Feasibility Research on the System of Real-time Traffic Information Between Taxis and Passengers

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Abstract: Based on the previous schemes to solve the problem of high empty-loading ratio to taxies, the paper discusses the development of taxi radio dispatch system, and the causes to the low efficiency of the system. By the system that mentioned previous, the effective information between passengers and taxi can’t be transferred on time; therefore, the problem of high taxi empty-loading ratio remains undecided. Combined with the existing experiences and the domestic market present situations, we design an operation framework of the interaction system of real-time traffic information, and analyze its applicability. This paper argues that traditional taxi radio dispatch system should be changed, and the system of real-time traffic information should be promoted, thus the problem of taxi empty-loading ratio can be solved effective. Copyright © 2013 IFSA.

Keywords: Transportation economy, System analysis, Taxi, Real-time, Traffic information.

1. Introduction

Based on GPS technology, the real-time traffic information interaction system will exchange the information between taxis and passengers real-timely, and match the two effectively. The system is focus on reducing the taxi empty-loading ratio and improving the utilization rate of social traffic resources. Taxi empty-loading ratio, generally refers to the percentage of the mileage that a taxi doesn’t carry passengers in the whole journey. High empty-loading ratio of taxi will cause a series of problems, such as the high fuel consumption, the low income of taxi driver, serious pollution and waste of road resources. According to Zhou Yong-Sheng and Wei Jie-Yu (2009), as the taxi mainly use the method of carrying passengers along the road, which is a traditional and backward mode of operation, empty-loading ratio is usually over 40 %, in the part of the city can even reach 50 % to 70 % [1].

"The daily damage statistics" about 66000 no-load taxis which takes the main models (Beijing Hyundai Elantra) as the prototype in Beijing is shown below. (Assume that each taxi travel 400 kilometers per day, with 10 liters fuel consumption per 100 km, and the average oil price is 8 Yuan. saving 1 liter of gasoline = 2.3 kg of carbon dioxide emissions reduction = 0.717 kg of carbon emissions reduction. Taxi’s occupation of road resources is 2.5 times as much as that of social vehicles). The harm of empty-loading ratio is shown in Table 1 and Table 2.

<table>
<thead>
<tr>
<th>Empty-loading ratio</th>
<th>Mileage (100km)</th>
<th>Empty-loading fuel consumption (t)</th>
<th>Empty-loading fuel cost (Million Yuan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 %</td>
<td>105600</td>
<td>1056</td>
<td>844.8</td>
</tr>
<tr>
<td>30 %</td>
<td>79200</td>
<td>792</td>
<td>633.6</td>
</tr>
<tr>
<td>20 %</td>
<td>52800</td>
<td>528</td>
<td>422.4</td>
</tr>
<tr>
<td>10 %</td>
<td>26400</td>
<td>264</td>
<td>211.2</td>
</tr>
</tbody>
</table>

Table 1. Damages of empty-loading ratio statistics 1
It is not difficult to see that, if the taxi empty-loading ratio decreased 10%, the waste of resources can reduce 25%. It is necessary to find effective and feasible ways to solve the problem of high empty-loading ratio. Some research suggested that the quantity of taxis can be controlled to reduce the empty-loading ratio of taxi, but this method does not have high practical significance. In many cities, the situation of surplus taxis and high taxi empty-loading ratio have developed for a period of time before taking the policy of limiting the number of taxis. However, the way which considers the actual situation and then limits on the size lack qualitative estimation of the scale of taxi, so it is not desirable. Many scholars have mentioned that we can utilize the imbalance between supply and demand to solve the problem of high empty-loading ratio. Guo Rui-Xin (2007) proposes that taxi fares can be adjusted according to the demand in a certain range; appropriately decrease taxi freight during off-peak hours, and increase the freight in the peak and the night. This method can compensate the driver for the congestion cost in peak period to some extent, but did not take into account the taxi drivers’ cost of looking for passengers during off-peak hours. [2] Hu Lie-Ge (2011) argues that when the spatial empty-loading ratio exceeds 40%, the taxi transportation capacity shows a state of oversupply; the traffic mode split model should be established to determine the relationship between the amount of urban taxi and the whole way of traffic sharing. [3] For large and medium-sized city, taxi’s operating range is so large that the phenomenon of “the driver could not find the passengers” and "passengers couldn't catch a ride” would appear at the same time, and the problems cannot be solved by changing the number of taxis simply.

