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항공사 정시성에 영향을 주는 요인에 관한 연구

A Study on the Factors that Affect the On-Time Performances of Airline Companies

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[요 약]

항공사에서 정시성(on-time performance, OTP)이란, 항공사의 신뢰성의 척도이며, 타 항공사와 비교할 때 중요한 지표로 활용된다. 본 연구는 코로나로 인해 항공 편수가 급격히 줄어든 2020년 3월을 기준으로 전후 1년간의 국내 K항공사 자료를 분석하여 지연 요인들이 항공사의 정시성에 미치는 영향 및 강도를 분석하였다. 또한, 계절에 따른 기상 영향으로 발생되는 지연을 분석하였으며, 코로나 상황으로 급감한 승객이 지연요인에 어떠한 영향을 주는지 연구하였다. 지연 요인(delay factor)은 IATA의 지연 코드(delay code)에 자체 코드를 추가한 K 항공사의 지연 코드를 적용하였다. 본 연구의 분석을 바탕으로 항공사의 정시성에 영향을 주는 지연 요인을 최소화하는 방안을 제안하고자 한다.

[Abstract]

In airlines, on-time performance (OTP) is a measure of an airline's reliability and can be used as an important indicator when compared to other airlines. This study analyzed the effects and strength of delay factors on airline punctuality by analyzing the data of domestic K airlines for one year before and after March 2020, when the number of flights drastically decreased due to the corona virus. In addition, delays caused by seasonal weather effects were analyzed, and how the number of passengers who plummeted due to the corona situation had an effect on delay factors was studied. As for the delay factors, the delay codes of K airline which added its own codes to the delay codes of IATA, were applied. Based on the results of the analysis, we would like to suggest a method to minimize the delay.

Key word : Airline Delay, Airline OTP, Delay Code, IATA Delay Code, On Time Performance.

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Ⅰ. Introduction

On-time performance (OTP) is greatly perceived by public and is often the most important factor in choice of airline for passengers. OTP influences not only punctuality reputation of an airline but also public perception and satisfaction of passengers with the airline. Customers place high value on reliability in schedules. All other things being equal, customers will prefer an airline with a consistent record of dependability.[1]

We need to first define the term “late” before explaining the OTP. Delay of less than 15 minutes has been generally accepted as being on time. When OAG first published its Punctuality League in 2014 the technical definition of 15 minutes was that anything up to 15 minutes and 59 seconds was considered to be on-time. Flights that were cancelled were not included in the calculation. The following year, the range has been slightly reduced to be anything up to 14 minutes and 59 seconds was on-time and cancelled flights were counted among the flights which were not on-time. However, the term has not been formally assigned as an industry standard by any of the committee of ICAO, IAA or ACI.[2]

Although some airports and/or airlines have put efforts in airport/airline management to reduce possible delays, flight delays become unavoidable in some airports. In reality, multiple factors that impact flight delay are in many cases independent.[3]

There are so many factors that affect aircraft delays. There are internal factors such as airline's own flight scheduling, aircraft type and numbers, but airport congestion, weather conditions on airports or/and routes, and the ability of state’s ATC also affect delays. In addition, late arrival of passengers and delay of immigration, security check and quarantine procedure could significantly impact the schedule. In Europe, more than 2.4 million flights are delayed or canceled each year due to various factors, such as weather, airlines, and air traffic control (ATC).[3]

In the case of Korea, due to its geopolitical characteristics the Airway composition is constrained and the B576 route SEL to Jeju and Southeast Asia preferred by tourists is one of the busiest airway in the world. It currently operates multiple routes under the name of Y711 to Southeast Asia, and Y712 back to SEL respectively. As of May 2018, the route was used by about 820 flights a day which was the highest traffic volume among 49 Airways in Korea. It connects air routes to major Southeast Asian countries such as Taiwan, Hong Kong, Macau, Vietnam, Thailand, Bali, Singapore, the Philippines, Malaysia, Indonesia, and Bali, and traffic is mainly concentrated during dawn and late night hours.[4](Fig.1)

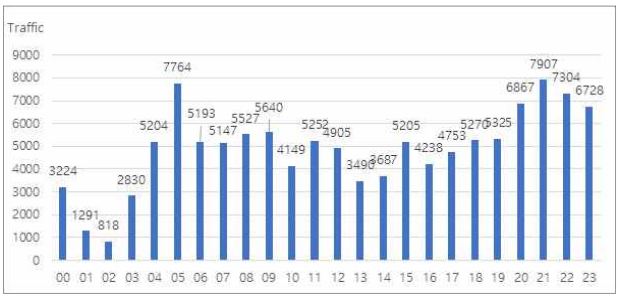

그림 1 인천발 동남아행 B576 항공기 시간별 통행량 (2017)
Fig. 1. Traffic volume on B576 Route from ICN to Southeast Asia by time (‘2017)

