DEMAND MANAGEMENT BY ITS : AREA PRICING FOR IMPROVING SUSTAINABILITY OF TRANSIT DEMAND

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1 INTRODUCTION

Metropolitan cities in all over the world experience severe transportation problems. Congestion is one of the most probed one in literature among those problems. For solving transportation problems, it is understood that the conventional approach: building more and more roads does not work anymore for a variety of political, financial and environmental reasons. The inability to expand the system in many areas has resulted in the need to find methods of using the existing systems as efficient as possible. This idea brought up the issue of management in transportation field. The new management concept focuses on the primary objective of ensuring an effective and efficient transportation system which is also the main idea of ITS. Thus, the motivation of this paper can basically be defined as applying ITS technologies to Demand Management strategies, particularly for reducing automobile traffic in downtown areas, reducing congestion and its negative effects and thus increasing quality of life. In this paper, a proposal of ITS application, which is mainly a demand management tool for improving sustainability of transit demand, is aimed to open to discussion. The idea is a pricing strategy, which employs advanced ITS technologies to divert demand from automobile use to transit ridership in city centers.

2 METHODOLOGY

The proposed management strategy needs to work on two main components of transportation: demand and supply side. Demand side works include grouping automobile users and determining their price elasticity. First step of the supply side work is building a cordon network according to city structure. Then, according to the price elasticity of the automobile users, special pricing schemes should be identified for all cordons. These pricing schemes should be variable according to real traffic conditions (depending on congestion level). Real-time traffic conditions will be obtained by using ITS technologies from a Traffic Management Center (TMC) and variable-pricing schemes will be determined with the help of an advanced algorithm. In addition to these transportation system related
technologies, drivers too need special devices in their cars to enable them to pay for using specific roads to enter predetermined areas. The devices in the cars will be charged automatically as they passed through a cordon. Then the revenue earned from pricing strategy can be used for mainly improving transit facilities. Here, it is expected that pricing schemes will lead demand for transit to increase.

2.1 Works related with demand
For employing an effective variable pricing policy on an area base, it is very important that determining the price ranges of user groups. Therefore, a survey will be needed to obtain user profile (socio-economic or census information also can be used if suitable). On the other hand, to reach a satisfying result from pricing policy, the price elasticity of the users should be examined very precisely and an adequate level of elasticity should exist. While doing this research, factors affecting price sensitivity should also be considered since elasticity is actually functions with several possible variables. These factors can be stated as follows (On-line TDM Encyclopedia):

- Type of price change (magnitude of change)
- Type of trip
- Type of traveler (income level)
- Quality and price of alternative routes, modes and destinations

In this proposal, cordon pricing is chosen among road pricing methods. In a study by May and Milne, an urban traffic model was used to compare the impacts of four types of road pricing schemes: cordon tolls, distance pricing, time pricing and congestion pricing. Significant differences had been found in the performance of these different strategies. In the table below, it is shown that the estimated price level required to achieve a 10% reduction in total vehicle trips in the region. (May and Milne, 2000)

<table>
<thead>
<tr>
<th>Type of Road Pricing</th>
<th>Fee Required to Reduce Trips 10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cordon (pence per crossing)</td>
<td>45</td>
</tr>
<tr>
<td>Distance (pence per kilometer)</td>
<td>20</td>
</tr>
<tr>
<td>Time (pence per minute)</td>
<td>11</td>
</tr>
<tr>
<td>Congestion (pence per minute delay)</td>
<td>200</td>
</tr>
</tbody>
</table>

As it can be seen in Table 1, the most effective strategy is time-based pricing providing the greatest overall transportation benefits. It is followed by distance-based pricing, cordon pricing and finally congestion pricing. In this proposal, cordon pricing will be used with varying pricing policy according to real time traffic conditions. Therefore, it can be assumed as a combined pricing policy including time, cordon and congestion types at the same time. In this case, since the prices will be charged automatically from the driver’s
account, several prices can be combined and charged all together. For instance, constant amounts can be charged for environmental reasons.

2.2 Works related with supply

2.2.1 Network identification
First of all, study area should be identified and then transportation network of the study area including surrounding area should be obtained. The decision of the cordon borders to implement pricing policy is the most important and critical part of the project. In this step, designer should conduct a very comprehensive study considering land use pattern, city development plans and user characteristics. Another important issue is that the designer should get in contact with decision makers and community.

