Ticket Price Sensitivity of Airport Rail Link—a Case Study of Changsha Maglev Express

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Abstract. There is difference between airport rail link and urban rail transit in service tenet and service object. Urban rail transit serves mostly for urban residents, to meet their needs of commuting and daily life, while the chief target passengers of airport rail link consist of air passengers whose trip purposes are connecting flights from or to the city. The travel time value and price sensitivity of passengers who take the airport rail link are quite different from those who take the urban rail transit. Changsha Maglev Express Line, opened in May of 2016, is an airport rail link applying the technology of urban maglev transportation. Before the opening of commercial operation, the authors conducted a sample survey on passengers and staffs at Changsha Huanghua International Airport, to get information of the willingness of the target passenger’s ridership and acceptable fares of the rail. Passenger's price sensitivity of Changsha Maglev Express is calculated, and the price deciding work of Changsha Maglev Express is contributed. The paper could provide some useful reference to the study of pricing and incomes on other airport link rails.

1. Introduction
As a mass public-transportation mode, the rail transit performs an important role in the landside of large airports. It can reduce part of the ridership of cars and taxis, alleviating road congestion around the airport area, partly changing passengers’ transport structure in the airport's landside. It also improves environmental protection and energy conservation in the landside transportation.

In a good situation, the investment of roads and parking facilities in the airport area could be partly reduced, on account of the substitution effect of rail transit. And the land-side accessibility of the airport could be improved, which will enhance the competitive power in the regional airports system.

On airport rail link, the passengers generally have very higher travel time value than those on other urban rail. They require more time reliability, more comfort and more convenience to the rail link. So the ticket price of dedicated rail line, which connects airport to the city, is generally more expensive than other urban rail transits, under the condition of equal distance.

2. Literature Review
The number of literatures on fare sensitivity of the airport rail link line is rather small. But as a kind of public transportation, the fare directly affects the passenger's ride demand. Fare sensitivity is directly related to demand elasticity.

Pels et al. (2003) concluded that business travelers have a higher value of time than leisure travelers.
In the access mode choice, leisure travelers have higher cost elasticity, while business travelers have higher access time elasticity[1]. Among the literatures on public transport, Litman (2004) studied transit elasticity values based on short- and medium-run impacts, by changes of real incomes, fare increases and service cuts[2]. Paulley et al. (2006) had their key findings on the factors affecting public transport demand, regarding the influence of fares, quality of service and income and car ownership, after a wide range of factors was examined[3].

In China, the history of urban rail transit began to appear and in operation is not long. In Wang’s (2008) research, the price of the rail transit shall insure the maximum profits, the balance between the operating costs and social benefits. The different pricing strategies should be adopted in different times, the initial period of operation, the period of operation revenue equilibrium and the period of profits retained[4].

3. Methodologies
With the increasing income level of residents, passengers prefer to choose more comfortable, more convenient and more reliable transportation modes. When making travelling decisions, the price factor will gradually be less important than before. However, at present stage, the fare is still an important factor which affects travelers’ choice of transportation modes. Passengers need to balance their needs and make better choices between trip time, reliability and fares. The fare is a sensitive factor. When it changes, the passenger’s ridership and the ticket incomes of the rail will both be affected.

The formula for calculating Ed is as follows:

\[ E_d = \frac{\Delta Q}{\Delta P} = \frac{Q}{P} \]  

In Equation (1): Q, P——the amount of demand and fare
\[ \Delta Q, \Delta P —— the amount of change in demand and fare \]

When the fare of urban maglev is lower, the induced traffic volume will be higher. On the contrary, the fare increased, the passenger traffic will decrease. The passenger traffic elasticity is different at variable prices. The economic meaning of Ed is: when the fare increases or decreases by 1%, the demand will decrease or increase by a few percent.

Through demand-price elasticity formula, the sensitivity of passengers to different fares can be measured, and then the passenger traffic under different fares can be analyzed to provide a basis for comparative analysis of fare schemes.

4. Results and Analysis

4.1. Briefing of the Survey on Changsha Maglev Express Line
Changsha Maglev Express Line, started trial operations in May 2016, is the first and unique urban maglev line in commercial operation in China. It locates in suburb of Changsha City, the capital of Hunan Province. The track stretches 18.55 kilometers, connecting Changsha South Railway Station to the terminal of Changsha Huanghua International Airport.

On June of 2015, the research team of National Maglev Transportation Engineering R&D Center of Tongji University, assisted with the team from Hunan Maglev Transportation Development Co. Ltd, carried out the survey of passengers’ willingness of ride Changsha Maglev Express Line in near future. About 1960 valid samples of air passengers were got.

