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Evaluating the Effects of a Landing Charge Discount for Large Aircraft on Congestion Levels at Jeju International Airport

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ABSTRACT

제주공항은 슬롯 증대사업을 통한 정시성 개선 노력에도 불구하고 항공 교통량의 확대에 따른 혼잡도의 증가가 지속되고 있다. 제주공항 혼잡도의 근본적인 해소를 위해서 추진되고 있는 신공항 건설이 여러 가지 사유로 지연되고 있으며, 실제 건설계획이 확정되더라도 정상적인 공항 운영까지 상당 기간의 시간이 소요될 것으로 예상된다. 따라서 제주 신공항 건설이라는 대규모 신규 투자와는 별개로 신공항 개항 전, 기존 제주공항을 운영하면서 혼잡도를 해소할 수 있는 중단기적 대안을 마련할 필요가 있다. 이에 국토교통부와 한국공항공사는 제주공항에 소형기보다는 최대이륙중량 100톤 이상의 대형항공기(통상 270석 이상 공급) 투입을 유도하는 착륙료 감면 조치를 시행하였으며, 최초 착륙료 10% 감면에서 추가 활성화를 위하여 착륙료 20% 감면으로 확대하여 운영 중이다. 항공사는 착륙료 감면 비율 상향을 통해 대형기 투입에 따른 실질적인 비용이 절감된다면 상기 정책에 적극 동참하게 될 것이다. 본 논문에서는 제주공항에서 실시 중인 착륙료 감면율 확대 조정이 항공사의 대형기 배정에 미치는 효과를 분석하여 정책의 실효성을 고찰하였으며 이에 따른 개선책을 제시하였다.

Key Words : Jeju International Airport(제주공항), Slot Expansion Project(슬롯증대사업), New Airport Construction(신공항 건설), Landing Charge Discount Rate(착륙료 감면율), Congestion Levels(혼잡도)

Ⅰ. INTRODUCTION

1.1 Research Background and Goals

Jeju International Airport continues to experience overcrowding and delays due to increasing passenger traffic. In 2019, out of a total of 170,854 flights operating from Jeju Airport, 24,052 flights (approximately 14.1%) were delayed. In particular, 18,148 departing flights, or 21.3% of departures, were delayed. This serious delay rate is 2.2 times greater than the average rate of 9.91% for departures nationwide. The factors that contribute to the delays of these individual flights are the increase in flights that lead to airport capacity saturation [1].

The expansion of aircraft spots at Jeju Airport resulted that it would accommodate the parking capability by 2030 while it was expected that the runway capacity would be exceeded after 2019. Also, it was analyzed that the domestic passenger terminal would exceed its capacity in 2020. Plans were prepared for the expansion of the airport as well as for the construction of a new airport. However, due to the densely populated area where the airport is located, expansion was limited and the proposed

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new airport construction site raised environmental concerns [2].

Korea Airports Corporation has been conducting a feasibility assessment of a slot expansion project in order to find possible solutions for expanding slot availability. These measures include installing additional high-speed exit taxiways, improving parking flow, installing additional self-towing ramps, as well as making improvements to the geometry and alignment of parallel taxiways as well as other existing taxiways [3].

Nevertheless, these short-term strategies have been unable to address the ever-increasing traffic demands. Accordingly, the government has investigated the feasibility of the construction of a new airport and has pushed forward the construction process by acquiring land in the area of Sinsan-ri, Seongsan-eup, Jeju-si for a runway measuring 3,200 meters in length and 60 meters in width [4].

Although the construction of the proposed new airport has been delayed for a variety of reasons, it is anticipated that it will require a considerable amount of time (10 years or more) before the airport will be able to open and resume normal operations. It was therefore suggested that airlines operating out of Jeju Airport replace the small aircraft currently in operation with larger ones which would alleviate congestion at Jeju Airport. It is anticipated that this will result in fewer flights being operated as a result of net reduced operational expenses.

To increase the options for airlines to operate large aircrafts to Jeju Airport, policymakers implemented a plan aimed at reducing landing charges. These charges are a direct cost for airlines with access to large aircraft. As a result of the initial 10% reduction in September 2016, which was not deemed strong enough of an incentive, an expanded 20% discount has been introduced since September 2018 as a replacement.

