Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2014, 6(4):370-375

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Airport transport corridor system dynamics model and simulation

He Changquan[1,2]

[1]School of Transportation and Logistics, Southwest Jiaotong University, Chengdu, China
[2]School of Architecture, Southwest Jiaotong University, Chengdu, China

---

ABSTRACT

A complex and stable system is constituted by airport passenger volume, airport transport corridor and construction investment. In the system, the capacity and congestion level of airport transport corridor would affect airport passenger volume, and construction investment would improve airport transport volume to meet the needs of airport passenger volume growth. From the view of system dynamic, system dynamics mechanism on airport transport corridor was analyzed, a system dynamics model containing airport passenger volume, airport transport corridor capacity and construction investment was established, and then the reasonableness was examined. Two conclusions were obtained through simulation analysis. On the one hand, it is related to the long-term development of the aviation industry whether two parameters, congestion threshold and improvement coefficient on airport transport corridor, should be set reasonably. On the other hand, within the allowable range, moderate advance investment on airport transport corridor can meet the needs of long-term traffic development, and promote the healthy development of the aviation industry.

Key words: airport transport corridor; passenger volume; congestion level; system dynamics; simulation

---

INTRODUCTION

Because of its fast, convenient and comfort features, air transport has been a major mode of transport commonly used in international passenger and freight transport in the long-distance transport, and plays an important role in the overall transportation system. Airport, as an important node in air transport, which provide a place to facilitate passenger boarding and take down, plays a transportation hub role. Airport transport corridor connects airport and the main urban areas, and affects passengers' chooses for air transport because of its convenient. And reasonable prediction for airport transport corridor passenger volume is an important significance for planning airport transportation corridor scale and promoting the healthy development of air transport.

Airport transport corridor has researched on since 1960s. Yoichi Arailz[1] described the airport transport corridor in the world's major hub airport in "The world Airports". Most scholars focused on the choose behavior for airport transport corridor. Monteiro & Stephane Hess[2] studied the effects owing to the passenger choice of different transportation modes to airport in the case of multi-airport. Costas Abacoumkin[3] analyzed the choice of airport transport corridor based on cost and time expenditure. Lythgoe & Wardman [4] studied the effects of travel price and service levels and other factors to travel options and discusses the measures to attract more travelers to choose public transportation to airport. Loo [5] adopted Stated Preference data to analyze the travelers choice behavior in Hong Kong International Airport. Tam [6] researched on the transport mode choice problem to airport, which is affected by time reliability and perceived service quality, and service quality can be proved improving through application of the Hong Kong International Airport data. Chang [7] studied the special factors of the elderly on the choice for airport transportation corridor. In addition, Mark [8], Su [9], Tam [10] and others have done some research in the fields.

In the existing literature, the majority studies of scholars are based on certain assumptions and simplified reality from a certain aspect. However, a large complex system, which is constituted by airport transport corridor, air passenger volume, and construction investment for airport transport corridor volume, etc, has not been found from perspective of system dynamics to study. The paper intends to discuss the development of airport transport corridor passenger volume s from the perspective of system dynamics.

1. Problem description and Assumption

Problem description

The airport transport corridor system studied in this paper consists of airport transport corridor capacity, air passenger volume and construction investment. In this system, changes in airport passenger volume can impact on airport transport corridor congestion, and construction investment can improve airport transport corridor capacity so as to improve airport transport corridor congestion. Specifically, the growth of airport passenger volume will increase airport transport corridor congestion level, and the increase of congestion level will make passenger dissatisfaction, so affect travelers choose air travel again. When airport transport corridor congestion reaches a certain threshold, it is necessary to increase the airport transport corridor capacity through the channel of the investment to improve airport access crowding to meet passenger air travel needs.

2.2 Assumption

(1)Passenger in and out of airport contains four categories: airline passenger, sent-off and pick-up passenger, commuter passenger and passenger using airport to transfer other transport modes. Assuming these four are in and out of airport through airport passenger transport corridor, while do not stay airport long time.

(2) To facilitate the study, assuming only passenger satisfaction rate is proportional to the rate of flights taking off and landing on time, while is inversely proportional to the airport transport corridor congestion.

