

Impact Of Covid-19 On Operations And Cyber-Vulnerability Of Civil Aviation

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Abstract—The civil aviation industry which is susceptible to periodic crises in the form of financial crunch (M/s Jet Airways), Ebola virus, SARS, 9/11 terrorists attack etc. is reeling under various economic, operational and social pressures. Civil aviation by its nature is a capital intensive industry accounting for around 35% to 40% fixed cost in the form of aircraft lease rents, taxes, employee's salary, administrative costs etc. Majority of airlines, despite employing all cost cutting measures, are not even able to make a break-even. Novel Coronavirus (Covid-19) pandemic has impacted the civil aviation industry very hard. Besides, financial and operational issues, the aviation industry has seen a rise in cyber-attacks, thereby raising the concerns of industry leaders, regulators, ANSPs and other stakeholders to take necessary steps including raising the investment in cyber-security. During Covid-19 pandemic, several vulnerabilities in aviation sector have come to the forefront. The airlines along with the airports have served as portals for novel corona virus leading to its spread worldwide. Airport operators have been compelled to embrace stricter screening and health checks at airports and airlines are constrained to reduce seating capacity in aircrafts i.e. Available Seat Kilometers (ASK). The bailout packages from Government and loans from financial institutions have been announced. There has been tremendous increase in cyber-attacks on the civil aviation critical Infrastructure during Covid-19 pandemic, including the Air India data breach. This paper seeks to review and analyze the literature available on civil aviation operations and cyber-security during Covid-19 pandemic.

Keywords—*cyber-vulnerability, civil aviation, covid-19, operations*

I. INTRODUCTION

The first case of novel coronavirus was reported in December 2019 from People's Republic of China's Wuhan city. On 11 March, 2020 World Health Organization (WHO) designated novel corona virus as global pandemic. Since its appearance in China in December 2019, novel coronavirus had spread from local to global in no time. The airlines operating in and out of China, though unknowingly, played as a catalyst in the spread of corona virus from mainland China to almost every corner of the world through this fastest mode of transportation. The number of persons infected with corona virus throughout the world has crossed 200 million mark with death toll over 4.26 million. The novel corona virus has infected 220 countries and territories throughout the world. Hardly any country or territory is left which is not affected by novel coronavirus. India is also deeply affected by the corona virus pandemic with over 31.8 million cases and over 0.426 million deaths reported till 4th August 2021. Corona virus pandemic, popularly known as Covid-19, has impacted the lives in every household, every industry and

every service sector. Aviation sector is not untouched from the impact of Covid-19. In fact, Aviation sector has been deeply affected. The flights stands cancelled for months, employees have either been retrenched or their salary has been reduced. The ancillary industry associated with the aviation too got impacted. Several airlines are on the verge of bankruptcy. The airports and Air Navigation Service Providers (ANSPs) are reeling under economic pressure. Both the aeronautical and non-aeronautical revenue of the airports and ANSPs have taken a catastrophic nosedive. Besides, the operational impact, the cyber-attacks have also increased many folds during novel coronavirus pandemic as majority of work has been shifted from offline to online. The work is dependent on data, internet and technology thus giving hackers more opportunity to commit cybercrime. Aviation industry has seen rise in the cyber-attacks on their critical infrastructure through ransom ware, phishing, hacking etc.

II. LITERATURE REVIEW

The novel coronavirus (Covid-19) pandemic has influenced economies of the countries throughout the world due to its widespread. The COVID-19 is causing different externalities, both positive and negative. The positive externalities have manifested in the sudden reduction of pollution level due to the closure of schools, college, shops, malls, industries and reduction in various modes transportation owing to partial or complete lockdown. The negative externalities manifested in the form of lock-down and panic buying etc. Lockdown results in "no production" of goods or no supply of services, loss of job or reduction in salary of employees. The aviation industry is not untouched with these negative externalities of Covid-19 Pandemic. During Covid-19 pandemic, panic purchasing can shoot up cost of essential commodities and lead to its scarcity. Tourism, which to a great extent is dependent on aviation, especially the international tourism, is one of the world's biggest businesses and one of economic activity's fastest growing industries. Aviation industry and tourism goes hand in hand and one supplants the other. India, which earns the laurels of being the third largest domestic civil aviation market in the world, boosts the tourism to a great extent.

