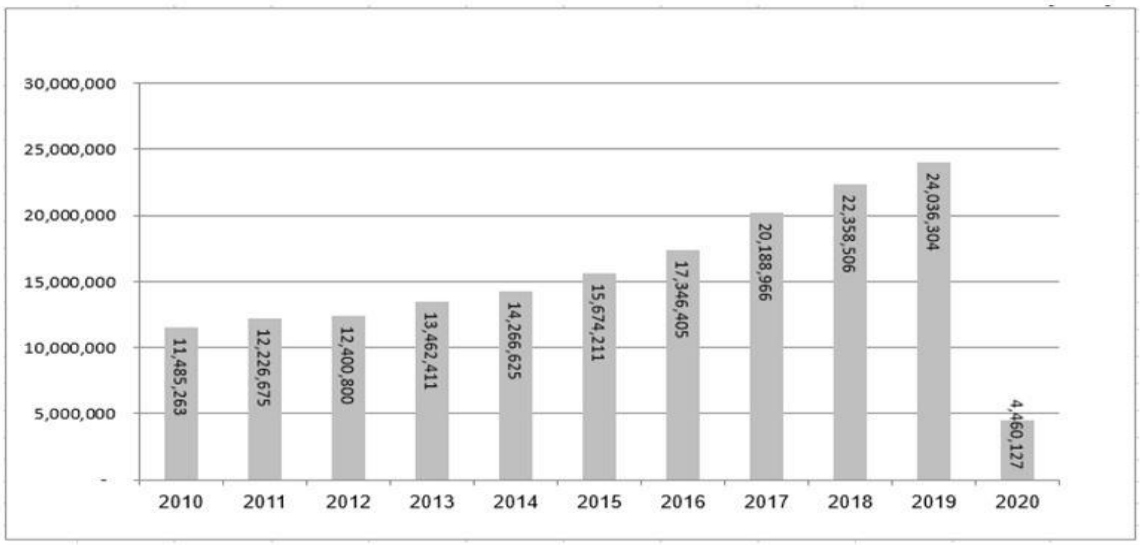


Figure 32 LLBG International passenger flow 2010-2020[47]

Figure 33 represents the domestic flights from 2010-2020. We can see the there was a decrease in these flights from 2011 until 2018 and then an increase but, since covid-19 erupted, there was a decrease from 2019 to 2020.

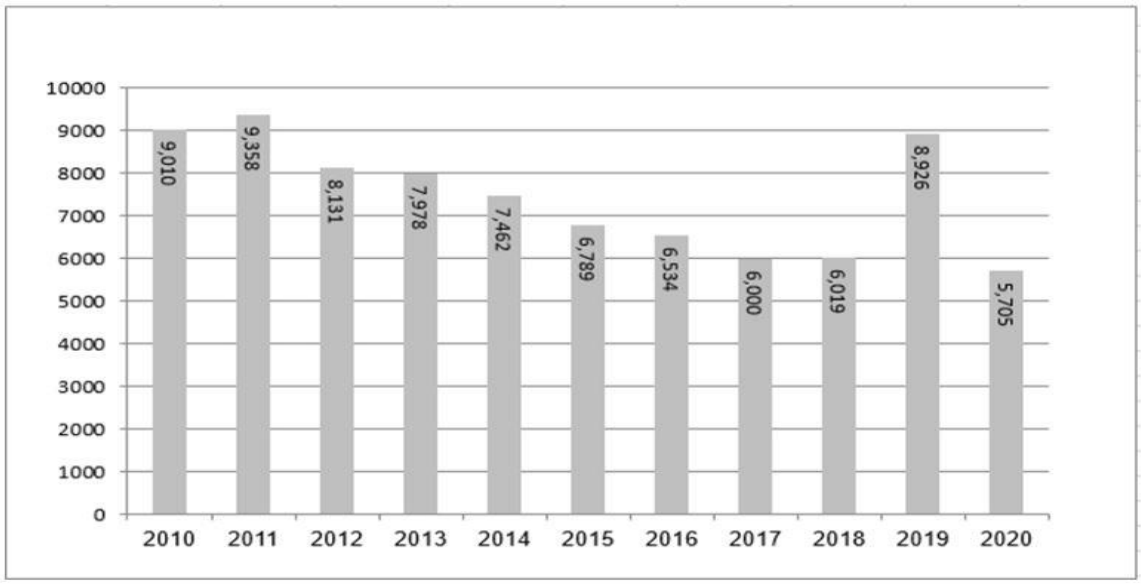


Figure 33 Domestic a/c movements 2010-2020 [47]

In figure 34 there is a representation of the passenger domestic flow. We can see the highest pick was in 2019 with 785,783 domestic passengers moving through LLBG airport.

