Taxi Development Scale Forecast Two Step Method in Ju County

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Abstract: It is important to scientifically and reasonably put forward the number, and improve transportation capability and proportion of actual loading. Based on Ju county as an example, this paper proposes two step method of taxi development scale forecast based on the analysis of the taxi industry including vehicle, operation status, mode of operation, the proportion of actual loading, taxi passenger travel characteristics, etc. The first step is predict taxi scale, with use real load proportion control method and the second step is reasonably increase and implement taxi scale based on the actual demand. This paper synthetically takes into account of actual demand and theoretical prediction, and deficiency avoid of traditional taxi forecast model and give the corresponding development measures to provide some reference for the taxi operation and development of small cities in China.

Keywords: Ju county; Taxi; The scale prediction; Two step method; Development advices

1. Introduction

The taxi as a kind of effective supply of urban public transportation, convenient to provide "door to door" service, is an essential part of urban residents travel mode of transport. Taxi with "optimal path, real-time feedback" model plays a role in rush hour traffic jam in the city, at the same time gives an effective supplement for replacement part of private car travel and solve residents travel difficult night. However because of the living standards of urban residents have been continuously improved and people's travel ideas continue to improve, higher challenges can put forward both quantity and quality of the taxi service. Reasonable scale not only meet the needs of people travel, but can avoid the waste of resources, and guide the healthy development of the city. Ying-jun Yang etc. put forward taxi traffic volume delivery plan model based on the analysis of the taxi operation parameters, and give an demonstration through an example[1]; Yan-hong Li etc. collected Suzhou city taxi Origin and Destinate data and the travel characteristics of different time were compared and analyzed[2]; Lie-ge Hu etc. Based on the relationship between the medium-sized city taxi number and different modes of transportation and studied the amount of taxi[3].

In summary, the present study focuses on the following aspects: 1) mainly for large and medium cities, the number of taxis for small cities is less studied; 2) the development of small city taxi is short of quantitative analysis. Therefore, this paper is based on the deficiency above, relying on urban public transport and taxi passenger transportation development planning study in Ju county of Shandong province, organizing and carrying out the investigation by the transport department of Ju county

and Shandong Jiaotong University in December 19, 2012 and 2012 on December 20, study the taxi operation characteristics and scale forecast, and puts forward some suggestions.

2. The Taxi Industry Development Analysis

2.1. Vehicle development analysis

Ju county is located in the southeast of Shandong province, close to Qingdao, the transportation is convenient. Four existing taxi company, as 199 vehicles, Hongda, world, Travel, Modern, the number of taxis is 101, 44, 41, 13 car, respectively part of the motor tricycle participates in taxi passenger transport business, ten thousand people reach 8.7 taxi[4]. The taxi companies and the development of the taxi number over the years is shown as Figure 1.
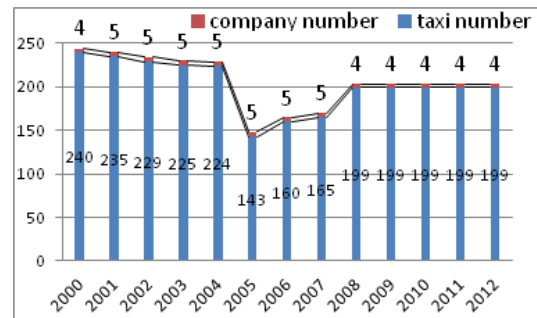

Figure 1. The taxi companies and the development of the taxi number over the years

Ju county taxi vehicle development is divided into three stages: from 2000 to 2005, taxi ownership is relatively large, but the overall number is on the decline, at the end

of 2005 to 143; 2005 to the end of 2007, taxi ownership increased by 22, presented the rising trend year by year, but growth is lesser, at the end of 2007 to 165; 2008 to the end of 2012, the taxi number were 199 and remained the same.

2.2. Analysis of taxi operation condition

Taxi operation condition is mainly including the average daily passenger capacity, daily working hours, running speed, etc. The all the taxi operation condition is shown as Table 1. The change trend of average daily travel kilometer of taxi over the year is shown as Figure 2. The development trend of average daily passenger capacity of taxi over the year is shown as Figure 3.

