A study on travelers' transport mode choice behavior using the mixed logit model: A case study of the Seoul-Jeju route

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ABSTRACT

This study is to analyze passengers' choice of the mode of transportation when air transportation is in competition with high speed rail (HSR). The Seoul-Jeju route analyzed as an empirical case study, in which the construction of an undersea tunnel to connect Seoul and Jeju city by HSR has been considered. The study also included two new variables, 'safety of transportation' and 'availability of duty free shopping' in addition to traditional transport choice variables such as travel time, travel costs and frequency of service to reflect special characteristics of the market. As data gathering tools, SP techniques and mixed logit model, for analytical methodology, were utilized. The authors found that the goodness of fit of the models was improved with new variables. The models also showed that the characteristics of business passengers and leisure passengers in choosing the mode of transportation were different. Business passengers were apt to choose a safety secured mode of transportation regardless of fare while leisure passengers preferred to use duty free shops more than business passengers.

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1. Introduction

The launch of High Speed Rail (HSR), named KTX, on the Seoul-Busan route in 2004 reduced travel time between the two cities from five hours to two hours and eighteen minutes. This led to rapid decrease in air passenger demand in the same route and accelerated the competition between airlines and HSR services.

Regarding this matter, various studies have been conducted to comprehend the change in mode choice behavior of incumbent air passengers. The studies also tried to develop strategies for air transportation to remain competitive in the face of new forms of transportation services such as HSR or the network expansion of alternative options. However, because the studies only consider limited variables such as fare, travel time and frequency, the models may have had limitations in fully reflecting the reality of the current transportation market.

This study is designed to assess passengers' transport mode choice behavior utilizing stated preference (SP) techniques with some additional variables which incorporate the special characteristics of the chosen market. The empirical case study investigates competition between airlines and HSR with the assumption that an undersea tunnel has been opened to connect Mokpo and Jeju, which was planned by the central government of Korea several years ago (see Fig. 1). The introduction of HSR service in the Seoul-Jeju route utilizing an undersea tunnel will become a strong competitive alternative to incumbent air transport services. This study also examines the influence of new variables on the goodness of fit of the model.

2. Literature review

2.1. Literature of transport choice behavior by air passengers

Hess et al. (2005) classified passengers into two distinctive groups as business/travelers and residents/visitors in order to analyze each group's choice of airports among San Francisco International (SFO), San Jose Municipal (SJC) and Oakland International (OAK) airports, all located in vicinity of San Francisco Bay area. Flight fare, frequency and access time were considered as explanatory variables.

Park and Ha (2006) carried out SP research on Seoul-Daegu route air passengers supposing that KTX is introduced on the Seoul-Daegu route. After KTX was introduced, it was proven that there were actual changes in air transportation demand and
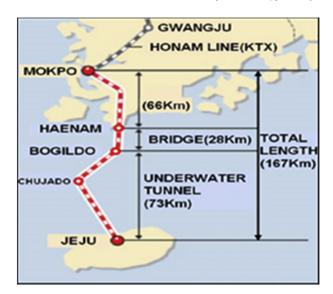
Fig. 1. Concept of Mokpo and Jeju high-speed rail.
Source: The Jeju weekly, 4. January. 2010.

passengers' preference compared to periods prior to the launch. To carry out the preference survey, access time, fare and the frequency of operation were set as variables. As a result, preference towards air transportation in the SP research turned out to be 14% which increased to 28% after the KTX entry, slightly higher than the supposed value.

Jou et al. (2011) simulated the initiation of hyper-speed transportation service bound to Taoyuan International Airport (TIA) in Taiwan and analyzed international passengers' choice when under the influence of in-vehicle travel time, out-of-vehicle travel time and fuel cost.

Jung and Yoo (2014) hypothesized that a faster version of Korea Train Express (KTX) service would connect Gimpo (Seoul) and Gimhae (Busan), and analyzed business and leisure passengers' mode choice behaviors among Full Service Carrier (FSC), Low Cost Carrier (LCC) and KTX through a comparison study using the Multinomial Logit (MNL) and Nested Logit (NL) models. Fare, access time, travel time and frequency were considered as variables. The result shows that passengers generally give weight to the reducing access time in choosing mode of transportation.