Later on, in 2020 we can see the flow is reduced to 352,354 due to covid-19 impact on the aviation market. A decrease of 123 % from 2019 to 2020.

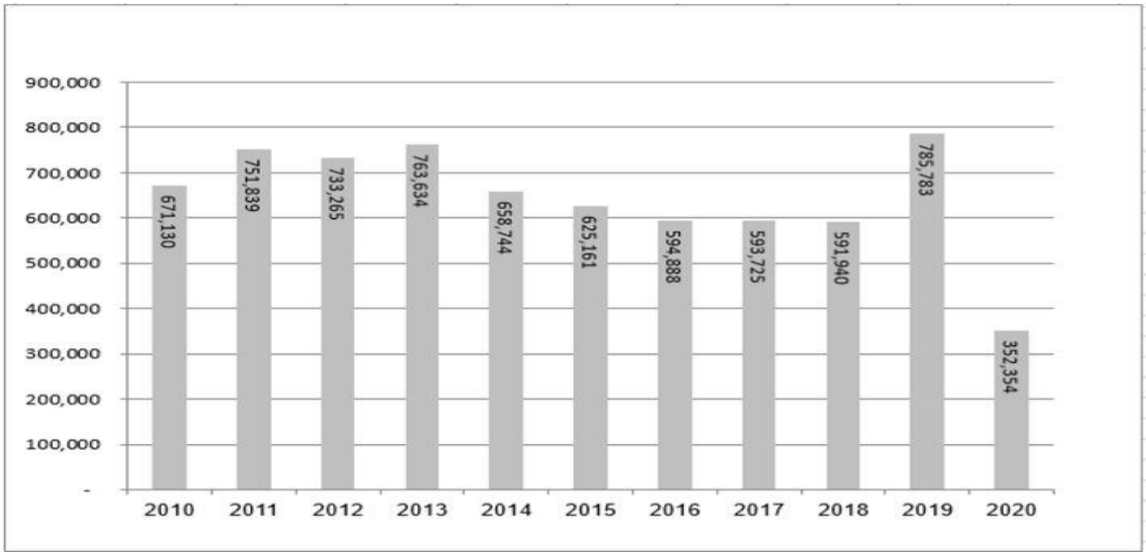


Figure 34 LLBG Domestic passenger flow 2010-2020 [47]

Figure 35 represents the vector of operation at LLBG by presenting the accumulated date for total a/c movements, total passenger flow, and the total amount of cargo in tons. The figure presents a comparison of total values of half-year (Jan-June) between these three years. We can see that in cargo there is a decrease from 2019 to 2020 and then an increase for 2021. As for passenger flow, there is a continuous downward trend. In 2019 10,845,608 passengers were moving in LLBG and, in 2021 1,617,515 passengers were moving in LLBG. As for a/c movements, we can see a continuous decrease from 2019-2021.