The purpose of this paper is to examine the effectiveness of the policy described above. This policy is intended to encourage the operation of large aircraft by reducing landing charges. Our analysis focuses specifically on how the adjusted discount rate has affected the airlines' choice of aircraft. The effectiveness of the initial 10% rate is compared to the effectiveness of the increased 20% rate when comparing the two rates.

1.2 Literature Review

A study by Webin Wei (2005) examined how landing charge policies affect airlines' decisions on aircraft size and frequency of service, while Wei and Hansen (2003) demonstrated that airlines could use larger aircraft when airport authorities refunded a portion of the landing fee surcharge to those using large aircraft as a bonus for reducing congestion [5].

A study conducted by Robert Malina (2011) examined the types and scope of the various incentive programs in use in the European Union and found that one-third (66 out of 200) of the airports studied had implemented incentive policies as a tool for determining airline schedules and network planning. In addition, Malina found that different policies were in place based on the characteristics of each airport. As a result of these policies, airlines were able to select which airports to operate from. Dusseldorf Airport, Germany's third-largest airport, offered a discount of 22.5% on airport fees in order to incentivize larger aircraft and increase the number of passengers per movement [6].

Kwang-Eui Yu (2003) identified the landing charge, the largest of the fees that airports charge in exchange for traffic services, as the item that airlines respond most sensitively to. ICAO's traditional recommendation that landing charges be determined based on weight has been criticized by the author. He proposes a price-setting policy based on marginal costs and efficiency maximization. When peak demand approaches capacity, Yu argued that additional facilities should be constructed or that peak users would be able to pay fees that include operational expenses as well as long-term marginal costs, including the construction of additional runways or adjustments of landing charges based on peak time rather than weight [7].

According to Yeong Hun Yun (2020), even though airports are considered public goods, air transportation operators are required to pay airport facility use fees in accordance with the beneficiary-pays principle, as specified in the Airport Facilities Law, in addition to the regulations that accompany it. According to Yun, special use fees can be levied for aircraft that utilize slots with high economic value in comparison with other slots [8].

Through the literature review confirmed that regulations pertaining to costs, including landing charge discounts, peak time adjustments, and additional charges for the use of economically highly valuable slots, can reduce congestion at an airport that faces constant congestion as its runway reaches saturation due to constant traffic congestion. Additionally, we confirmed that policies governing the determination of landing charges may offer an alternative solution to addressing airport congestion.

Ⅱ. BODY

2.1 Airline Cost Structure

Airline costs are generally divided into three categories: production costs, operating costs, and general management costs. There are a variety of business production costs, including fuel costs, depreciation costs, labor costs, contracted maintenance costs, ground handling fees, cabin passenger costs, and other incidental costs, as well as navigation and landing charges and maintenance material costs.

Approximately 50% of these costs are associated with operational charges where more than 50% are comprised of fuel cost. The remaining costs are composed by ground handling fees, security service fees, and other flight related charges such as maintenance, landing fees, overflight fees, and others. Costs associated with passengers and freight include in-flight meals, insurance, freight/airport facility usage, and passenger service charges. A large proportion of airlines' fixed costs are toted with aircraft leases and depreciation while other costs include branch administration, head office administration, advertising, marketing, and labor costs for cabin, flight, and maintenance crew.

In general, the five most significant airline costs are fuel, depreciation, labor, contracted maintenance, and flight related charges (i.e., aeronautical charges). As a percentage of the total cost of business production, aeronautical charges represent 6% to 7%. These charges include landing fees, parking fees, lighting fees, noise fees, navigation fees, and overflight fees. Unit rates can be found in a state's Aeronautical Information Publication or in documents published by airport authorities.

2.2 Definition of Aeronautical Charges

A landing charge is a charge assessed by airports for the use of runways and other runway related facilities. They can be applied on takeoffs or both takeoffs and landings. Unit rates are associated with the aircraft's Maximum Takeoff Weight (MTOW) or Maximum Landing Weight (MLDW).