Table 1. All the taxi operation condition

Year	Average daily travel kilometer	average daily transport passengers kilometer	Average daily passenger capacity	Average working hours	Average driver travel hours	Average running speed
2000	100	80	4	5.5	10	60
2001	120	75	5	5	9	65
2002	120	80	7	6	11	62
2003	150	90	6	7	10.5	60
2004	150	95	8	6	10	50
2005	250	175	39	12	12	42
2006	260	180	42	13	13	40
2007	265	170	35	11	12	38
2008	248	175	40	12	12.5	40
2009	260	180	41	12.5	12	32
2010	265	185	43	13	12.5	35
2011	289	214	41	13	10	30
2012	312	243	38	12.7	8	24.5

Comments: the data from 2000 to 2011was provided by taxi passenger management department, part of the data was obtained though field surveys in 2012.
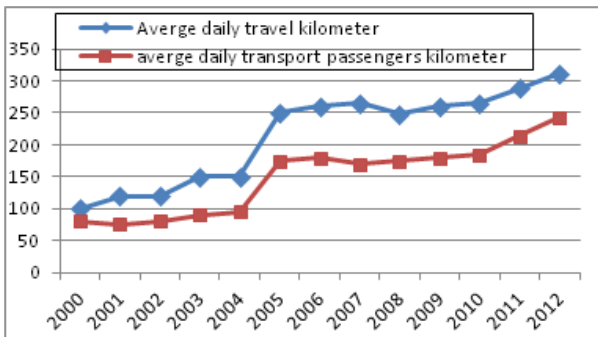

Figure 2. The change trend of averge daily travel kilometer of taxi over the year
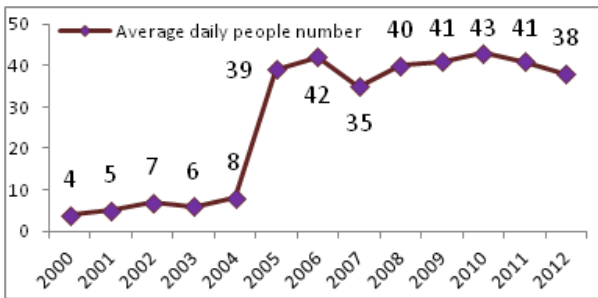

Figure 3. The development trend of average daily passenger capacity of taxi over the year

Average daily transport passenger kilometer and average daily travel kilo meter maintained a synchronous changes: Since 2005, after the decrease of the number of taxi, the travel kilo meter of the taxi and the transport passenger kilometer increased significantly; In 2005 to 2010, he travel kilometer of the taxi and the transport passenger kilometer tended to be stable, taxi passenger transport industry was relatively normal;2011 years later, the taxi travel kilometer and the transport passenger kilometer presented a tendency of increasing, which reflected the existing capacity cannot adapt to the existing market demand.

By change trend of the average daily taxi transport passenger over the year. Since 2005, after the decrease in the number of taxi, the average transport capacity significantly increased, to 2010, the travel kilometer tends to be stable, that state taxi passenger transportation industry development is relatively normal, but since 2011, taxi transport passenger is on the decline, manifests the capacity is insufficient, but also reflects the taxi passenger trip distance is increasing. The taxi operation parameters of each branch is shown as Figure 4.

Through investigation of the taxi parameters of each branch, in addition to Hongdataxi is relatively low, the average running speeds of 17.6 km/h, the taxi operation conditions of other company are consistent, it explain operating conditions of the taxi companies is not high of the different degree.

2.3. Analysis of characteristics of taxi passenger travel

According to the per resident travel times of 2.2 ~ 2.8 times/day from 2005 to 2012, it can calculate the passen-

gers capacity, passenger throughput and share proportion of the taxi passengers. The calendar year taxi travel features is shown as Table 2. The Historical average distance and the share proportion of the taxi about Ju county is shown as Figure 5.
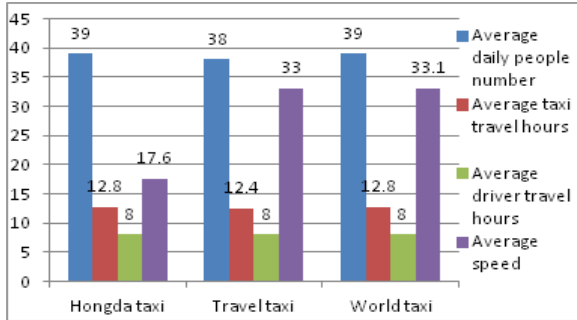

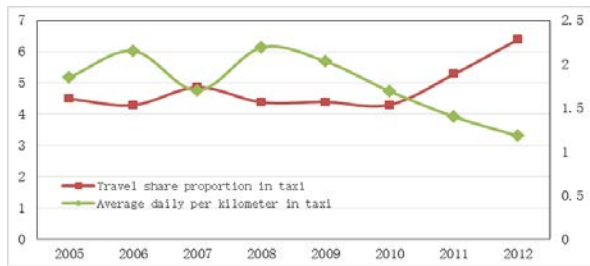**Figure 4. The taxi operation parameters of each branch**

Figure 5. Historical average distance and the share proportion of the taxi about Ju county

According to the above analysis, it can draw the following conclusions:

(1) The continuous rise of passenger through put indicates that the taxi demand is increasing. The increasing passenger capacity from 2005 to 2010reflects that the taxi passenger transport industry is becoming more and more mature, but since 2009, the share proportion of taxi travel is declined year by year, it shows that the decline of the reliability of the taxi passenger travel caused by the lack of capacity, and it directly affects the competitive power of the taxi passenger transport industry.