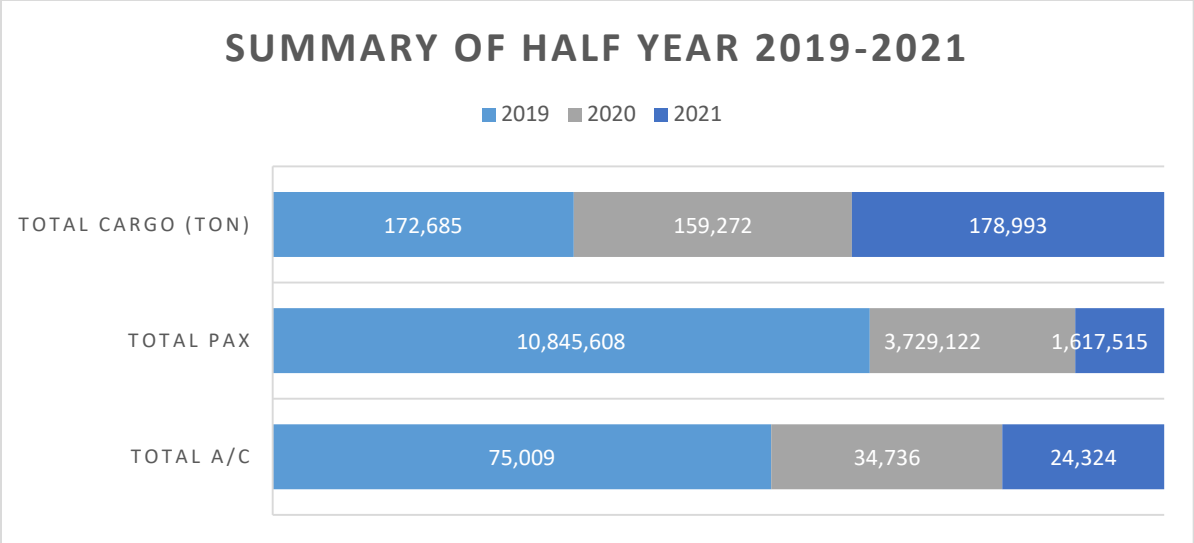


Figure 35 Operational change at LLBG half-yearly of 2019-2021 [14]

In Figure 36 we can see the operational vector of change divided into types of flights, types of passengers, and types of aircraft that carry cargo. We can see that generally, the domestic operation was less affected compare to the international trend. As for cargo, it is possible to observe an increase of values (tons) that embarked both on cargo a/c and charter a/c.

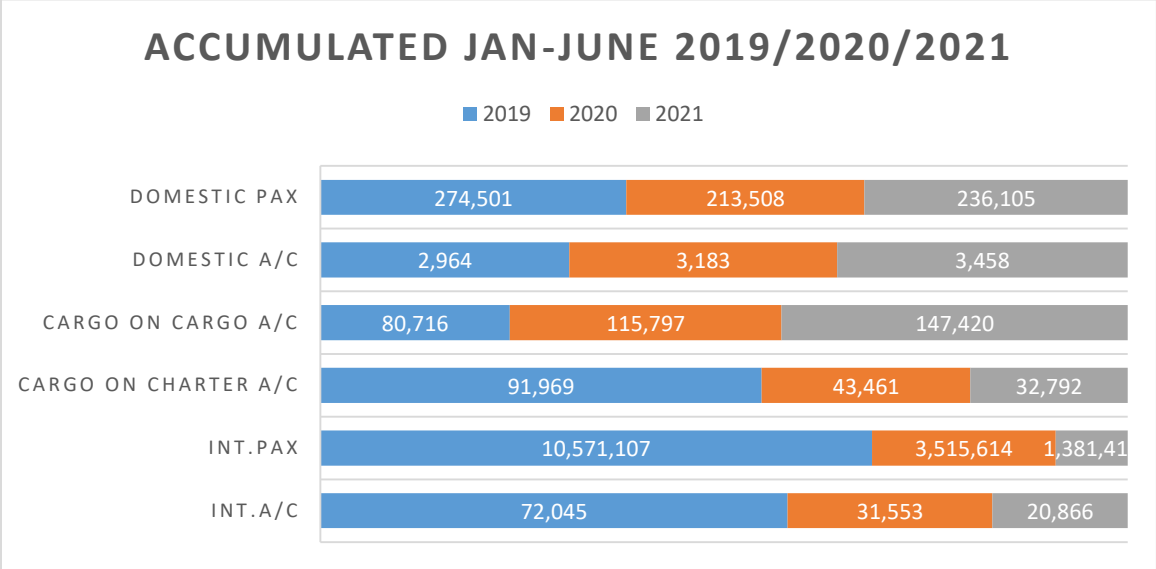


Figure 36 Operational change at LLBG half-yearly of 2019-2021 distributed by types [14]

4.5 Process change LLBG

Ben-Gurion airport has made a physical change of process to cooperate with the recovery path from covid-19. The process was concerning the terminals, aircraft and passengers.

Aircraft:

Figure 36 presents an Israeli charter a/c that were converted to cargo. As it was explained in "Info-Data" newspaper [49] (A newspaper presenting supplies technology and changes) was, that EL-AL (The national Israeli Airline) immediately when assistance was required to supply medications, masks, etc turned their Passenger airplanes into cargo airplanes by removing as many seats as possible from the cabin. Therefore, they could still work to support physically to health companies and financially to their revenue. As it was Sayed by E. Sela [49] *"The reduction of passenger activity caused many airlines to look for sources of income during the crisis and the airline began to operate the passenger planes in favor of cargo transportation. Some airlines such as El-Al have dismantled the passenger seats to increase the cargo capacity in the cabin. Operating a passenger plane for cargo transport only is significantly high and the cost price per kilogram is very high compared to the price per kilogram of combined air transport in a passenger plane and cargo, the economic viability will continue as long as prices continue to be expensive and there is demand".*