A parking charge is levied for aircraft parked at the apron for a certain time; most airports charge this fee after a time threshold has been exceeded.

Lighting A lighting charge is imposed in order to recover the cost of lighting runways, taxiways, and approach systems. They can be charged upon each takeoff or landing.

A noise charge is levied in areas near the airport that needs compensation of aircraft noise pollution and thus to fund noise mitigation projects. In accordance with ICAO recommendations, the charge is determined by both the authorized noise level and the weight of the aircraft.

A navigation fee is charged for the use of navigation facilities, such as radios and communications equipment. They can be charged upon each landing or both takeoff and landing.

Overflight charges apply to the use of navigation facilities and air control services during an overflight of a country. This policy does not apply to the country in which the airport of arrival is located.

2.3 Summary of Airline Incentive Schemes

A number of incentives are available to airlines in order to stimulate airport revitalization through the expansion of airline networks and the increase of transfer passengers. The airline can be offered incentives, including discounts, exemptions, or refunds of landing charges for increased passengers, according to its performance status.

Incheon International Airport offers the following incentives for passenger airlines. First, landing charge discounts and advertising subsidies are offered for newly established airlines or new routes developed at the airport. Second, expanded service for regular flights is eligible for landing charge refunds depending on whether the flight operates on-peak or off peak. Third, new or expanded regular service on strategic routes exceeding 6,000 km in distance is supported by a reduction in landing fees. Fourth, cash or transfer promotion points (transfer hotel, food, and beverage coupons, advertising) are offered to airlines exceeding the previous year's transfer passenger volume by 1,000 passengers, based on the airline's actual contribution level (based on each airline's share of transfer traffic and increased transfer rate) and actual expansion level (based on each airline's share of increased transfer traffic) [9].

With respect to freight traffic, new flights, new routes, late-night flights, expanded operations, and increased freight volume may be eligible for incentives such as discounts on landing charges in order to encourage airlines' participation in airport revitalization [10].

Airports The Korea Airports Corporation which operates airports in South Korea besides Incheon offers various incentives based on their characteristics and situation as follows: First, new or expanded domestic and international services are eligible for discounts on landing charges, parking charges, and lighting charges. Minor airlines offer discounts on landing charges, parking fees, and lighting charges for all routes. Third, domestic routes with 30% or less terminal usage are eligible for discount landing, parking, and lighting charges. Fourth, the airport provides landing fee discounts for large aircraft flying the Jeju and Gimhae routes [11].

2.4 Research Procedure, Scope, and Methodology

Choosing the right aircraft for a route when planning their fleets is imperative for airlines as profitability changes with passenger capacity. External factors such as airport congestion policies can also influence the choice of aircraft size. Therefore, when deciding on the size of aircraft, airlines must consider factors such as operating cost structure, flight frequency, and marginal costs at airports where demand limits have been reached such as Jeju Airport [12].

Airport administration consider ways to improve the airport's efficiency through revitalization or congestion mitigation. Particularly, mid-long term plans must be developed for the operation of the airport separately from considering the construction of a new airport; as the new airport will not open for some time, a methodological framework for maintaining the existing airport in the interim will be needed. It is pertinent to note that landing charges and passenger service charges are of particular revenue sources to the airport. As a result, airlines will consider these high-cost charges when choosing which aircraft to use and with frequent takeoffs and landings at major airports, the landing charges will generally be determined in consultation between the airlines and the airport authority [13].

Based on the general principle that heavier aircraft require more cost related support for takeoff and landing, including longer and stronger runways, the International Civil Aviation Organization (ICAO) recommends that landing charges be set in accordance with the aircraft's weight. Following this, the currently applicable landing charges at Jeju Airport (Table 1) are differentiated based on aircraft type, with larger aircraft subject to relatively higher landing charges.

The Korean Ministry of Land, Infrastructure and Transport considered the use of large aircraft in its second aviation policy master plan (2015-2019) to alleviate the lack of passenger capacity at densely populated airports such as Jeju. Given Jeju Airport's saturated capacity, and the fact that the new second airport is expected to be completed after 2025, obtaining slots for new and expanded services will not be trivial and thus maintaining a fundamental solution through infrastructure expansion will be difficult [14].