(2) From the point of the taxi passenger travel share proportion, it keeps basically stable from 2005 to 2008, but since 2008, it appeared a downward trend, there are two aspects of the reason, one is the impact of the increasely number of the private cars year by year, another important aspect is the decreased competitiveness caused by the insufficient capacity of the taxi passenger transportation system.

(3) From the point of transportation distance, it keeps basically stable from 2005 to 2010, while it rapidly rised after the year of 2011,thatshows the increase of urban area leads to the increase of transportation distance, in this case it should increase the transport capacity to meet the traffic demand.

2.4. Taxi passenger transport business model

Taxi passenger transport system of Ju county adopt enterprise management mode, namely the taxi property rights and management rights owned by the enterprises, the drivers and taxi passenger businesses sign the lease and operation contract, opeproportion in renting. Government carries out licenses for them, allocate the resources reasonably, and supervise the operator to provide high quality service for the society.

Table 2. Calendar year taxi travel features

Year	Urban total travel times	Average daily transport passengers capacity in taxi	Average transport passengers kilometer	Average daily per kilometer taxi passenger throughput	Travel share proportionin taxi
2005	301620	5577	4.49	25025	1.85
2006	312106	6720	4.29	28800	2.15
2007	340576	5775	4.86	28050	1.70
2008	364140	7960	4.38	34825	2.19
2009	401380	8159	4.39	35820	2.03
2010	506222	8557	4.30	36815	1.69
2011	573936	8060	5.28	42586	1.40
2012	640640	7562	6.39	48357	1.18

2.5. Actual loading proportion analysis

The actual load proportion can reflect the efficiency of taxi passenger load proportion, the index is one of the important indicators of evaluating the taxi passenger operation condition. Through to survey of relatively large real load proportion and the average passenger capacity in the peak and flat peak period of taxi traffic, of which the peak time select five sections, such as Wenxin middle road and so on, the flat peak time select sixteen sections, such as Youth road, Fulai road, Zhenhua road, and so on. The Rush hour real load proportion survey is shown as Figure 6. The Flat peak period of real load proportion survey is shown as Figure 7.

The result shows that the flat peak time mainly for no passenger and passenger 1from the point of passenger capacity; From the perspective of the period of passengers, passenger of the flat peak times were higher than the peak times, the peak demand of the small city is small.

In general, average actual load of the taxi at a proportion of 60.1%, that significantly more than the Code for transport planning on urban road (GB50220-95) (hereinafter referred to as the "specification") requirements, the taxi transportation capacity is insufficient. From the space distribution, taxi passenger transportation mainly concentrate on administrative region, the city commercial residential area of urban area in Ju county. From the point of the time distribution, time real load proportion of the peak times is obviously higher than the flat peak period.

According to the survey we can be calculated with the average passenger capacity of taxi of urban area in Ju county: passenger capacity of taxi is 1.44 on average, that in the normal range, from the point of space distribution, on both sides of road have stream of people rally point of big business center, hospital, administrative units etc. Average passenger capacity in taxi is higher than other roads.
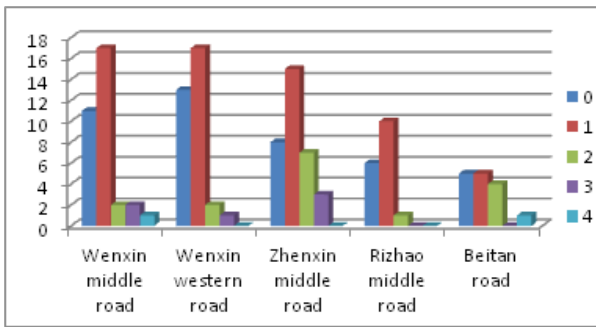
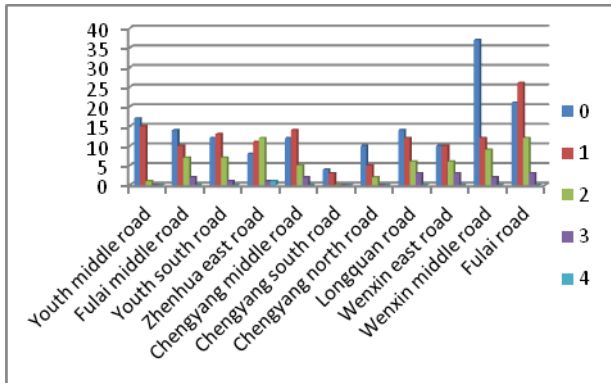

Figure 6. Rush hour real load proportion survey

Figure 7. Flat peak period of real load proportion survey

2.6. Operating conditions analysis

From historical development condition analysis, before 2005, taxi passenger transportation industry obviously competitiveness, that appear the status of the supply is greater than demand. From 2005 to 2010, taxi passenger transportation industry smoothly development gradually. 2011 years later, due to the increase in urban area and the insufficient of taxi capacity, it appear the condition of demand outstrips supply, so it should increase capacity.