The aviation industry has a characteristic feature of very high operating cost owing to high cost of Aviation Turbine Fuel (ATF), cut throat competitive price, high cost owing to expenditure on cockpit and cabin crew, higher taxes etc. The airlines' price dynamic for operations has to an extent changed by the entry of low cost carriers (LCCs). The air transportation operating cost structure consists of a major chunk in the Aviation turbine Fuel (ATF), followed by

rentals of leased aircrafts and other operational costs like flight equipment, maintenance, repair & overhaul (MROs), route navigation and facilitation charges (RNFC), landing charges, parking charges etc. There is certain fixed overhead expenditure like salaries of cockpit and cabin crew, taxation, aircraft lease rental and interest etc., which airline has to bear even if there are nil operating flights. This fixed expenditure keeps the airlines trying hard for managing cash flows.

III. RESEARCH METHODOLOGY

This study is an exploratory research design since there is cause and effect relation that seek to assess Covid-19's impact on operations and cyber-security issues in civil aviation industry. This article relies on secondary data derived from prior scientific articles and the data available on websites, newspapers (e-papers) and various government agencies' data.

IV. COVID-19's IMPACT ON OPERATIONS OF CIVIL AVIATION

A. Airlines

The operational-commercial dynamics of an airline primarily comprises of

- ASK-Available Seat Kilometers, which signifies the capacity of airline,
- PLF-Passenger Load Factor, which means the capacity utilized by airline,
- RPK-Revenue Per Kilometer, which signifies the income earned by airline and
- BELF-"Break-Even Load Factor", which signifies "operating cost"/Available Seat Kilometer (ASK) on "operating revenue"/ Revenue per Kilometer (RPK).

Prior to Covid-19 pandemic in the financial year 2018-19, out of 16 scheduled domestic operator, only five airlines in India viz. Air India express, Go Air, Indigo, Spice jet and Zoom Air were operating above breakeven load factor (BELF) with the safety margins ranging between 3.4% to 11.5%, and the remaining scheduled domestic airlines were in red. The outbreak of Covid-19 pandemic has fuelled more financial loss to the airlines. The Government of India vide CircularNo. 4/1/2020-IR dated 19 March 2020 has suspended the operations of all Indian and international airlines engaged in scheduled international air transportation with effect from 0131 IST (Indian Standard Time) of 23 March 2020. This suspension of international scheduled flights is being continuously extended and is in place till 30 August 2021, spanning over a period of 16 long months. During the period, Government of India had allowed scheduled flights on select international routes on a case-to-case basis. The Government of India permitted flight operations of international flights under the "Vande Bharat Mission" with effect from 7 May 2020 for the evacuation of stranded passengers, especially students in various countries. As per data available from Government of India, Air India Ltd and its subsidiary Air India Express, under Vande Bharat Mission, had flown a total 7856 inbound flights carrying 1263894 passengers and 7866 outbound flights carrying 865192 passengers, in eight phases till 01 Feb 2021. More

flights under phase nine and ten have also taken place. Government of India had also entered into bilateral agreements with select countries with effect from July 2020 and these agreements were known to be "air bubble" agreements. The procedure under such an "air bubble" bilateral agreement is that "special international flights can be operated by the country's airlines between their territories". India, till date has entered into special bilateral "air bubble" agreements with 28 countries i.e. Bangladesh, Bhutan, Bahrain, Iraq, Japan, Kuwait, Maldives, Nepal, Oman, Qatar, United Arab Emirates (UAE), Afghanistan and Uzbekistan in Asia; Ethiopia, Kenya, Nigeria, Rwanda, Seychelles and Tanzania in Africa; France, Germany, Netherlands, Ukraine and United Kingdom (UK) in Europe; Canada and United States of America (USA) in North America.