In addition, flights departing from Incheon International Airport and bound for Europe are via China's FIR, and China also has frequent delays due to its excessive traffic and ATC separation policy between traffics on the route. Flights departing from Incheon International Airport to Europe have been delayed for more than an hour as flights separation more than 15 minutes between traffics if the adversary weather conditions by Thunderstorm or fog due to the performance of surveillance RADAR of Chinese ARTCC.

As for the delay rate by route, the Middle East route has the highest delay rate of about 21.76%, followed by the European route delay rate of about 17.24%, and the delay rate of the foreign airline's China route of about 11.60%. In the case of the national airline's Middle East route, the delay rate was high due to congestion on the route and the influence of severe weather during the period. In the case of national airlines' European routes and expanded routes, the delay rate was about 9.95% and 12.20%. Respectively, compared to the same period of the previous year, indicating a high increase in delay rate. In the third quarter of 2017, the the most frequent cause of for delays in international flights by national airlines was flight connections, which recorded 2,213 cases, accounting for about 48.08% of all delays. Delays due to traffic congestion occured 1,362 times which were 29.59% of all delays. Korean Air had a higher rate of delays due to traffic congestion at 41.48% compared to other airlines. The average delay rate of foreign airlines operating in Korea in the third quarter of 2017 was about 8.41%.[5]

The Ministry of Land, Infrastructure and Transport noticed that the improvement of the route system on the DEC 6, will limit the flight volume to 150,000 flights a year(410 flights per day) using the route can benefit. Many traffics have frequently experienced waiting and delays for inbound the route due to the rapid increase in traffic volume in China, and delays of more than an hour have frequently occurred during high traffic hours (11-15 AM). In particular, the delay rate of flights to Europe, where heavy delays of 1 hour or more are frequent, range from 12%(2,188 flights) to

7%(1,276), which is expected to decrease significantly.[5]

IATA specifies[6] the following components of airline caused delay:

- Passenger and baggage
- Cargo and mail
- Aircraft and ramp handling
- Technical and aircraft equipment
- Damage to aircraft & Automated equipment failure
- Flight operations and crewing
- Other airline related causes

Air demand plummeted from March 2020 as countries restricted travel due to the pandemic caused by COVID-19, which was first reported to have occurred in Wuhan, China in 2019.(Fig.2) Contrary to initial expectations, COVID-19 has even caused a mutated virus, and the pandemic situation continues through 2021.

K Airline, likes as other airlines in the world, has suffered a drastic decline in the number of flights and passenger occupancy since March 2020. IATA predicts that air demand, which has plummeted due to the pandemic, will recover to the 2019 level in 2022 for domestic flights and 2024 for international flights.[8](Fig.3)

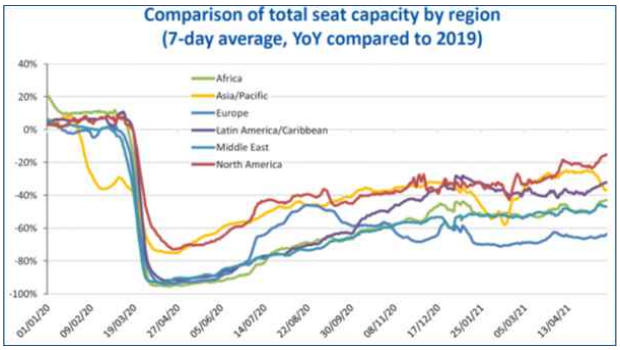

그림 2. 지역별 좌석공급 비교[7]
Fig. 2. Comparison of total seat capacity by region[7]