2.2. Studies on airline choice attributes

Mason. (2001) analyzed the importance of choice attributes by conducting a survey which used seven choice attributes including punctuality, frequency, flight fare, ticket flexibility, in-flight service, frequent flyer program, and availability of business lounge for business air passengers on FSC at Heathrow airport and LCC at Luton airport.

Fourie and Lubbe (2006) analyzed choice attributes of FSC and LCC business air passengers in South Africa. The choice attributes included eleven variables of degree of seat comfort, schedule/frequency, fare, authority of seat choice, cancellation charge, airport lounge facility, frequent flyer program, business seat choice, in-flight food and drinks, method of payment and in-flight entertainment.

3. Consideration of additional variables to reflect characteristics of the market

Many studies related to transport choice issue have considered three major factors, travel cost, travel time and frequency of service as explanatory variables. And many studies have applied additional variables reflecting characteristics of the targeted market of their research. This study also aims to find additional explanatory variables to improve the reliability and reality of the research results by examining specific characteristics of the targeted market.

3.1. Influences of LCC service in Seoul-Jeju route

Before LCCs were introduced, South Korea's two FSCs operated in the Seoul-Jeju route. Since all flights were operated by jet aircrafts (manufactured by Boeing or Airbus), air passengers of Korea were used to travelling in jet aircrafts. The safety of air travel was highly appreciated by air passengers of Korea since there were no serious aircraft accidents by Korean FSCs since the year 2000.

LCCs' contribution to increasing air passenger demand is significant in the market. As shown in Fig. 2, the average annual growth rate of air passenger volume in the Seoul-Jeju route had been 6.10% before 2006, the year that LCCs started service. After the LCCs' market entry, annual growth rate of air passenger volume jumped to 9.18%. On the other hand, the number of FSC passengers has decreased by an annual average of 4.14% since the introduction of LCCs' to the market. The average growth rate of LCCs' passenger volume has been 75.55%.

3.2. LCC operation on the route

Jeju Air, one of the LCCs which started its Seoul-Jeju route service in 2006, adopted the use of Q400 turboprop aircrafts for its initial operation. Passengers were hesitant towards LCCs because it was the first time that a turboprop aircraft like the Q400 was introduced in Korea for regular flight service. Moreover, because there have been several minor safety events since the first propeller powered aircraft flight service on the route, Korean passengers have become aware of safety issues of LCCs. Eventually, Jeju Air changed all of its aircraft types to jet aircrafts. Furthermore, all of the new LCCs also shifted to jet aircrafts such as the Boeing 737. Nowadays, LCCs have partly overcome the safety problem by reducing frequency of accidents and incidents (Fig. 3).

Meanwhile, one of the advantages of the Jeju route is that the duty free shops in Jeju airport is the only place where domestic route passengers can access duty free items. As you can see from Table 1, the Jeju airport's domestic flight duty free shops' sales has increased at an annual average of about 24.6% with domestic passengers taking up about 30% of the Jeju airport users. Travelers can buy liquor, cigarettes and cosmetics in duty free shops at a relatively lower price (Table 2).

3.3. AHP analysis for selection of new variables

Through the review of previous studies and the Seoul-Jeju route's market situation, a bundle of variables were drawn for the SP experiment on air travel choice as shown in Table 3.

Since it is necessary to limit the number of attributes for an effective SP experiment, choosing only a few important variables which have significant impact on travel choice is inevitable. This study utilizes major variables of travel choice such as, travel costs (air and HSR fare), travel time and frequency of service. In addition, we decided to include a few more variables in order to reflect special characteristics of the market. To choose the additional variables, the study surveyed experts' opinions. A panel of eight experts of aviation industry in Korea were asked to select candidate variables which may have affected the increase of air passengers on the Seoul-Jeju route. Based on their selection, an Analytic Hierarchy Process (AHP) analysis was done to select two additional variables