The scheduled domestic airlines' operations were suspended vide Government of India order AV.11011/1/2020-US (AG) Office-MOCA dated 23 March 2020 and with effect from 0001 hrs. IST of 25 March 2020. This suspension of scheduled domestic operations was lifted after a period of two months in a calibrated manner with effect from 25 June 2020. The scheduled domestic flights started operating initially with 33% Available Seat Kilometers (ASK) (seating capacity) with Social distancing norms, face masks and Covid appropriate behaviour in place. The capacity was raised to 50% of ASK and subsequently to 65% and finally the airlines could fly with the capacity of 80% by December 2020. The capacity was again capped to 50% of PSK amid 2nd wave of Covid-19 Pandemic. Government of India on 28 May 2021 again relaxed and increased the capping to 65% and the airlines are at present operating under this 65% capping. Morgan Stanley Research in its report on aviation sector said that Indian aviation industry will rebound to 80% of pre-Covid capacity during October-December 2021 period as about 9.2 crore domestic passengers are expected to take to the skies during financial year (FY 2021-22) and 14.4 crore during FY 2022-23.

With the pandemic, the already tighter situation of the airlines got worst and they are struggling for their survival. Many airlines like indigo and spice jet have reduced salaries of their employees by up to 25% and retrenched upto 10% of the employees. The airlines are not only struggling for breakeven but to sustain their operations and avoid bankruptcy. The health of airlines can be better adjudged from the fact that the air passengers during the Covid-19 pandemic, following the restrictions, has drastically reduced to such an extent that a Boeing (B-777) airplane of Emirates Airlines with a capacity of 350 passengers took off from Mumbai Airport with just one passenger on board. According to the ANI, the plane was entirely vacant due to UAE's restrictions on the Indian passengers amid the rising cases of the new variant. Another dismal situation was that the airlines were not in a position to refund the amount to the passengers who either booked the flights during lockdown or whose flights were cancelled. Instead, the airlines were providing credit shell for one year. Pravasi Legal Cell, an NGO filed petition in Hon'ble Supreme Court of India for seeking directions for airlines to refund money as non-payment of money for the cancelled tickets, violates Ministry of Civil Aviation's Office Memorandum No AV-29011/27/2020-DT dated 16 April 2020 and DGCA's Civil

Aviation requirement (CAR) of 2008 on the subject. The bench consisting of Hon'ble Justices S K Kaul, M R Shah and Ashok Bhushan issued notices to Ministry of Civil Aviation and DGCA asked to find out ways for full refund of amount against cancelled tickets.

Table 1: Scheduled Aircraft movements in 2019 and 2020 (June)
(Source: DGCA Handbook 2019-20)

S.No	Scheduled Aircraft Movements (in Lakhs)	2019	% change from previous year	2020	% change from previous year
1.	Domestic	10.5	14.4	10.5	0.0
2.	International	3.9	3.2	3.6	-7.7

Directorate General of Civil Aviation's (DGCA's) handbook 2019-20, indicates the number of Scheduled International aircraft movements registers a decline of 7.7% in 2020 as compared to 2019. Similarly, the comparison of international passengers travelled in 2020 (till September) vis'-a-vis' in 2019 during the same period indicates a sharp decline in passengers.

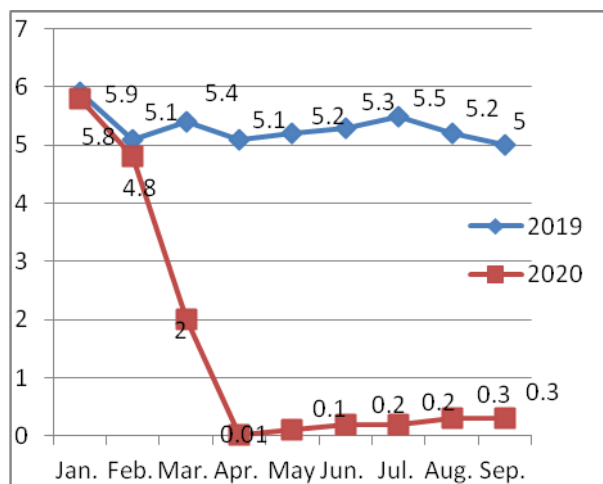


Table 2: International Passenger (in million) in 2019 and 2020 (till Sept.)
(Source: DGCA Handbook 2019-20)

The situation of air traffic and passengers travelling has taken a nosedive throughout the world, though varying at different time at different places in the Covid-19 pandemic. Recent data from Statistics Finland has revealed that the arriving passengers to Finland in June 2021 have reduced to 32067, a decline of 90.4 % as compared to the figures of June 2019. Furthermore, Airports of Thailand reported passengers in June 2021 as 688211, indicating a decline of 93.5% as compared to passengers in June 2019. This includes 607844 domestic passengers (-85.9%) and 80367 international passengers, a decline of 98.7% as compared to June 2019 figures. The aircraft movements of 11593 also showed a decline of 83.5% in June 2021 as compared to June 2019 figures. This includes domestic aircraft movements at 5865 flights (decline of 81.2%) and the international aircraft movements at 5728 flights, showing a decline of 85.3 % as compared to June 2019 figures.