Figure 36 EL-AL applying the strategy of cargo on passenger a/c [48]

The Israeli government regulation determined that an operator of an airport shall appoint from among its employees an employee who will be responsible for carrying out the actions specified in the government regulations for aircraft handling. Some of the regulations concern [50]:

- Restrict access to the cockpit [52]
- Disinfection - an air operator shall regulate and implement a cleaning and disinfection program for the aircraft it operates which includes, the dates of the cleaning and disinfection operations, the cleaning and disinfecting materials, the items to be cleaned and disinfected, and how to perform the cleaning and disinfection operations [52]. An example of part of the program is presented in Table 4.

Table 4 Disinfection sheet [51]

AIRCRAFT COVID-19 DISINFECTION CONTROL SHEET

Aircraft Registration and nationality: _____

Date (dd/mm/yy)	Time (24hr – UTC)	Airport ICAO code)	Remarks	Disinfector name
Aircraft areas treated		Disinfectant material	Comments	Disinfector signature

[ ] Flight deck
[ ] Passenger cabin
[ ] Cargo compartment(s)
Other: _____

- Passengers allocation - The operator will seat the passengers at the maximum distances which can be under proper weight and balance conditions [50].

Passengers:

According to a decision by the government of Israel and following aviation regulations, all passengers departing from Israel, except recovering and vaccinated passengers, will be required to present a negative covid-19 test (PCR) before boarding the aircraft, taken no more than 72 hours before takeoff [51].

A decision by the government of Israel, as of 14.02.21, all passengers arriving in Israel, including recovering and vaccinated passengers, must present a negative covid-19 (PCR) test before boarding, take no more than 72 hours before takeoff [51]. In addition, arriving passengers will be required to have a covid-19 (PCR) test after landing in Israel, in a special complex at Ben-Gurion Airport.

As for June 2021, According to a decision by the Israeli government, Israeli citizens and residents, with few exceptions, will be prohibited from traveling to the following countries: Brazil, South Africa, India, Russia, Argentina, Mexico, Belarus, Uzbekistan, Spain, Kyrgyzstan, UK, Turkey, Cyprus, and Georgia [51].

A decision the two PCR tests will shorten the isolation. Starting from July 15, 2021. The first one will be upon arrival and, the second will be after seven days. When the second test result was published, the isolated person can go out from home isolation [51].

Airport employees:

As was mention in chapter 2.2.3, Most of the workers have been furloughed. The Airports Authority has 4,500 employees, of whom about 2,600 were furloughed, and about 220 retired [32].

Moreover, a change was done in some qualifications. As the regulation from the government released [50], they demanded that any International airport operator shall appoint from among its employees an employee who will be responsible for carrying out the actions specified in the government regulations for the management of Covid-19 inside the terminals.

In addition, they said no employee can work if was having symptoms or living with a person which is having home isolation [50].

4.6 Data Cleansing

The data was collected each month from Ben-Gurion's airport operational reports. The information was inserted into Microsoft Excel files. It included everything that could be monitored such as international and domestic flights distributed into charter, private, cargo and other. In addition, we collected the passenger and, we could classify them by type of flights as well. The information was collected until the last month in which there was publication before writing this thesis. This month was June 2021 therefore, we made a decision to make a comparison between the months of January to June over the years 2019, 2020 and 2021. Once we consolidated the data we were able to make graphical comparisons. Moreover, we had an advantage of native Hebrew speaker that could interview the public speaker of the Israeli Aviation Authority in order to perceive a better understanding about the Israeli airport market.