The taxi has the nature of quasi-public transport, with indefinite lines and stations, operating in log or timing way and no fixed transaction site between passengers and drivers. [4] Therefore, it is necessary to solve the problem of information searching caused by the nature of taxi industry in order to solve the problem of taxi empty-loading ratio is to. Taxi drivers do not know the distribution of passengers when they facing a greater running route. Since the 1990’s, the on-call taxi service has been developed, however it does not solve the problem of taxi empty-loading ratio effectively.

The purpose of this paper is to design a more effective way to solve the problem of high taxi empty-loading ratio, i.e. the interaction system of real-time traffic information between taxi and passengers.

2. Analysis of Domestic On-call System

2.1. The Development of Domestic On-call Taxi Dispatch System

Researches on vehicle dispatch and control system have been made from the early 90’s. With the continuous improvement of technology, more and more cities began to use the on-call taxi system.

Taking Beijing as an example, since Beijing Qihua Taxi Dispatching Center opened the car phone in 1999, there are more than 30,000 taxis that can provide on-call service in Beijing, accounting for half the total number of taxi in Beijing. Citizen can obtain the on-call service by dialing either 96103 or 68373399.[5] However daily taxi reservation business is less than 10000, and the proportion in the taxi business volume is much less than 1%.

2.2. The Technological Process and Present Situation of On-call Taxi Dispatch System

The process analysis of Beijing Yinjian Taxi Company’s on-call dispatch system is shown in Fig. 1.

In the on-call system, the operator acts as an information intermediary. The demand information from passengers is sent to the empty taxis, and the taxi’s feedback information is transferred to the passenger.

Fig. 1. The process analysis of Beijing Yinjian Taxi Company’s on-call dispatch system.
2.3. Limitations of On-call Taxi Dispatch System

In the survey of passengers in Beijing Zhongguancun area, 83% of the respondents know the on-call taxi service, but only 20% of them have used the system. The problem of "high input, less use" exist in the On-call taxi dispatch system can be explained by the follow factors.

1) As the amount of information transfer is too small, the problem of uneven distribution of passengers and no-load taxis cannot be solved. On the premise that information of supply and demand is transferred sufficiently, the distribution of passengers with demand is consistent with no-load taxis. [6] The on-call taxi dispatch system provides a point-to-point taxi service, which unable to realize the efficient matching between taxis and passengers.

2) The risk of default is huge. On-call taxi dispatch system is mainly managed by the dispatching center and reflects the passenger's demand to the taxi driver to some extent. The agreement between the passenger and the taxi driver comes into effect only after the passenger gets on, before this, both sides will bear the unilateral risk of default from each other, thus the efficiency of the point-to-point information transmission is low.

3) The regulation is not perfect. Despite almost all large and medium-sized cities all over the country have started to apply the on-call taxi dispatch system, there is a shortage of the regulations on both sides after reaching a preliminary agreement successfully.

3. The Interaction System of Real-time Traffic Information

3.1. Introduction of the System

The system is based on the geographic information system (GIS), global positioning system (GPS) and GPRS/CDMA mobile communication technology, designing the real-time transport interaction system between passengers and drivers. Flow chart is shown in Fig. 2.

No-load taxis and passengers release their location information through the GPS device, after the central information system deals with it, taxi drivers can drive to the area where passengers’ density is higher when electronic map in the taxi shows all passengers’ distribution that are using the system. Accordingly, passengers can apparently see the empty vehicles’ distribution nearby. In this way, no-load taxis and passengers’ demands can match well and the distribution of the two is rational in the city.

In addition, passengers can send their own specific information immediately to the taxi driver nearest through the system. At the same time, taxi drivers can choose whether to accept the passengers’ requests or not. If a driver accepts request, the pairing is successful, and the passenger will receive further information feedback. Otherwise, the request will be returned to the information center once again. After the transaction, the passenger and the taxi driver will evaluate each other on honesty, quality of service and so on, in this way, the system can be established to record the passengers’ and taxi drivers’ integrity and service.

3.2. Analysis of Advantages

1) From the angle of passengers, they can possess the initiative in the scheduling process, which means they can participate in the scheduling process through view themselves and surrounding taxis’ location directly. Compared with Beijing call-taxi system (3 RMB once), passengers will cost lower fees from the GPRS flow.

2) From the perspective of drivers, the distribution of passengers becomes visible hence the driver’s running become more effective and drivers can earn more by reducing no-load rate.