IATA's Director General Willie Walsh said "Indian government should relook at their decision to ban scheduled international flights and said things have improved. The decision to ban international flights was applicable to last year when situation was worse but with all the regulations in place and safety being paramount consideration for airlines, center should allow scheduled international flights. The regulations on capacity utilization as well as fare caps on domestic aviation sector is slowing down the industry's recovery." Walsh said, India's aviation market will recover much faster, if these regulations are removed. Previous data points showed that India's domestic air passenger volume growth as measured in revenue passenger kilometers (RPKs) has plunged by 42% in April 2021 vis'-a-vis' April 2019. The country's domestic available passenger capacity, as measured in available seat kilometers (ASKs) has fallen by over 15 per cent. Besides, this IATA has predicted that India's aviation market will recover to the 2019 levels by 2024. According to recent data and estimates of IATA, airlines worldwide had lost USD 126.4 billion net profits in 2020. Region wise details are depicted in Table 3. The estimates of IATA are relied upon "region of airline registration" while the estimates of International Civil Aviation Organization (ICAO) upon "all traffic from states in each region" for the regional breakdown.

Region of airline registration	Revenue Passenger Kilometres (RPKs) - international and domestic (vs 2019)		Net profit (USD billion)	
	2020	2021	2020	2021
Africa	-68.9%	-64.5%	-2.0	-1.7
Asia/Pacific	-62.0%	-57.8%	-35.0	-10.5
Europe	-69.9%	-66.3%	-34.5	-22.2
Latin America/Caribbean	-62.1%	-48.9%	-11.9	-4.0
Middle East	-72.1%	-67.6%	-7.9	-4.2
North America	-65.2%	-41.5%	-35.1	-5.0
Total	-65.9%	-57.0%	-126.4	-47.7

Table 3: Airline's Net Profit in USD in 2020 and estimates in 2021
(Source: IATA)

According to India Brand Equity Foundation (IBEF), the passengers flown in India FY 2020-21 were 115.37 million. Both the Domestic and international passengers declined at a CAGR of -9.02% and -28.64%, respectively in FY2020-21 as compared from FY2015-16 due to Novel Corona Pandemic and its associated restrictions. This figure as compared to FY2019-20 was 105.2 million and 10.1 million respectively, thus showing a decline of 61.7% year on year (YoY) and 84.8% YoY respectively.

B. Airports and Air Navigation Service Providers (ANSPs)

Airport Council International (ACI) in an analysis of passenger data of 12 airports in 2020 in Asia-pacific region which includes Delhi's IGI Airport, indicates towards a decline in air passenger traffic to a drastic 80% when compared to 2019 level and further indicates a decline of over 1.5 billion passengers in an event of prolonged outbreak of Covid-19. Airports, after lockdown, will start with a zero-passenger level and may see ~20-25% passengers as compared to the normal level, owing to anticipated cautionary behaviour towards air travel. Loss of traffic

impacts both the prime revenue streams— aeronautical and non-aeronautical—for airports. Non-aeronautical concessionaires, airlines and other airport stakeholders have already started asking for relief measures from airport owners, which, in turn, impacts airport operators’ revenues. ACI estimates put the loss for the first-quarter for airports in Asia-Pacific approximately \$5.6 billion and loss for FY 2020 at \$23.9 billion.

Center for Asia Pacific Aviation (CAPA) estimates the first-quarter loss for airports in India to be around \$1.5 billion. As per the latest data released by ACI through ACI advisory bulletin dated 25 March 2021, the airports worldwide has lost a total revenue (both aeronautical and non-aeronautical) of USD 124.820 billion (a decline of 66.3%) in 2020 vis’-a-vis’ 2019. The airports worldwide are estimated to make a loss of revenue (both aeronautical and non-aeronautical) of USD 94.106 billion (a decline of 50%) in 2021 as compared to 2019.