By considering all above mentioned points, cordon lines can be determined according to city structure (whether grid, radial or longitudinal). In order to provide a properly working charging system, this data should be in electronic format. A GIS based map will be suitable for this purpose. In GIS medium, all information about the area borders can be stored and connection between vehicle and TMC can be provided.

2.2.2 Proposed system structure and its components
The system consists of three main components: Traffic Management Center, Satellite System (for Vehicle Positioning System) and vehicle system. The structure of the system components and their relations can be seen in (Fig. 1) below.

![Figure 1. The structure of the pricing system components and their relations](image-url)
Traffic Management Center

TMC is one of the very important components of the system since pricing scheme will be varying according to real time traffic conditions. In this proposal, one more function will be assigned to TCMs in addition to their classical functions. The cordon network will be defined in electronic map. Real time traffic conditions, particularly congestion propagation will be detected by relevant ITS technologies. Obtained traffic data and predetermined elasticity characteristics of the user groups will be the input for a specially developed algorithm which will determine the appropriate price for each cordon (or area border). Then with the help of satellite technology, estimated charge values will be transferred to IVUs installed into the vehicles.

Vehicle Positioning System(VPS) and Vehicle System

Although the method is developed recently, the research on application of the method is still ongoing. Until recently, most approaches to electronic fee collection have been based on vehicle-roadside links using a method named as Dedicated Short-Range Communication (DSRC). A new method, called as Vehicle Positioning System technology has introduced the concept of ‘virtual gantry’. Although only Germany and Hong Kong have tested systems with full enforcement capabilities, trials in Australia, Denmark, Germany, Hong Kong and the UK have demonstrated its potential. (Path, Berkeley, On-line Library).

For this system, an In-Vehicle Unit (IVU) is necessary to use an autonomous positioning system to locate a vehicle within a network or a special charge area. The autonomous positioning system can be GPS. The IVU contains all necessary information of charging structure and can determine whether charges should be applied or not. In this proposal, charging information will be sent through TMC as traffic conditions require a price change. Therefore, charging information will be updated regularly. The deduction of the charge can either be directly from a smart card held in the IVU or stored for later transmission and debiting to a centrally held account.

By this way, there is no need for extra infrastructure on roadside. On the contrary, VPS-based systems potentially offer much greater flexibility in defining, or refining, charging systems. Communication between TMC and IVU will be provided by GPS and GIS technology. Also any changes in road networks or land use patterns can be readily implemented without on-street alterations. The main disadvantage of VPS is the higher cost of the IVUs. Although VPS-based in-vehicle costs are likely to remain higher than the equivalent DSRC equipment, full system costs may be comparable because of the smaller infrastructure cost using VPS. (Path, Berkeley, On-line Library)
3 CONCLUSIONS

It has become a current issue that a changing management and policy climate, coupled with new technological developments, could improve the prospects for TDM to work effectively, despite the past negative experiences. With the experience obtained from the history of TDM, it is known that TDM efforts should focus on long-term goals, not short-term band-aids. Many studies and research projects conclude and suggest that TDM measures have not been implemented properly, therefore their potential has yet to be realized.

It is clear that the range of capabilities offered by ITS represent a potential breakthrough in the implementation of transportation demand management measures. The next several years will be most critical in determining how the adoption and implementation of these technologies will occur. And proponents of transportation demand management are hopeful that ITS technologies will be integrated into the array of policy goals that drive an environmentally-sustainable transportation policy today. (Chen, D.T,1996)

After this general overview, the results expected from this proposal, using ITS technologies for demand management and improving sustainability of transit demand, are stated below:

- By using proposed pricing strategy as a demand management tool, reducing automobile use in city centers, increasing demand for transit and thus increasing transit service quality
- Promoting carpooling and nonmotorized transport
- Shifting at least some portion of peak-hour travel to off-peak hours
- Shifting travel from congested locations
- Increasing overall quality of life (social, cultural, environmental and the like)
- Changing cites into livable places for people
- Increasing mobility for everyone, providing equity in society
- Relieving negative effects of congestion such as fuel consumption, air and noise pollution, time lost

REFERENCES


On-Line TDM Encyclopedia-Road Pricing Section, www.vtpi.org

Path, Berkeley, On-line Library, www.path.berkeley.edu/