Based on the survey data of passengers’ willingness of ridership, the paper analyzes the impact of fare changes on the passenger traffic and the operating income.

4.2. The Survey Results of Changsha Maglev Express
The authors compare Changsha Maglev Express with other transport modes from Changsha Huanghua International Airport to Changsha South Railway Station, including time, cost and comprehensive utility
in comparison. The results show that the Changsha maglev project has obvious advantages in riding time. The travel time is only 45% of the airport bus; and the price of 20~30 CNY of one person is also lower than the taxi fare. From the perspective of comprehensive utilities, taxi is relatively close to airport bus, which currently is the same as the situation of passenger traffic. We predict that when the fare of Changsha maglev project is in 20-30 CNY, the comprehensive utilities of taking maglev is better than taking the airport bus or taking taxi.

According to the survey on the willingness of passengers in Changsha Airport for the fare of Changsha Maglev Express, the result is, that more than half (51.32%) of the passengers are willing to accept fares of more than 20 CNY, but the proportion of passengers willing to accept more than 30 CNY is only 7.71%. Only 21.87% of passengers will only accept fares below 15 CNY (Figure 1).

4.3. Fare Sensitivity Analysis of Changsha Maglev Express

In view of the results of the passenger sample survey, the authors measured the expected operating costs and revenues of the operator, Hunan Maglev Transportation Development Co. Ltd. The Price Administration Bureau of Changsha City, in April 2016, invited experts and departments representing relevant interests to participate a demonstration conference, and most of the attendees thought it better to charge a 20 CNY one-way ticket. After that conference, the Price Administration Bureau approved the proposal of 20 CNY for one-way standard fare for the Changsha Maglev Express Line.

According to the sample survey results and the average passenger traffic of the Changsha Maglev Express Line from 2017 to 2018, the authors made a polynomial regression analysis on the relationship between the ridership and the fare of this line (Figure 2).
The result of the polynomial regression is:

\[ Y = -14.238x^2 - 75.506x + 15576 \]  \hspace{1cm} (2)

In Equation (2), \( Y \): Ridership, 
\( x \): Single-way standard ticket fare.

In this regression equation, the significance level \( R^2 = 0.9876 \).

After that, the corresponding elastic value can be calculated (Figure 3).

![Figure 3. Price Elasticity Coefficient of Passenger Traffic Demand](image)

From the calculation results, it can be seen that, in the price range of 5 CNY to 20 CNY, the change of passenger traffic demand is not too obvious with the increase of the fare, and the absolute value of the demand price elasticity is obviously less than 1, indicating that the passenger's price sensitivity is very low within this price range.

Although the passenger traffic demand is relatively large, the income of the operating enterprise is too low due to the low fare; while in the price range of 20~25 CNY, the absolute value of the demand elasticity coefficient is larger than 1, and the passenger traffic demand changes significantly, indicating that the passenger traffic demand is sensitive to price in this price range. Also in this range, the economic and social benefits can be maximized at the same time; after the fare exceeds 25 CNY, passengers are too sensitive to price, passenger demand is low, and it is difficult to achieve the maximized economic benefits and social benefits.

5. Conclusions

The express rail of airport landside is a public transportation mode with high operating costs and relatively narrow service scope. It mainly provides rapid connection services between the airport and the city, more directly and with fewer stops.

With these kinds of services, the ridership of cars and taxis to access the airport could be partly reduced, and road congestion could be alleviated around the airport area. And the land-side accessibility of the airport could be improved. Most importantly, it can improve the land-side accessibility of the airport.

As an important public transportation mode to connecting the airport and the city, the airport express rail must be priced in cooperation with the average income of the residents. When formulating the fare, it is necessary to focus on the passenger's economic ability and willingness to pay. Therefore, in order to meet the travel demand of different people, it is necessary to analyze and predict the economic affordability of residents for travel, and accordingly formulate a reasonable fare plan.

At the same time, we also refer to the case of landside rails in large hub airports of China and abroad, when making the price plan of Changsha Maglev Express. And the preliminary works are also in consideration with, such as passenger traffic forecasting, operating cost estimation, and residents’ average income analysis. The overall social benefits and operational benefits are also taken into account.

Based on the above works, the fare plans of Changsha Maglev Express are proposed to attract more passenger ridership, which are a pricing scheme of single-way standard fare in 20 CNY/per person and
a series of preferential price and discounting schemes.

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