(3) Assuming congestion threshold is the indicator for the control of whether to invest in improving the airport transport corridor capacity. If airport transport corridor congestion is greater than the congestion threshold, construction investment will is adopted to improve the degree of congestion; while if airport transport corridor congestion is less than the threshold, no investment will happen.
(4)Assuming investment to improve airport transport corridor is proportional to improving airport transport corridor capacity.

2. System dynamics modeling and Examination

2.1 System flow graph model

Base on the analysis, the system flow graph model is shown in figure 1. In which, the spare parts inventory in central warehouse is decided by the spare parts production, the spare parts sale volume and the spare parts emergency replacement volume. Spare parts inventory in local warehouse is decided by the spare parts sale volume and the spare parts storage replacement volume. The holding products volume is determined by the obsolete products volume and sales volume.

Base on the analysis, the system flow graph model is shown in figure 1. In which, state variables contain passenger volume, airport transport capacity, and construction fund pool, and rate variables contain the growth of passenger volume, the growth of capacity, the increase of construction fund, and consumption of investment. In all variables, passenger volume depends on the growth of passenger volume, and airport transport corridor capacity depends on the growth of capacity, and construction fund pool is determined by the increase of construction fund and consumption of investment.

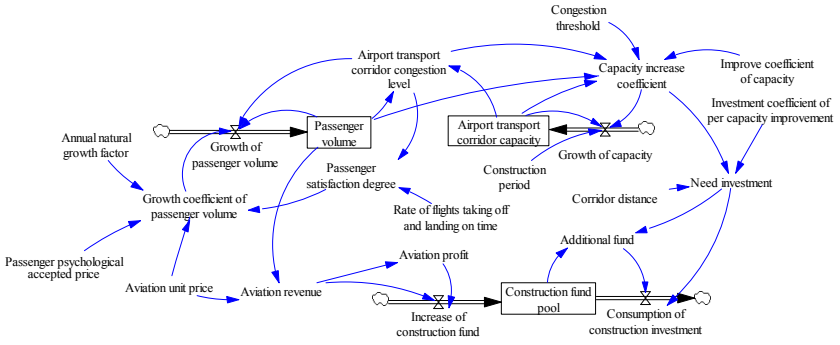

Figure 1. System flow graph model

2.2 Instruction for equations

(1) Equations for passenger volume

Passenger volume= INTEG (Growth of passenger volume+ Growth of passenger volume, 3000)

Growth of passenger volume= Passenger volume×(1-Airport transport corridor congestion level) ×Growth coefficient of passenger volume

Growth coefficient of passenger volume= Annual natural growth factor×(1-Aviation unit price/Passenger psychological accepted price + SIN(Passenger satisfaction degree))

Airport transport corridor congestion level= Passenger volume/Airport transport corridor capacity

(2) Equations for airport transport corridor capacity

Airport transport corridor capacity= INTEG (Growth of capacity, 6000)

Growth of capacity= DELAY1I(Airport transport corridor capacity×Capacity increase coefficient, Construction period , 0)

Capacity increase coefficient=IF THEN ELSE(Airport transport corridor congestion level>= Congestion threshold, (Passenger volume/(Airport transport corridor congestion level-Improve coefficient of capacity)-Airport transport corridor capacity)/Airport transport corridor capacity , 0)

(3) Equations for construction fund pool

Additional fund= IF THEN ELSE(Needed investment>0:AND:Needed investment> construction fund pool, Needed investment-construction fund pool , 0)

Aviation profit= Aviation revenue×0.005

Aviation revenue=Aviation unit price×Passenger volume×1000

Construction fund pool= INTEG (+Increase of construction fund-Consumption of construction investment, 0)

Consumption of construction investment=Needed investment-Additional fund

Increase of construction fund= Aviation revenue*0.002+Aviation profit×0.3

Needed investment= Investment coefficient of per capacity improvement*Corridor distance*Capacity increase coefficient ×100

Passenger satisfaction degree= Rate of flights taking off and landing on time/Airport transport corridor congestion level

(4)Constant setting

Constant setting is shown in table 1.