Region	Passenger number - international and domestic				Airport revenue - aeronautical and non-aeronautical			
	million and % change from "business as usual" baseline scenario				USD billion and % change from "business as usual" baseline scenario			
	2020		2021		2020		2021	
Africa	-165	-67.6%	-147	-55.8%	-2.670	-67.6%	-2.378	-55.8%
Asia/Pacific	-2,148	-61.3%	-1,474	-40.3%	-36.206	-61.3%	-24.837	-40.3%
Europe	-1,764	-70.5%	-1,490	-58.1%	-44.368	-70.5%	-37.486	-58.1%
Latin America/Caribbean	-433	-61.1%	-360	-48.8%	-7.090	-61.1%	-5.889	-48.8%
Middle East	-304	-70.5%	-267	-58.9%	-10.762	-70.5%	-9.444	-58.9%
North America	-1,307	-62.5%	-936	-43.5%	-23.723	-67.0%	-14.071	-47.2%
Total	-6,121	-64.6%	-4,673	-47.5%	-124.820	-66.3%	-94.106	-50.0%

Table 4: Airport’s Revenue (Aeronautical and Non-Aeronautical) 2020 and estimates 2021 (Source: ACI)

EUROCONTROL has reported a revenue loss of € 140 billion for Air Navigation Service Providers (ANSPs), Airlines and Airports in 2020. EUROCONTROL has also anticipated 21% to 50% lower flights in Europe in 2021 as compared to 2019.

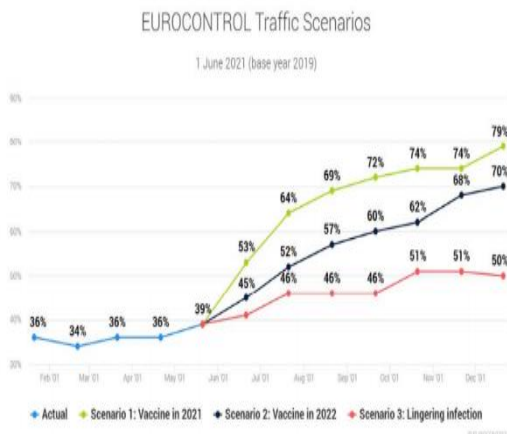


Table 5: EUROCONTROL Traffic Scenario for 2021 (Source: EUROCONTROL)

V. IMPACT OF COVID-19 ON CYBER-VULNERABILITY OF CIVIL AVIATION

Cyber security is to protect the integrity of electronic data and to prevent its unauthorized use. It encompasses not only technical measures, but also requires a regulatory framework. In aviation three principally different areas vulnerable to cyber interference and attacks can be distinguished, which merit different technical and legal measures for cyber security:

Non-safety relevant ground infrastructure with an impact on the regularity and efficiency of air traffic, e.g. airline booking systems and airport luggage transport systems,

Safety relevant aviation infrastructure, e.g. Air Traffic Management, Communication, Navigation and Surveillance, and Flight controls and navigation of manned and remotely-piloted aircraft.

During Covid-19 pandemic, rising dependence on digital technology, internet etc. has increased cybercrimes many folds. In India, the number of cyber-attacks has increased by 20 times (2,000%) during the novel coronavirus pandemic, said experts at Pursuit 2021 - a cyber-security event. "In India, almost every sector has been breached because they all are inter-connected. During the pandemic, the number of breaches increased by 2,000 per cent because we were using ASL or DSL from home. ASL, DSL, fiber, nothing is secured, this whole scenario reflects that your sensitive information is at risk and is being used for a variety of purposes, causing financial fraud, causing a threat to national security," Gulshan Rai, India's first Cyber-security Coordinator said. National Cybercrime Reporting Portal (NCRP) under Ministry of Home Affairs (MHA) has received 0.4 million complaints including financial frauds. In a written reply to Rajya Sabha, Parliament of India, Hon'ble Minister of State for Electronics and IT informed that a total of 454, 472, 280 and 138 phishing attacks were observed during 2018, 2019, 2020 and 2021 (till June) by Indian Computer Emergency Response Team (Cert-In).