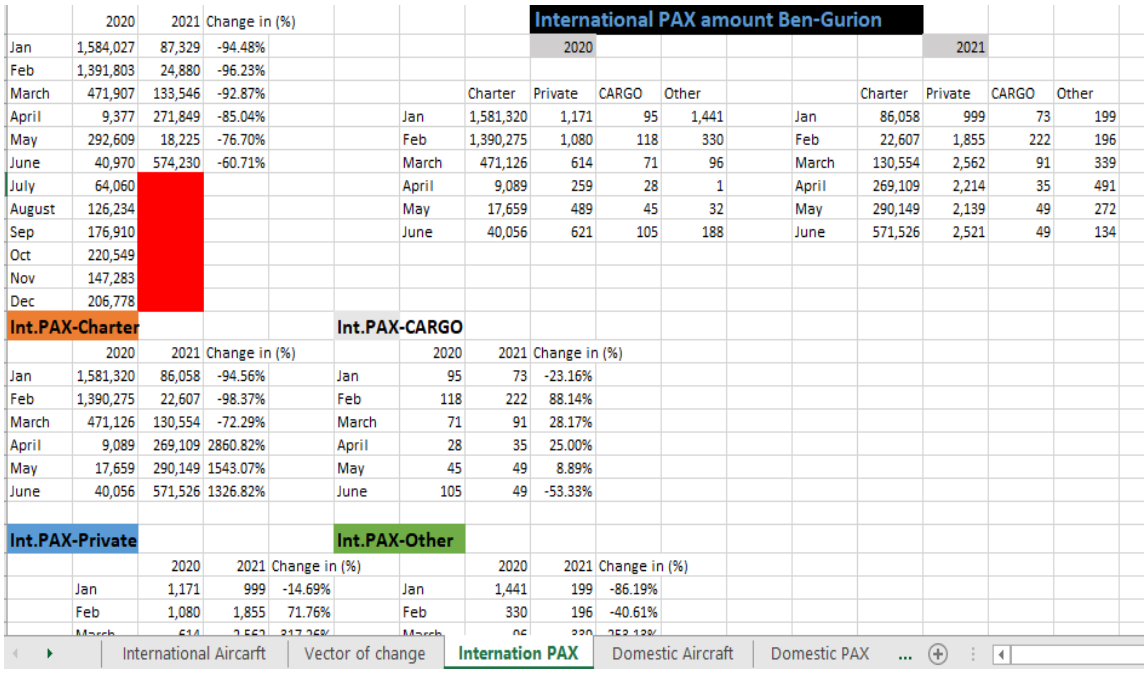
4.7 Analysis method

The analysis method was performed on the cleansed data. The main goal was to create a mathematical picture about the impact of covid-19 crisis on the Israeli international airport Ben-Gurion, in order to identify how the crisis affected the Israeli aviation market. We chose to use the ToolPack from Excel software because we found it simple and effective. The formula we have used to create a percentage change is:

$$Change\ in\ rate\ (\%) = (100\%)\frac{(X-Y)}{Y}$$

X - The values of 2021

Y - The values of 2020



	2020	2021	Change in (%)
Jan	1,584,027	87,329	-94.48%
Feb	1,391,803	24,880	-96.23%
March	471,907	133,546	-92.87%
April	9,377	271,849	-85.04%
May	292,609	18,225	-76.70%
June	40,970	574,230	-60.71%
July	64,060		
August	126,234		
Sep	176,910		
Oct	220,549		
Nov	147,283		
Dec	206,778		

International PAX amount Ben-Gurion

	2020				2021			
	Charter	Private	CARGO	Other	Charter	Private	CARGO	Other
Jan	1,581,320	1,171	95	1,441	86,058	999	73	199
Feb	1,390,275	1,080	118	330	22,607	1,855	222	196
March	471,126	614	71	96	130,554	2,562	91	339
April	9,089	259	28	1	269,109	2,214	35	491
May	17,659	489	45	32	290,149	2,139	49	272
June	40,056	621	105	188	571,526	2,521	49	134

Int.PAX-Charter

	2020	2021	Change in (%)
Jan	1,581,320	86,058	-94.56%
Feb	1,390,275	22,607	-98.37%
March	471,126	130,554	-72.29%
April	9,089	269,109	2860.82%
May	17,659	290,149	1543.07%
June	40,056	571,526	1326.82%

Int.PAX-CARGO

	2020	2021	Change in (%)
Jan	95	73	-23.16%
Feb	118	222	88.14%
March	71	91	28.17%
April	28	35	25.00%
May	45	49	8.89%
June	105	49	-53.33%

Int.PAX-Private

	2020	2021	Change in (%)
Jan	1,171	999	-14.69%
Feb	1,080	1,855	71.76%

Int.PAX-Other

	2020	2021	Change in (%)
Jan	1,441	199	-86.19%
Feb	330	196	-40.61%

International Aircarft | Vector of change | **Internation PAX** | Domestic Aircraft | Domestic PAX ...

Figure 37 Example of cleansed data of international passenger flow in LLBG

Using this data, comparative charts were made. We also created a summary of the data for 2021 which we compared two years back.

