

# Hierarchy Analysis and Strategies on the Imbalance between Supply and Demand of Urban Traffic

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**Abstract:** It is well-known that traffic congestion results from the imbalance between supply and demand of urban traffic. However, the phenomenon of “shifting the burden” exists in urban traffic management. This phenomenon stems from the lack of understanding of the essential cause of traffic imbalance and the validity evaluation of the traffic strategies. To probe the essence of traffic imbalance, traffic imbalance concept is classified into structural imbalance and coupling imbalance. It is also pointed out that game relationships with conflict of interest and dynamic reaction between traffic suppliers and travelers exist. Based on the effect analysis of game relationships on the urban traffic, the hierarchical strategy frame is proposed to balance the relationship between traffic supply and demand.

**Key Words:** urban transport; supply-demand imbalance; hierarchy analysis; control strategy

## 1 Introduction

It is well known that the urban traffic system is the lifeline of a city, which plays a key role in maintaining economic development and the citizens' daily lives. People's demand on traffic is increasing sharply with the rapid development of national economy and the speedup of civilization in China. Unfortunately, traffic jams appear frequently and the contradiction between traffic supply and demand is becoming increasingly serious owing to the inherent limitation and time delay characteristics of traffic supply. How to mitigate urban traffic congestion has been constantly investigated by several scholars and practitioners in the world<sup>[1–17]</sup>. However, the previous research in this field lacks a clear hierarchy framework, which often results in the occurrence of “shifting the burden” phenomenon in the course of traffic management.

In this paper, the factors that may cause the imbalance between urban traffic supply and demand are classified by the use of the systematic analysis approach. A system framework with two hierarchies is established and two key reasons that lead to “shifting the burden” phenomenon are presented. It is seen that there is a game relationship between traffic supplier

and travelers with the conflict of interest and dynamic responsive characteristics. After analyzing the impacts of this game relationship on the supply-demand balance of urban traffic, the strategic framework of how to adjust the balance between urban traffic supply and demand from the two hierarchies is provided.

## 2 “Shifting the burden” phenomenon in urban traffic management

To mitigate the increasing contradiction between traffic supply and demand and to meet the travel demand of the citizens, the local government in China has invested a large amount of money in building roads or broadening road capacities. For example, in the earlier 1980s, with the aim of solving the traffic congestion in the old city area, the government of Beijing made a huge investment to remove several houses and to reform several tens of planar intersections and a good number of bottleneck links. These activities actually improved the traffic condition in the old town area for a short period of time. However, the congestion occurred again soon owing to the fact that more and more

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traffic flows were attracted to this area in virtue of the improvement of the traffic conditions.

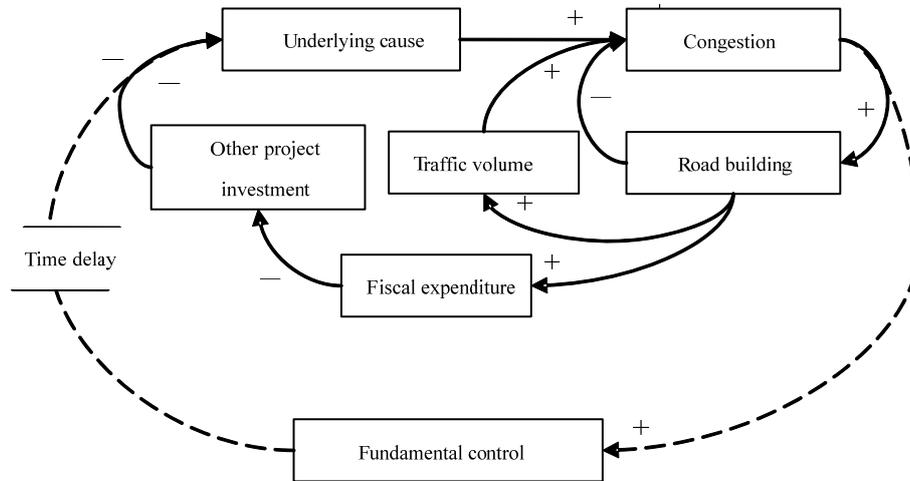


Fig. 1 Structural analysis of “shifting the burden” phenomenon in urban traffic management

The urban traffic system is a dynamic system involving several related factors. There exists an interactive relationship among these factors. If one of these is changed, it will result in a series of changes of several factors, which will eventually lead to an unexpected consequence. For instance, the managers become conscious of traffic congestion and conclude that it is a result of shortage of traffic supply. They thus take measures such as building new roads and widening the old ones to enhance the traffic supply. However, they do not get the expected results finally. The other two kinds of influence in the urban traffic system are depicted in Fig. 1. Firstly, the increased supply attracts more rapid increase of resident trips, which will make the limited incremental road capacity fail to meet the demand and let traffic congestion become worse than earlier owing to Downs law. Secondly, building new roads and widening old roads need to expend huge amount of money and resources. Owing to the limited financial budget, investment to other transport projects such as public transport and intelligent transport will be cut down accordingly.

It can be concluded that building road and widening road is a surface control method of “shifting the burden”, which is essentially an ineffective and inefficient method. The two major reasons of the occurrence of this phenomenon are the lack of understanding of the fundamental reason of the imbalance and the failure to evaluate its validity objectively when one measure is under consideration. Only when the essential cause behind the imbalance is found and the approach addressing both the surface and root is adopted, the traffic congestion can be reduced.

To determine the essential cause of the traffic supply-demand imbalance, it is necessary to establish a correct

analysis framework.

### 3 Hierarchy differentiation of cause of urban traffic supply-demand imbalance

The supply side and the demand side of the urban traffic system is a contradiction unity with mutual interaction and influence. When one side is rising, the other is increasing accordingly. If two sides can not match in traffic products and service attribution, such as time, space, quantity, model, quality, etc, the traffic supply-demand imbalance will occur. In order to probe the essence of the supply-demand imbalance, we will discuss it from the view of structural imbalance and coupling imbalance.

#### 3.1 The urban traffic supply-demand structural imbalance

Structural imbalance can be described from the supply side and the demand side. The imbalance between city land use and road network layout is a major structural contradiction. In a narrow sense, the supply structure of urban traffic is composed of urban road network (driving road, pedestrian road), parking facilities, and all the means of transportation. According to the generation mechanism of traffic demand, the city population scale and the land use pattern determine the total load of demand and its temporary and spatial distribution characteristics, the trip generation intensity, and the flow direction. City traffic jams may be caused by inadequate consideration of some demand factors such as city morphology, population distribution, etc. It may be caused by the lack of consideration of the impact of the traffic bottleneck, which may cause the imbalance between city land use and road network layout.

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