Besides, travel restrictions, steep decline in air traffic and air passengers, the Covid-19 pandemic has impacted our work life leading to an increased dependence on electronic gadgets, technology and internet to new record levels. Hackers and cyber criminals are using this urgent and uncertain situation of Covid-19 pandemic as an opportunity to hack the sophisticated aviation systems. They use phishing attacks, cyber espionage to steal vaccine research and pharming attacks directing airline ticket holders to fake refund sites. Airports and airlines played a vital role in Covid-19 vaccine distribution supply chain. Thus airports have opened up new round the clock high-tech cyber-security operation center to protect airports, facilitations, airlines from cyber-attacks, a recent addition is Prague's Havel Airport.

Airport Council International (ACI) conducted an airport cyber-security Covid-19 survey for assessing the impact of

Covid-19 pandemic on airport cyber-security. The respondents managing over 100 airports worldwide (Asia-pacific, Africa, Europe, Latin and North America) participated in the survey. Over 61.5% of the respondents confirmed to have had cyber-attacks on their airports and 54.1 respondents admitted budget reduction in Corona-19 Pandemic as biggest challenge. Further, over 80% respondents had updated their remote working policies in response to excessive remote working and their over dependence on gadgets and technology.

The Financial Stability Board (FSB), London, a financial regulator for G20 group of nations, said, remote working due Covid-19 enabled lockdown has opened new horizons for cyber-attacks. Cyber-attacks in the form of phishing, malware and ransom ware grew over 40 times, from February 2020 to April 2021, from 5,000 per week to over 200,000 per week. During April 2021, nearly 450 email addresses and passwords leaked from World Health Organisation (WHO) and thousands of other individuals' information associated with the coronavirus response teams became available worldwide. Their details were leaked on the public platform and the case is still under investigation. In the past few months, there has been a growing fear of cyber-attacks on civil aviation critical infrastructure. The attack on civil aviation can come from anywhere and in many forms. A recent example is cyber-attack of 24 February 2021 on Societe Internationale de Telecommunications Aeronautiques (SITA), an industry owned company that provides IT services to airports and a serves approximately 400 airlines worldwide. This February breach has impacted the SITA Passenger Server System of several airlines which include among others Air India (AI), Cathay Pacific (CX), Jeju Air (7C), Malaysia Airlines (MH), Singapore Airlines (SQ), Air New Zealand (NZ), Finn Air (AY), Lufthansa (LH) and many more. In this major cyber-attack, personal data of 4.5 million Air India passengers registered over a period of 10 years has been hacked. The hacked personal data includes Passenger's frequent flyer details, credit card details, name, date of birth, passport details, contact information etc. In a national privacy test conducted recently by NordVPN, a global VPN service provider, India stood at 19th rank out of 21 scoring just 51.2 points out of 100. The countries that topped the chart came from Europe with Germany (71.2 points out of 100), Netherlands (69.5/100) and Switzerland (68.9/100) in the top three spots followed by United States of America (68.5/100). Indian respondents were found to be more reckless in respect of online bargains and social media use.

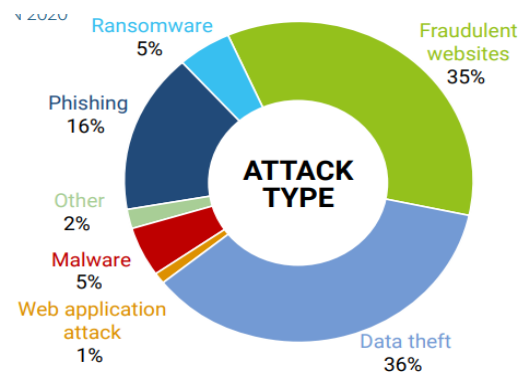
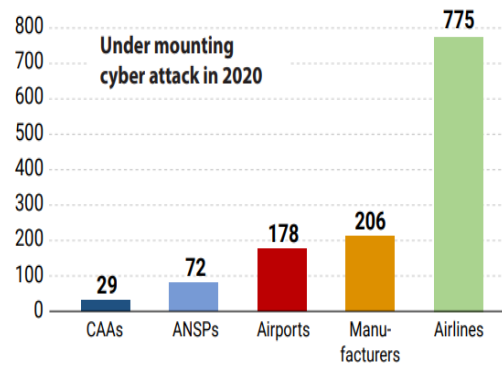