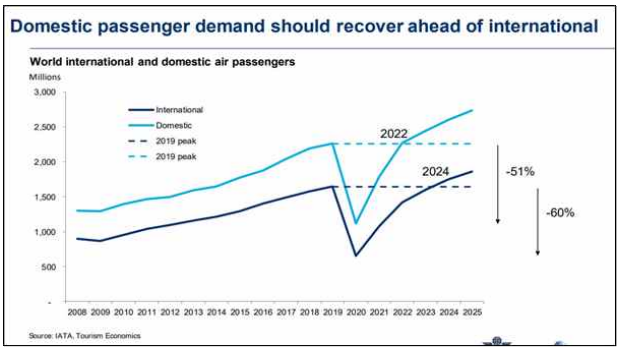

그림 3. IATA의 업계 회복 전망
Fig. 3. Pandemic Recovery Forecast by IATA

Analysis of operation delay causes is a very important means to improve OTP. This study analyzed and compared analyzed the K airlines delay cases of 2019, then compared them with the data after March 2020, when traffic volume plummeted due to the pandemic. We need to figure out what is the main cause. And it is necessary to analyze which factors have had a major impact on flight delays. Through this detailed analysis, it will be possible to identify the cause of flight delays and come up with countermeasures. In addition, it is necessary to examine how the delay rate changes from the internationally accepted delay standard of 15 minutes to 30 minutes or longer. Currently, the Ministry of Land, Infrastructure and Transport applies a delay standard of 30 minutes for domestic flights and 1 hour for international flights.

Ⅱ. Methodology

This paper analyzed delay data of more than 15 minutes collected by K airlines from January to December 2019, when flights were normally operated, and from both March 2020 to February 2021, when air demand plummeted due to the pandemic, as IATA delay code items classified according to. The delay code of IATA consists of 11 categories of major casual factors and 95 sub-categories, and the details are as follows.

- Airline own codes : 11ea
- Pax & Baggage : 8ea
- Cargo & Mail/Mail only : 9ea
- Aircraft & Handling : 9ea
- Technical And Aircraft Equipment : 8ea
- Damage To Aircraft/ EDP & Automation Equip Fail : 6ea
- Flight Operations And Crewing : 9ea
- Weather : 7ea
- Airport And Governmental Authorities : 9ea
- Reactionary : 6ea
- Miscellaneous : 3ea

The research finds the total number of flights operated by K airlines for each period and the number of flights delayed by more than 15 minutes and more than 30 minutes to check the percentage of delayed flights, and then compares the results before and after Mar 2020.

Next, Collecctd data will be reviewed with K Airline DELAY CODE to verify whether there is a correlation.

Analyze sub-categories in detail for items with many changes before and after the Pandemic of COVID-19. PAX FLIGHT schedules decreased more than 80% and cargo flights have increased than 2019 or before due to COVID-19, so we verify

how reasons of delay were changed.

The countermeasures are reviewed by analyzing whether the delay caused by the weather shows a significant difference by season.

Ⅲ. Data Analysis

K Airlines operated a total of 160,674 flights in 2019 when flights were in normal condition, and operated 66,395 flights from March 2020 to February 2021, resulting in an average flight decrease of about 59% since the pandemic.(Table 1) Delayed flight status was analyzed under two conditions: ‘delayed by more than 15 minutes’ and ‘delayed by more than 30 minutes’. As a result of the analysis under the delay of 15 minutes or more, the delay rate before and after the pandemic was similar, and in the condition of ‘delay of 30 minutes or more, the delay rate after the pandemic was about twice as high as before, so an in-depth analysis was needed.

In-depth analysis was conducted using the general current status due to the limitations of accessible data. In order to reduce costs after the pandemic, on-site support staff lacked the number of workers to perform actual work due to unpaid leave or leave of absence. This is presumed to have caused a delay.

In particular, in January and February of 2021, there was a lot of snowfall and adverse weather around the world, where delay was caused due todelays for deicing aircraft and snow removal at airport facilities. In addition, narrow cargo plane ramps at airports in the United States, simultaneous parking of multiple aircraft at the same time, and lack of snow removal equipment at the apron acted in a complex way, and there were many cases where cargo unloading and loading were delayed by several hours due to heavy snow and strong winds. In particular, there were many delays due to snow removal at Chicago O'Hare Airport. Actual cargo volume did not increase remarkably(Figure 4) if comparing before and after the pandemic. However, before the pandemic, it is estimated that various delays occurred because freighters were in charge of transporting cargo that was transported by passenger aircraft before. Relatively, the delay rate due to weather was the lowest in spring.