Table 1. Jeju Airport landing charges by aircraft type

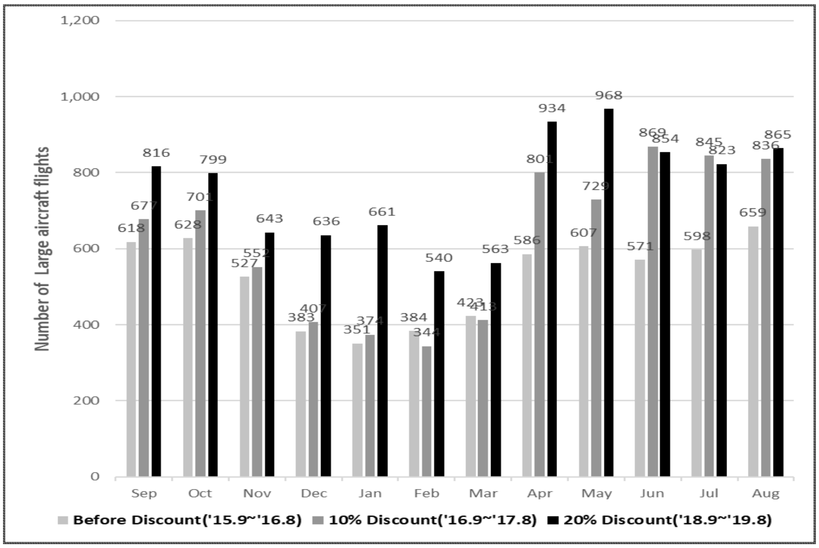
Aircraft type	MTOW (ton)	Landing charge (won)
A320	76	160,308
A321	89	191,612
A321(NEO)	94	203,652
B767	157	387,276
A330	230	603,940
A350	268	716,274
B777	287	773,116
B747	395	1,093,660
A380	569	1,610,092

In order to encourage the use of wide-body (generally with 270 seats or more), Jeju Airport reduced landing charges by 10% since September 2019 for large aircraft of 100 tons or more and with 270 seats or more. From April 1, 2018, the discount was increased by 10 percentage points (i.e., a reduction of 20% from 2016 levels) to further enhance the use of large aircraft in accordance with the 2018 work plan of the Civil Aviation Office of the Ministry of Land, Infrastructure, and Transport [15].

In the purpose of this study is to assess whether the landing charge discount policy instituted by the Ministry of Land, Infrastructure and Transport and the Korea Airports Corporation to relieve capacity saturation at Jeju Airport has an effect on the use of large aircraft. Fig. 1 shows the number of flights operated by large aircraft at Jeju Airport using data obtained from Korea Airports Corporation’s aviation statistics. In the 12-month period beginning in September 2015, when the discount policy was not in effect, a comparison is made between the 12-month period starting in September 2018 when the 20% discount policy was implemented, and the period starting in September 2016 when there was a 10% discount in effect. In this period, approximately 10% of all flights were operated by large aircraft at Jeju Airport. Therefore, it is necessary to examine the discount rate and the increase in flight numbers in order to compare the changes in large aircraft flights between the pre-discount, the 10% discount, and the 20% discount periods from a statistical perspective.

2.5 Statistical Examination and Analysis

To examine changes resulting from the discount policy, we conducted a statistical analysis of the mean differences between the two groups, through the program R. The changes in stepwise means according to the introduction of the discount policy were analyzed using a Two-



Source: Korea Airports Corporation Aviation Statistics, Aircraft Type Statistics.

Fig. 1. Monthly number of large aircraft flights at Jeju Airport

Sample T-test, considering whether the independent mean difference between the two groups was zero.

As seen in Table 2, testing the difference in the variance between each group yields *p*-values greater than 0.05. Therefore, the null hypothesis of equal variance between the groups is not rejectable, and each group can be judged to have statistically equal variance. Based on these findings, we conducted Two-Sample T-tests on the three groups based on pooled variances.