Discussion

As the main aim of this thesis was to investigate the change that took place in Israel's international airport market (Ben-Gurion) before and after the eruption of the covid-19 pandemic, the results of the research in this thesis can be counted as partially satisfactory. We were able to conduct operational change statistics but, as for the economical aspect, we were unable to perform market share calculations due to the limitation of available data. The only thing we were able to perform is, to present the vector of change of the airport revenue [53]. We have reached a result from which it is possible to compare the movements of the airplanes types and passenger's types that passed through Ben-Gurion pre and post covid-19 eruption for the half-year of 2019-2021 and, to draw charts from collected data [14].

As for the findings, we observed a decrease in the flow of all types of traffic, since February 2020, due to the covid-19 eruption which affected the Ben-Gurion airport market. As the revenues are mainly from international passenger traffic [53] but, on the other hand, the cargo movement increased due to an initiative of local airlines to cooperate with cargo companies [49]. From 2019 to 2020, the cargo amount in tons decreased by 8 % but then increased by 11 % in 2021. As for a/c movements, from 2019 to 2020 it decreased by 116 % but then decreased by only 43 % in 2021. The last accumulated data we gathered was the passenger flow which decreased from 2019 to 2020 by 191 %, and then from it again decreased but only by 131 %. All types of operations are presenting an improvement.

An unexpected result was to see how the domestic market recovered quickly. In June 2021 (post-Covid-19) there were already 3,458 domestic flights compare to June 2019 (pre-Covid-19) which noted 2,964 flights[14], The assumption is the "traffic light" strategy which created isolated vacation places in Israel, one of them is Eilat, which is near the second busiest airport in Israel [40].

Israel made a path of recovery from 2020 to 2021 in terms of airport traffic flow. The accumulated values are not back to as they were in 2019 yet but, due to the active attitude of vaccinations from the government side [40] and opening the opportunity for private companies to take advantage of the slow government and start a lab for testing departing and arrivals passengers with results of 4 hours [8, 14] we could see the improvement. The theory of operational statistics was reachable every month, therefore we could create a precise analysis in our software. The understanding of the airport

market was from previous research that explained the concept of the general market and, specifically the airport market. With this knowledge, we knew what to seek for our investigation.

In addition, it is possible to measure the change in rate for all types of movements that we found plus the economical revenue trend of Ben-Gurion. If one day, there will be publications of the airport financial data more than revenues, it would be possible to calculate the airport market share in Israel to other factories.

Conclusion

In this thesis, an investigation about the Israeli international airport named “Ben Gurion” was made, before and after the eruption of the covid-19 pandemic. The main statistics evaluation was in the operational data. In the beginning, research on general markets was done to understand the structure of the economic market, which is divided into product share, and geographical share.

In addition, an airport market structure was learned. The theory was taken from articles explaining the European airport market by examples of some European airports, and also, an example of Sydney, Australia airport as no articles were found explaining the market structure of Ben Gurion Airport. During this process of work, I learned how the eruption of the covid-19 affected the airport markets at the global level and what challenges were created for the market, for example, employee management, parking problems, lack of passenger traffic which is the main income to the market and more.

It was later explained how Ben-Gurion evolved from history, the geographical location that gives it a strategic advantage because it has no equal competitors due to the suitability of the operation to neighboring countries. Subsequently, as much operational and economic statistical information as possible was collected at the Israeli Ben Gurion airport, to create data analysis between the years 2019-2021. Since the most recent reports were until June 2021, the strategy was to compare only the first half of the selected years. After gathering all the information, a comparison was made with information such as international traffic flow and types of flights (charter, private cargo, and others), the same was done with the domestic traffic. Afterward, a summary of all the accumulated is combined into charts that show the vector of operational and economic change in LLBG. During the work, we identified that we lacked current status information and arranged a meeting with the Israel Airports Authority. There I interviewed the public speaker of the authority Mr. Lepler, who gave us a reflection on the processes that are being done inside and outside the airport these days. Finally, a discussion about the results was made with supportive articles.

In my opinion, the airport is progressing effectively in a recovery path. The decision to convert passenger planes to cargo impressed me and was creative. Regarding the publication of economic reports, the lack of information prevented from creating a deep economic analysis for example what are the revenues for cargo, charter, etc. but, a rough estimation could be that, as the number of international passengers decreases at Ben-Gurion, the amount of revenue decreases significantly as it was shown that passenger flow is the most powerful source of income. However, if the situation of Covid- 19 variants will grow, I assume other economical solutions for the airport should be made. According to Ben-Gurion's statistics, cargo flights are on the rise. Maybe, airports will be more geared for cargo operation rather than passengers but, this is, of course, only a hypothesis to the current situation.

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