In snowy weather conditions, aircraft must be performed de-icing procedures before take-off, which usually take 20 to 40 minutes per flight. And when it snows heavily, loading or unloading of cargo is delayed. Especially when the temperature is too low and the wind blows strongly at the same time, unloading and loading is very laborious and time-consuming. Workers must take measures to keep warm to prevent frostbite, and be careful about slipping, which slows down work speed. Because waiting is also required for snow-removing work on cargo ramp area, In winter, there are more delays or additional time for aircraft departure than other seasons.(Fig. 5)

Next, the cause of the delay was analyzed using the IATA delayed code. As a result of analyzing the cause of delays of more than 15 minutes, the cases marked as delays by the airline's own code were the highest in both 2019 and 2020. In 2019, 36.4% of the total number of delayed cases were accounted for, and 45% or 45% in 2020.(Table. 2)

표 1. 운항 횟수 및 지연율
Table 1 . Operation status & delayed rate [9]

	2019.1-2019.12	2020.3-2021.2
TTL OPERATION	160,674	66,395
DELAYED OPERATION ≥15min'	27,583	11,290
RATE OF DELAY	17.2%	17.0%
DELAYED OPERATION ≥30min'	9,628	8,288
RATE OF DELAY	6.0%	12.5%

그림 4. 월별 항공 화물 용량
Fig. 4. Monthly Cargo volume status

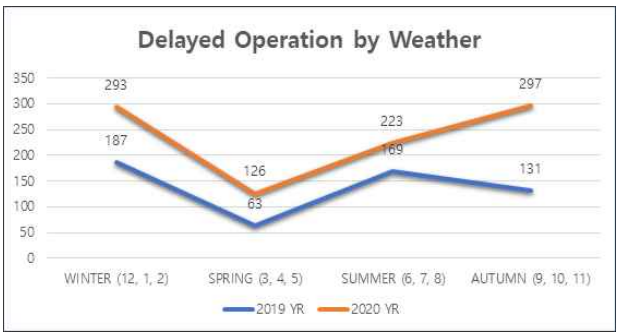

그림 5. 계절별 지연 횟수
Fig. 5. Delayed Operation status by Season

표 2. 항공사 지연 코드(IATA)
Table 2. Airline own delay code(IATA)

	Numeric	Alphabetic	Description
AIRLINE OWN CODES	1	MS	DEPARTURE TIME ADJUSTMENT FOR DESTINATION ETA CONTROL
	2	MF	FLIGHT SCHEDULE CHANGE, SCHEDULE TIME CHANGE DUE EXTRA/CHARTER SUPPORT, ROUTE CHANGE, ENDORSEMENT FROM OTHER FLIGHT, PASSENGER COVER FOR CANCELED FLIGHT
	3	TR	RETURN AFTER PUSH BACK OR TAKE-OFF
	4	NW	A/C CONNECTION BY WEATHER
	5	NA	A/C CONNECTION BY AIRPORT N GOVERNMENTAL AUTHORITIES
	6	NB	A/C CONNECTION BY BLOCK TIME DIFFERENCE BETWEEN SCHEDULE & ACTUAL
	7	NT	A/C CONNECTION BY MAINTENANCE
	8	NM	A/C CONNECTION BY MISCELLANEOUS, TRAFFIC, MARKETING, FLIGHT OPERATION, GROUND HANDLING, CABIN SERVICE, ETC
	19	PG	GROUP PAX LATE SHOW-UP, OR MISSING AFTER CHECK-IN
	70	FM	MALFUNCTION WHERE MEL ALLOWS DISPATCH BUT ITEM IS REPAIRED AT CAPTAIN'S REQUEST
O	9	SG	SCHEDULED GROUND TIME LESS THAN DECLARED MINIMUM GROUND TIME

표 3. 지연 요인 요약(국내 K 항공사)
Table 3. Summary of delayed reason(K airline)

	2019.1.1-12.31		2020.3-2021.2	
	≥ 15MIN	≥ 30MIN	≥ 15MIN	≥ 30MIN
Airline Own Codes	10,041	4,568	5,074	4,015
Pax & Baggage	1,189	188	113	22
CARGO & MAIL/Mail Only	40	21	400	299
Aircraft & Handling	308	78	154	103
Technical And Aircraft Equipment	598	344	154	148
Damage To Aircraft & Edp/Automation Equipfail	118	67	58	34
Flight Operations And Crewing	1,048	207	88	28
Weather	989	732	550	411
Airport And Governmental Authorities	8,486	1,933	1,275	570
Reactionary	1,921	823	1,222	970
Miscellaneous	131	27	3	1
ETC (code missing)	2,764	645	2,199	1,687
TOTAL	27,583	9,628	11,290	8,288

The number of flights in an year after the pandemic was about 41% of flights in the year before that. Based on the flight ratio(41%), delays of 15 minutes or more show a very similar ratio in the case of Airline's own code, but when the range is changed to 30 minutes or more, the two figures show similar values.(Table 3)

On the other hand, the delay caused by 'PAX & Baggage'(Table 4) shows a very large decrease. In the previous year, the number was 1,189, but in 2020, it decreased to 113, representing 9.5%. This is mainly due to due to the fact that there are many countries where passenger movement is restricted to other state, and departures are sanctioned.