Table1. constant setting

Rate of flights taking off and landing on time	0.4
Aviation unit price	0.75
Construction period	2
Corridor distance	15
Passenger psychological accepted price	0.8
Annual natural growth factor	0.1
Congestion threshold	0.7
Improve coefficient of capacity	0.3
Investment coefficient of per capacity improvement	1000

3.3 Model test

The test on system dynamics model includes dimensional consistency test, mechanical error test, model validation test and extreme conditions test. The established system dynamics model above passed the dimensional consistency test, mechanical error test and model validation test by the software of Vensim. We did the simulation test with the extreme condition that the initial value of passenger volume is 1, and annual natural growth factor is 0. Simulation

results show that passenger volume is a constant value of 1, and airport transport corridor capacity is a constant value 6000, and the growth of construction fund pool is linear, and capacity increase coefficient, needed fund, additional fund are constant values of 0. Based on the simulation, this model passed the extreme conditions test.

3. Simulation

The simulations below adopt the settings as follows: INSTALL_TIME=0, FINAL_TIME=50, TIME_STEP=1.

4.1 Congestion threshold variation

With the growth of passenger volume, under the conditions that airport transport corridor capacity is constant, the airport transport corridor congestion level will gradually increase. If the airport transport corridor congestion level does not exceed the congestion threshold, the airport transport corridor capacity is not changed. While once it goes beyond congestion threshold, construction investment will be needed to improve the capacity to reduce airport transport corridor capacity congestion level to meet passenger volume growth needs. Generally speaking, smooth and convenient airport transport corridor can contribute to improve passenger satisfaction, and further affect aviation revenue and profit. Therefore, a reasonable level of congestion threshold has a significant impact to construction investment, passenger volume, airport transport corridor capacity and aviation revenue.

Changes in different congestion threshold were used to analyze its effect to the key variables. The congestion threshold was set at 0.6, 0.7, 0.8, 0.9, and changes in key variables simulation are shown as below.