Figure 1: Cyber-attacks in 2020

Figure 2: Types of Cyber-attacks (Source: EUROCONTROL)

Cyber-attacks in the European Aviation industry during the Covid-19 pandemic have increased by over five times i.e. 530% in 2020 as compared to 2019. The breakdown of threats indicates a major portion of threats is occupied by data theft (36%) followed by fraudulent websites (35%), followed by Phishing. Though the cyber-attacks through ransom ware is just 5% but it has a higher potential and effect. The sectorial impact of Cyber-attacks during Corona-19 pandemic indicates that Airlines are the worst impacted. 739 out of 775 cyber-attacks (95%), were loaded with financial motive, resulted in financial loss and data theft in 55% and 34% cases respectively. Airlines alone accounted for over 61% of total Cyber-attacks followed by manufacturers (16%) and airports (15%). As far as ANSP is concerned, Phishing and malware accounted for 54% of total 72 reported cyber-attacks on ANSPs.

VI. CONCLUSION

Covid-19 pandemic has played havoc in the lives and livelihoods of the people around the world. There is hardly any sector of employment, revenue generation, service etc. which haven't felt the tremors of the Covid-19 pandemic. The aviation sector too remains impacted. In fact, it is one of the worst affected sectors- from operations, revenue and cyber-security point of view. Almost all the airlines are in red. Many airlines are struggling for sustainability and are trying their best to avoid bankruptcy. In aviation industry, the international scheduled airlines are most affected. In India,

the international scheduled flights were suspended with effect from 0131 IST, 24 March 2020 and are still on ground and are so expected till 30 August 2021 (except some special approved flights and flights under Vande Bharat Mission). However, domestic airlines after a closure of around two months have started operations in a calibrated manner and at present operating at a capacity of 65% of Available Seat Kilometers (ASK). The airports and ANSPs have lost a huge chunk of aeronautical and non-aeronautical revenue. The situation is almost similar in all the parts of world including Europe. Worldwide, there has been a decline of 60% in total passengers in 2020 and estimated decline between 41 % to 49% in 2021. The gross passenger operating revenues of airlines have shown loss of USD 371 billion and is estimated between USD275 billion to USD323 billion in 2021.

Covid-19 pandemic has impacted aviation industry in many forms. Besides, financial loss, all the sectors of aviation are reeling under the impact of enhanced cyber-attacks owing to overdependence on data, technology and internet. The cyber-attacks have increased many folds both in India and abroad. The cyber-attacks increased by 500 % to 4000% in different parts of world. In India, it was reported to have increased by 2000%. Financial Stability Board (FSB), London reported Cyber-attacks in the form of phishing, malware and ransom were grown over 40 times from 5000 to 200000. On the other hand, EUROCONTROL reported Cyber-attacks in the European Aviation industry during the Covid-19 pandemic have increased by over five times i.e. 530% in 2020. The European airlines are the most impacted sector of aviation with 61% of the total cyber-attacks in 2020. Furthermore, the aviation industry is struggling with reduced budget allocation to deal with this menace.