And the delay due to' Cargo & Mail' increased tenfold compared to the previous year.

This is believed to be because most operations were changed to cargo plane operation and the valley cargo operations using passenger planes.

Flight Operation & Crew(Table 5) also decreased by less than 10% compared to the previous year. This is because the total number of flights has decreased by about 40% compared to the previous year, leaving room for crew rotation.

Delays by 'Airport & Governmental Authorities'(Table 6) decreased by approximately 85% compared to the previous year. As the overall number of flights decreased, it seems that the airport security check time was shortened, the departure/arrival gate space was not limited, and the ramp of the aircraft and movement within the airport were not restricted.

However, delay due to 'Reactionary'(Table 7) shows a slightly different rate of decrease from the rate of decrease in the number of flights. The number of flights decreased by 60%, but the delay due to reactionary decreased by 40%. Looking at the causes, it was mainly found to be due to 'OPERATIONS CONTROL, rerouting, diversion, consolidation, aircraft change for reasons other than technical'. It accounts for 1,159 out of 1,222 delays caused by reactionary. It is believed that the reason for the high delay is because airlines quickly changes aircraft types and manages connecting flights in response to changes in cargo volume.

표 4. 승객 및 화물에 따른 지연 코드(IATA)
Table 4. Delayed code by PAX & Baggage(IATA)

	Numeric	Alphabetic	Description
PAX & BAGGAGE	11	PD	LATE CHECK-IN, acceptance after deadline
	12	PL	LATE CHECK-IN, congestion in check-in area
	13	PE	CHECK-IN ERROR, passenger and baggage
	14	PO	OVERSALES, booking errors
	15	PH	BOARDING, discrepancies and paging, missing checked-in passenger
	16	PS	COMMERCIAL PUBLICITY/PASSENGER CONVENIENCE,VIP, press, ground meals and missing personal items
	17	PC	CATERING ORDER, late or incorrect order given to supplier
	18	PB	BAGGAGE PROCESSING, sorting, etc

표 5. 노선 및 승무원에 따른 지연 코드(IATA)
Table 5. Delayed code by Flight Operation & Crewing (IATA)

	Numeric	Alphabetic	Description
FLIGHT OPERATIONS AND CREWING	61	FP	FLIGHT PLAN, late completion or change of, flight documentation
	62	FF	OPERATIONAL REQUIREMENTS, fuel, load alteration
	63	FT	LATE CREW BOARDING OR DEPARTURE PROCEDURES, other than connection and standby(flight deck or entire crew)
	64	FS	FLIGHT DECK CREW SHORTAGE, sickness, awaiting standby, flight time limitations, crew meals, valid visa, health documents, etc.
	65	FR	FLIGHT DECK CREW SPECIAL REQUEST, not within operational requirements.
	66	FL	LATE CABIN CREW BOARDING OR DEPARTURE PROCEDURES, other than connection and stand-by
	67	FC	CABIN CREW SHORTAGE, sickness, awaiting standby, flight time limitations, crew meals, valid visa, health documents, etc.
	68	FA	CABIN CREW ERROR OR SPECIAL REQUEST, not within operational requirements
	69	FB	CAPTAIN REQUEST FOR SECURITY CHECK, extraordinary

표 6. 공항 및 정부 당국에 따른 지연 코드(IATA)
Table 6. Delayed code by Airport & Governmental Authorities (IATA)

	Numeric	Alphabetic	Description
AIRPORT AND GOVERNMENTAL AUTHORITIES	81	AT	AIR TRAFFIC SERVICES, flow restrictions, slot, industrial action
	82	AR	RESTRICTIONS AT DEPARTURE AIRPORT, airport and/or runway closed due to obstruction, industrial action, political unrest, noise abatement, night curfew, special flights
	83	AA	NO GATE/ STAND AVAILABLE DUE TO OWN AIRLINE ACTIVITY
	85	AS	MANDATORY SECURITY
	86	AG	IMMIGRATION, CUSTOMS, HEALTH
	87	AF	AIRPORT FACILITIES, parking stands, ramp congestion, lighting, buildings, gate limitations, etc.
	88	AD	RESTRICTONS AT DESTINATION AIRPORT, airport and/or runway closed due to obstruction, industrial action, political unrest, noise abatement, night curfew, special flights
	89	AM	ATC/GROUND MOVEMENT CONTROL, including start-up and pushback, industrial action