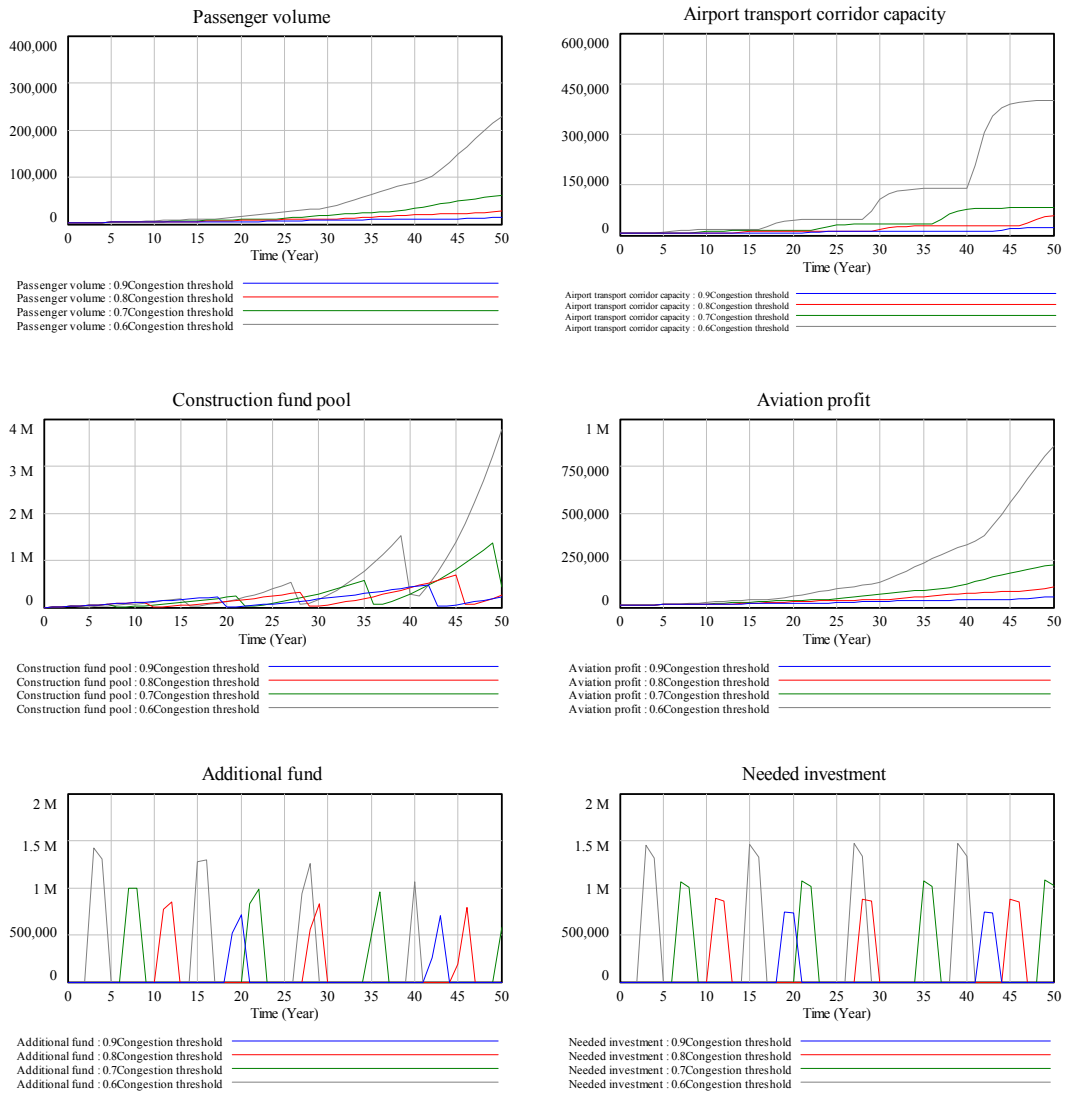

Figure 2. The simulation of congestion threshold variation

By the simulation of changes in different congestion threshold, the lower degree of congestion threshold, the more obviously that it does not only promotes the passenger volume and improves airport transport corridor capacity, but

also improve aviation revenue and profit. Meanwhile, the lower level of congestion threshold, the greater amount of construction investment needed, especially for additional fund in the early days. Therefore, a reasonable degree of congestion threshold setting, on the one hand need to moderate advance, never to improve congestion when a serious impact happens, while on the other hand to take the pre-investment funds into account. Meanwhile, additional fund can be seen as supportive to the development of aviation industry, and the support for the healthy development of the aviation industry plays an significant role.

4.2 Improvement coefficient of capacity variation

If airport transport corridor congestion level exceeds congestion threshold, airport transport corridor capacity is needed to improve by investment. Different measures to improve congestion usually need different investment amount, while the investment amount is related to the degree of improve congestion. In the paper, the degree of improvement airport transport corridor capacity is controlled by improvement coefficient of capacity. Therefore, a reasonable degree of improvement coefficient of capacity has a significant impact to passenger volume, airport transport corridor capacity, and aviation revenue and profit.

Changes in improvement coefficient of capacity were used to analyze its effect to the key variables. The improvement coefficient of capacity was set at 0.2, 0.3, 0.4, 0.5, and changes in key variables simulation are shown as below.