3) The system seems more practical comparing with the traditional "passive" waiting mode. Moreover, differ from the traditional call-taxi system, the system omits unnecessary artificial links and improve the quality of information transmission. At the same time, the system can establish a perfect credit system relatively by binding the ID of passengers and taxi together and designing a taxi and passenger peer review mechanism.

4) The phenomenon of “non-registered taxis joined transport” can effectively alleviate. The government controls the regular taxi strictly. There are blind spots that public traffic can’t cover, as well
as the travel demand of people can’t be met, which lead the non-registered taxis to joined in transport. [7]The interaction system of Real-time transport provides unique information database for each formal registered taxi and provides more customers for the regular taxi. The system effectively keeps the operators of non-registered cars from joining transport and maintains the taxi market’s order.

4.1. Feasibility of Macro Policy

5) The system advocates the green and low carbon concept, focusing on energy conservation and emission reduction. It will help our country to speed up the formation of resource conservation, the environment friendly transportation development and consumption patterns. Besides, it is conducive to the construction of the green transportation system and is helpful for realizing the harmony development of transportation and resource environment.

3.3. The Market Situation in China and Abroad

In recent years, with the popularity of intelligent mobile phone, many similar real-time systems have been introduced overseas, such as Hailo, Get Taxi and Uber. The system has significant effect that many drivers said the no-load rate decreased about 50 % the system has been applied in a week or so.

The prospect of taxi intelligent system seems bright. The registered taxi number increases rapidly and the quantity of clients download also shows an increasing trend. At present, Get taxi has developed the system in the 13 city like London, Moscow and other places of Israel, and proposes to set branches in France, Italy, Germany and Spain. The system is predicted to complete 500 transactions at least a week in a city, and growth rate is 100 % in 3 months.

4. Analysis of Feasibility

This paper argues that China can generate this transport real-time interactive system because of the various appropriate conditions. The following will analyze feasibility from macro policy, technology and market demand.

4.1. Feasibility of Macro Policy

Efficient public transportation system is beneficial to the development of the social and economic society. Taxi is an important part of the public transport system and has drawn whole society’s attention.

At present, the Chinese government has regarded the intelligent transportation system as an important development direction of China's future transport system. In April 13, 2011, the Department of Transportation issued the 12th Five-Year Plan for Transportation, which puts forward clearly that the country should recognize the power of science and technology, and constantly improves the technology content of transportation and information level. The implementation of this real-time transportation information system is conducive to promote the construction of traffic information system and enhance the level of modernization of transportation.

The extending of this system is also in line with the 12th Five-Year Plan for Internet of things (IOT), which the Ministry of Industry and Information Technology released in February 14, 2012. The planning advocates to vigorously promoting the IOT application policy which is conducive to development and industrialization of traffic field IOT core technology.

4.2. Feasibility of Technology

GIS, GPS, GPRS/CDMA and other information processing technology used by the system terminal is mature now. It means the system terminal can meet the requirements of capacity, precision, real-time speed, compatibility and powerful data processing function. Undoubtedly, the system terminal can achieve the goal of lowest cost and effect of the system.

In addition, the wireless network construction is constantly expanding and some cities have set free WIFI coverage in urban areas. At the meantime, Beijing, Tianjin, Wuhan, Shenzhen and other places have issued “wireless city” plan. The technical conditions for passenger’s client popularity are well prepared.

4.3. Feasibility of Market Applications

The taxi supply has become saturated and the number will not be large-scale "expansion" in most of Chinese cities. It’s necessary to solve the problem of information asymmetry between taxis and passengers.

The Interaction System of Real-time Traffic Information is based on intelligent mobile phone. With expanding of the share of intelligent mobile phone in the global, the number of user in China is also growing rapidly in large and medium-sized city. It provides the foundation for the promotion of the system.

5. Conclusions and Suggestions

This paper believes that when the aggregate demand and aggregate supply in taxi market remain unchanged, "difficult to take a taxi" for passengers and high empty-loading ratio of taxi are mainly due to the delay of information transferring during off-peak hours. And the current on-call system cannot solve the problem effectively. The interaction system of real-time traffic information can make the information of supply and demand in the whole taxi market intuitive and visualized, improve the quality of regular taxi service and distribute the no-load taxis and passengers properly. Finally, the problem of high taxi empty-loading ratio can be solved effectively.
Acknowledgements

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