REFERENCES

- [1] A. Agrawal, Sustainability of airlines in India with Covid-19: Challenges ahead and possible way-outs, *Journal of Revenue and Pricing Management*, Vol.20, (457-472) 2021.
- [2] ACI, Airport Cyber-security in a COVID-19 World, 6 January 2021, <https://blog.aci.aero/airport-cybersecurity-in-a-covid-19-world/>
- [3] ACI Advisory Bulletin – The Impact of COVID-19 on the Airport Business (dated 25 March 2021), <https://aci.aero/wp-content/uploads/2021/03/210325-Econ-Impact-and-Recovery-Analysis-Bulletin-FINAL.pdf>
- [4] Airlines in India will bounce back to 80% pre-Covid capacity this year, predicts Morgan Stanley, <https://www.traveldailymedia.com/airlines-in-india-will-bounce-back-to-80-pre-covid-capacity-this-year-predicts-morgan-stanley/>
- [5] Airports of Thailand pax declines 93.5% in Jun-2021, compared to Jun-2019 | CAPA, <https://www.centreforaviation.com>
- [6] Air India servers hacked, credit card details of fliers stolen: Here is everything we know about it so far - Technology News, available at <https://www.indiatoday.in/technology/news/story/air-india-servers-hacked-credit-card-details-of-fliers-stolen-here-is-everything-we-know-about-it-so-far-1805506-2021-05-21>
- [7] Coronavirus: The Psychology of Panic Buying, <https://www.bbc.com/worklife/article/20200304-coronavirus-covid-19-update-why-people-are-stockpiling>
- [8] 2000% increase in cyber security breaches during pandemic, IT Security News, ET CISO, <https://www.ciso.economicstimes.indiatimes.com/news/2000-increase-in-cyber-security-breaches-during-pandemic/84465800>
- [9] Debayan Roy, Airlines violating MCA order by not refunding full amount for tickets booked during COVID-19 Lockdown: Plea in Supreme Court, BAR AND BENCH, <https://www.barandbench.com/news/litigation/airlines-violating-mca-order-by-not-refunding-full-amount-for-tickets-booked-during-covid-19-lockdown-plea-in-supreme-court>
- [10] <https://www.dgca.gov.in/digigov-portal/jsp/dgca/homePage/viewPDF.jsp?page=topHeader/COVID/Circular%2019.3.2020-II.pdf>
- [11] Emirates plane flies from Mumbai to Dubai with just one passenger, here's how much he paid, <https://www.republicworld.com/entertainment-news/whats-viral/emirates-plane-flies-from-Mumbai-to-Dubai-with-just-one-passenger-here-s-how-much-he-paid.html>
- [12] Haritha Saranga & Rajiv Nagpal, 'Drivers of operational efficiency and its impact on market performance in the Indian Airline industry', *Journal of Air Transport Management*, Vol.53, (165-176), 2016. <https://doi.org/10.1016/j.jairtraman.2016.03.001>.
- [13] Indian Aviation Industry, Aviation Sector in India, About, Analysis, <https://www.ibef.org/industry/indian-aviation.aspx>.
- [14] IATA Airline Industry Economic Performance - April 2021 - Data tables, <https://www.iata.org/en/iata-repository/publications/economic-reports/airline-industry-economic-performance-april-2021---data-tables/>
- [15] Indian Aviation Industry, Aviation Sector in India, About Analysis, <https://www.ibef.org/industry/indian-aviation.aspx>
- [16] Mayday! Airports would need government support to stage a recovery, <https://www.financialexpress.com/opinion/mayday-airports-would-need-government-support-to-stage-a-recovery/1937992/>
- [17] Start Scheduled International Flights, Remove Fare Cap: IATA to Indian Govt. News18, <https://www.news18.com/news/auto/start-international-flights-remove-fare-regulations-iata-to-indian-govt-4016177.html>
- [18] Updated EUROCONTROL Traffic Scenarios for 2021 (dated 01 June 2021), <https://www.eurocontrol.int/press-release/updated-eurocontrol-traffic-scenarios-2021-clear-hope-some-recovery-summer-and-beyond>.
- [19] Why India fails in cyber security literacy test: WeSeSo, IT Security News, ET CISO, <https://www.ciso.economicstimes.indiatimes.com/news/why-india-fails-in-cyber-security-literacy-test-WeSeSo/84345343>
- [20] eurocontrol-think-paper-12-aviation-under-cyber-attack.pdf, <https://www.eurocontrol.int/sites/default/files/2021-07/eurocontrol-think-paper-12-aviation-under-cyber-attack.pdf>
- [21] Worldometer, <https://www.worldometers.info/Coronavirus> (last visited, 04 December 2021).
- [22] Work from home fuelling cyber-attacks, says global financial watchdog, IT Security News, ET CISO, <https://www.ciso.economicstimes.indiatimes.com/news/work-from-home-fuelling-cyber-attacks-says-global-financial-watchdog/84371710>
- [23] Vande Bharat Mission – Number of Flight and Passengers Flown | COVID-19 Inter-Ministerial Notifications | India, <https://www.covid19.india.gov.in/document/vande-bharat-mission-number-of-flight-and-passengers-flown-6/>
- [24] Visitor arrivals to Finland down 90.4% in Jun-2021, compared to Jun-2019 | CAPA, <https://www.centreforaviation.com>