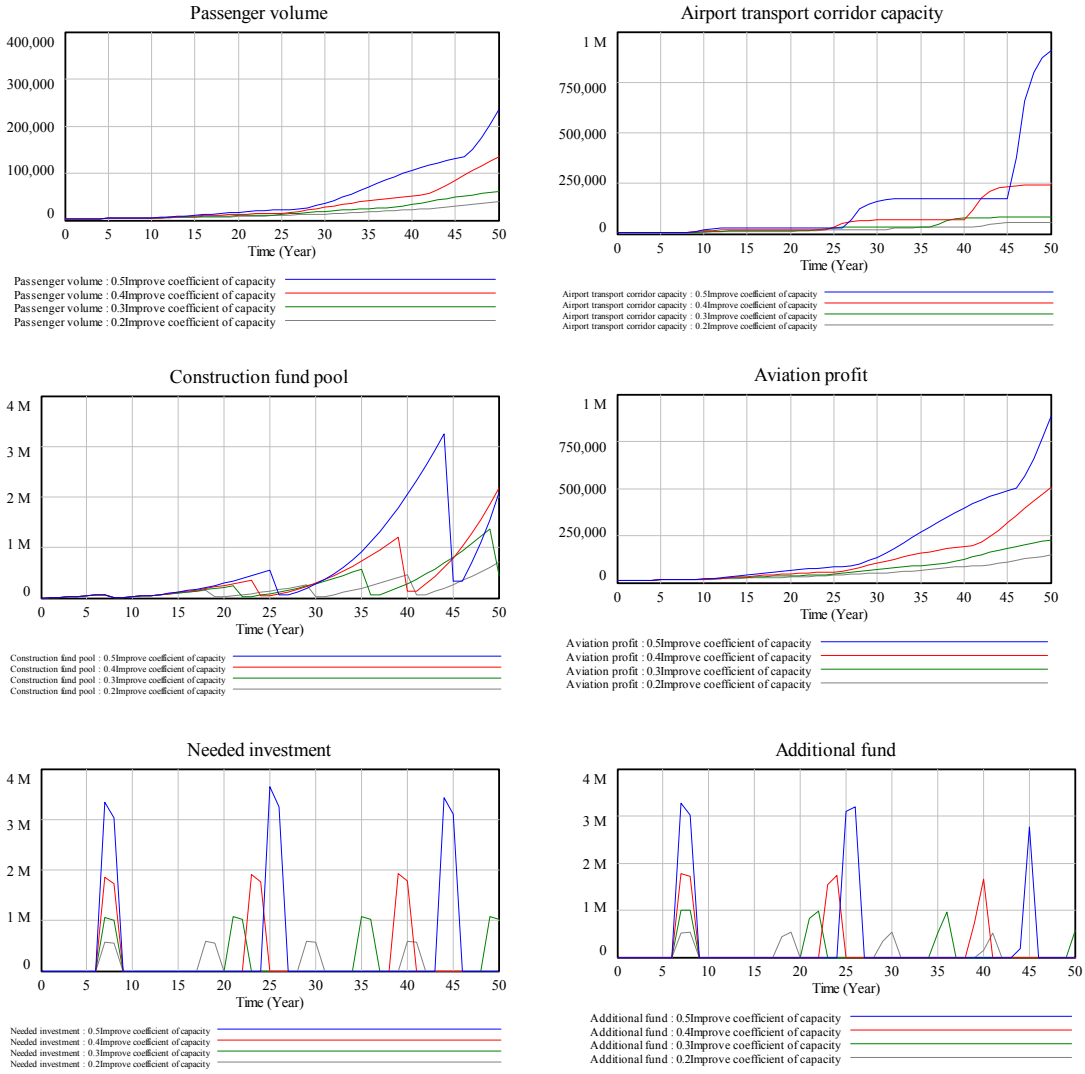

Figure 2. The simulation of improvement coefficient of capacity variation

By the simulation of changes in different improvement coefficient of capacity, it was not obvious to affect passenger volume, airport transport corridor capacity, and aviation revenue in the early. But in the long term, the greater improvement for coefficient of capacity, the greater amount of one-time construction investment needed, and meanwhile, the greater influence it increases passenger volume, improve airport transport corridor capacity, and

enhance aviation revenue, but the greater amount of additional fund needed. Therefore, within the allowance of funds, the improvement of airport transport corridor capacity can be moderate advance to meet the needs of long-term passenger volume, and it can promote the healthy development of the aviation industry.

CONCLUSION

Airport transport corridor, connecting the airport and the city, is the must pass which passenger choose air travel. Convenient and smooth airport transport corridor can play a certain positive role for people to choose air travel. This paper analyzed interaction mechanism of passenger volume, airport transport corridor capacity and construction fund pool, established a system dynamics model, and develop some meaningful conclusion by the simulation of changes in congestion threshold, improvement coefficient of capacity. The further research in the fields can enrich the theory by the actual data.

REFERENCES

[1]Yo1ehi Arai. The World Airports: International Airport sand Their Commercial Facilities. Tokyo: Shotenkenehiku-Sha,**1996**.
[2]Monteiro A B F , Hansen M. *Transportation Research Reeord* , **1999**, 12 : 38-47.
[3]Costas Abaeoumkin. *Journal of Air Transport Management* . **2002**, 8(2): 89-98.
[4]Lythgoe and W. Wardman. *Transportation*. **2002**, 29(2): 125 一 143.
[5]Beeky P , Loo H. *Journal of Transport Geography*, **2008**(16):117-125.
[6]Mei-Ling Tam, etc. *Journal of Choice Modelling* , **2011**, 4(2), 49-69.
[7]Yu-Chun Chang. *Transportation Research Part E*, **2013**,57(10),:105-112.
[8]Mark, T. L. and J., Swait. *Health Economics*,**2004**,13(6), 563-573.
[9]Su, F., Bell, M.G.H. *Transportation Economics* . **2009**, 25, 46–55.
[10]Tam, M. L., W. H. K., Lam and H. P., Lo. *Transportmetrica*. **2010**,6(1), 3-17.
[11]Zhong Y.G., Li X., Jia X.Q.. System Dynamics [M]. Science and Technology Press,**2009**.