It can be seen in Table 3 that a Two-Sample T-test comparing the periods in which no discount was offered with those in which a 20% discount was offered revealed a statistically significant difference in the number of flights with large aircraft. In other words, a statistically significant increase in flights with large aircraft was observed at Jeju Airport during the period when the 20% discount was applied.

As an additional instrument to assess the reliability of the sampling data, we include a table for analysis of variance (Table 4), and we find that the means do not equal those of the three groups.

Table 2. Test of equal variance between discount rates

	Discount 0%-10%	Discount 10%-20%	Discount 0%-20%
Null hypothesis	$\sigma^2_{0\%}=\sigma^2_{10\%}$	$\sigma^2_{10\%}=\sigma^2_{20\%}$	$\sigma^2_{0\%}=\sigma^2_{20\%}$
Test statistic F(df_1=11, df_2=11)	0.42098	3.1732	1.3359
p-value	0.167>0.05	0.068>0.05	0.639>0.05
Decision	$\sigma^2_{0\%}=\sigma^2_{10\%}$	$\sigma^2_{10\%}=\sigma^2_{20\%}$	$\sigma^2_{0\%}=\sigma^2_{20\%}$

Table 3. Test of the mean difference in flights with large aircraft based on discount rate

	Discount 0%-10%	Discount 10%-20%	Discount 0%-20%
Null hypothesis	$\mu^2_{0\%}=\mu^2_{10\%}$	$\mu^2_{10\%}=\mu^2_{20\%}$	$\mu^2_{0\%}=\mu^2_{20\%}$
Test statistic F(df=22)	-1.1989	-1.9186	-4.2303
p-value	0.243>0.05	0.068>0.05	0.0003438 <0.05
Decision	$\mu^2_{0\%}=\mu^2_{10\%}$	$\mu^2_{10\%}=\mu^2_{20\%}$	$\mu^2_{0\%}\neq\mu^2_{20\%}$

Table 4. Analysis of variance table for the discount rates

	Discount 0%/10%/20%
Null hypothesis	$\mu^2_{0\%}=\mu^2_{10\%}=\mu^2_{20\%}$
Test statistic F(df$_1$=2, df$_2$=33)	5.7763
p-value	0.007064<0.05
Decision	$\mu^2_{0\%}\neq\mu^2_{0\%}\neq\mu^2_{20\%}$

Ⅲ. CONCLUSION

Before the pandemic, the Gimpo-Jeju route was the world's most congested air travel route, with limited seating capacity and crowded timeslots. The Korean Ministry of Land, Infrastructure, and Transport has incentivized the operation of larger aircraft by introducing a discount on landing fees for large aircraft in stages. This is in order to overcome the limitations placed on expanded flights.

By analyzing actual aviation data, this study examines the impact of the discount policy on the use of large aircraft by airlines. Large aircraft averaged 527.9 flights per month before the discount period was introduced. This was compared to 629 flights per month during the 10% discount period and 785.5 flights per month during the 20% discount period. With larger aircraft, the number of flights raised as the discount rate increased. Though there was no statistically significant difference between the no-discount and 10% discount periods, only a statistically significant difference was found between the 20% discount period and the no-discount period.

According to statistical findings, the policy decision to increase the discount rate to 20% from 10%, and to operate a demonstration period in order to facilitate the change, proved to be practical. From the airlines' perspective, we confirmed that despite many variables being relevant to the composition of aircraft types for each route, landing charges at airports such as Jeju with frequent takeoffs and landings have an influential impact on airlines' cost analysis, influencing their aircraft composition. Thus, it is seen that an expansion of the landing charge discount to 30% at Jeju Airport could actively incentivize the use of large aircraft. This could significantly reduce congestion at Jeju Airport.

Future Research

Incentive policies should be studied further in order to determine when they become practically effective. In order to analyze the quantitative values relevant to the implementation of incentive policies that aim to affect airlines' routing decisions, it would be necessary to examine the different variables airlines use to choose aircraft for specific routes, including landing charge discounts. Furthermore, we intend to confirm whether landing charge discount policies, even when they are not directly decisive factors in the deployment of large aircraft, can at least act as mechanisms to prevent the loss of large aircraft operations.

Afterword

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