표 7. "Reactionary"에 따른 지연 코드(IATA)
Table 7. Delayed code by Reactionary (IATA)

	Numeric	Alphabetic	Description
REACTIONARY	91	RL	LOAD CONNECTION/ awaiting load from another flight
	92	RT	THROUGH CHECK-IN ERROR, passenger and baggage
	94	RS	CABIN CREW ROTATION, awaiting crew from another flight
	95	RC	CREW ROTATION, awaiting crew from another flight (flight deck or entire crew)
	96	RO	OPERATIONS CONTROL, rerouting, diversion ,consolidation, aircraft change for reasons other than technical

Ⅳ. Results

Based on the data generated by K airline, the cause of delay and delayed time were analyzed. In 2019, before the pandemic, 160,674 flights were operated annually, of which 27,583 flights were delayed by more than 15 minutes, accounting for about 17.2%.

Review the data from March 2020 to February 2021, after the outbreak of the pandemic, 66,395 flights were operated, of which 11,290 flights were delayed by more than 15 minutes, representing a delay rate of about 17%. almost same rate before and after Mar 2020. However, if I apply the condition of 'delay of more than 30 minutes', the delay rate changed to 6.0% before the pandemic and 12.5% after the pandemic.

Due to the pandemic, there are differences in the causes of delays. The delay caused by 'PAX & Baggage' shows a very large decrease. Because the movement of passengers was restricted due to the pandemic, causes such as late arrival of passengers were reduced, and due to the decrease in the number of flights in connection, airport security check, available for departure/arrival gates, aircraft ramp, and movement in the airport were not restricted. appeared as a result.

Delays due to 'Reactionary' appear to be higher than the rate of decrease in the number of flights, which is believed to be the cause of high delays because airlines quickly change aircraft types and manage connecting flights in response to changes in cargo volume.

Regarding meteorological factors, there is no significant difference when comparing pre-pandemic and post-pandemic factors. The meteorological factors could not be artificially changed, so the delay patterns were similar. However, in the winter season, aircraft removal and anti/de-icing operations are required due to snowfall, strong winds, and low temperatures, work efficiency is reduced due to low temperatures, and snow removal operations are required due to snowfall, so delays are inevitable. Sometimes typhoons in the fall are also contributing to the delay.

Lastly, Flight Operation & Crew also reduced the delay rate as the total number of flights decreased to about 40% compared to the previous year, which gave room for crew rotation because schedullers can secure more reserved pilot resources.

Ⅴ. Conclusion

Delay management in airlines is an essential process for improving OTP. In this study, delays in normal flight conditions before the pandemic and the causes of delays in the pandemic were investigated. A pandemic is a special situation that is difficult to experience in the aviation industry, but it was a meaningful study to compare the normal operation situation with the pandemic situation.

Although the causes of flight delays are very diverse, when analyzed by applying the delayed code suggested by IATA, a decrease in traffic or passengers does not reduce the delay rate. Rather, due to the same mission (eg. cargo transportation), delays occur due to increased congestion at the cargo stand, shortage of cargo loading/unloading equipment and manpower, and concentration of operation routes. In addition, the decrease in work efficiency due to quarantine and wearing protective equipment could not be measured, but it can be seen as a predictable situation.

Since weather factors cannot be artificially resolved, a similar pattern was shown regardless of the pandemic, and the number of delays increased despite the decrease in the number of flights compared to normal flights.

As passenger demand decreases and freight transport increases during the pandemic, complaints from passengers about delays are very few. In addition, it is a common phenomenon that passenger planes make a strong effort to operate on time as much as possible, and respond somewhat flexibly to cargo planes.

When the pandemic ends in the near future, the airport will be congested with traffic again, and the route will be difficult to obtain altitude assignments. Delays caused by passengers will increase when quarantine measures and security checks are strengthened for the safety of passengers.

OTP, which can increase airline reliability and passenger satisfaction, will be improved if behavioral studies that can reduce delays caused by passengers and introduction of buffer time that can alleviate delay factors caused by an increase in cargo planes and minimize delays caused by weather factors are reviewed.

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