3. Reasonable Scale Prediction

3.1. Real load proportion control reasonable size

(1) A taxi passenger volume forecast. Reference to the similar city taxi passenger share proportion characteristics, on the basis of the planning share proportion of taxi passenger capacity, passenger capacity is obtained by using the method of geometric growth.

$$C = p * r * s \qquad (1)$$

As represented by Equation (1), C is transport passengers capacity; p is the people of urban area; r is tavelproportion; s is share proportion.

(2) The average trip distance forecast taxis. Taxi average travel distance and the size of the city, with the increase of j city scale, the land area, taxi trip distance also will increase. Elastic coefficient method is used to predict the average trip distance taxis. In 2010, according to city planning, construction area of 27.19 km2, built in 2020, covers an area of 38.4 km2, according to the growth of proportion method can get each year's downtown area, predictable get taxi average trip distance. Among them, the elasticity factor as the equivalent diameter of the city, elastic coefficient of 0.8.

$$l = l_0[1 + 0.8 \times (\frac{S^{0.5}}{S_0^{0.5}} - 1)] \qquad (2)$$

As Equation (2), represent the average taxis trip kilometer in future; represent the average taxis trip kilometer now; represent the square kilometer of urban area in future; represent square kilometer of urban area now.

(3) A taxi passenger person-kilometres forecast. Taxi passenger turnover volume is equal to the product of passenger traffic volume and the average trip distance.

$$T = C * l \qquad (3)$$

(4) A taxi scale forecast. According to the taxi passenger person-kilometres from 2012 to 2020, on the basis of the survey, the average day trip distance was from 300 ~ 320 km, and the load proportion was controlled in 55 to 60%.On the basis of the average1.4 ~ 1.6 taxi volume, reasonable size number each year was available. Based on real load proportion control to forecast taxi passenger capacity shown as Table 3.

Table 3. Based on real load proportion control to forecasttaxi passenger capacity

Year	Ten thousandspeople	Daily travel times	Share proportion	Daily passenger capacity	An builtedsquare kilometer of city	Averagetaxistrip kilometer	Daily per kilometertaxi passenger person-	Reasonable taxi number

						kilometres	
2013	24.02	2.83	1.41	9585	31.15	6.47	62015	
2014	25.16	2.87	1.68	12131	32.17	6.56	79579	321
2015	26.30	2.90	1.89	14415	33.22	6.64	95716	390
2016	27.44	2.92	2.09	16746	34.31	6.73	112701	436
2017	28.58	2.94	2.19	18402	35.43	6.82	125502	473
2018	29.72	2.96	2.29	20145	36.59	6.90	139001	514
2019	30.86	2.98	2.39	21979	37.79	6.99	153633	557
2020	32.00	3.00	2.50	24000	38.40	7.04	168960	600

3.2. Based on the actual demand of correction

Taxi scale control needs to follow the principle of step by step, the combination of theory reality, and the optimal services. To meet the needs of the residents best, considering the increasing tendency of urban population and urban scale, the wishes of residents travel service quality increased year by year, so the taxi number, which should be taken into mode proportion growth model with elastic, the recent number of the taxi can be increased year by year; In order to reduce administrative costs, it will be better to increase the number of the taxi once every two years . The number of taxi selected is based on the real load proportion and the maximum specification control laws, then getting the taxi reasonable scale amount to 390 vehicles in 2015, betwwen2013and 2015, a total of 191 taxi was used by an average of 64 vehicles each year. Reasonable scale for 2020 was 600, between 2015 and 2020, 210 vehicles need to be put in by an average of 42 vehicles each year. The taxi development planning and nymber each year is shown as Table 4.

Table 4. The taxi development planning and nymber each year

Year	Taxi number	Taxi number of end of the year
2013	58	257
2014	64	321
2015	69	390
2017	72	473
2019	84	557
2020	43	600

4. Taxi Development Suggestions

4.1. Optimization of operating mode, strengthen the industry management

Along with the development of social economy and improvement of the living standard of residents, The paper suggested that draw lessons from other city taxi passenger transport business model, take the main body of the property right and the management right step by step, ensure the balance and coordination of the interests of all parties; and gradually formed the passenger transport market of proper profits and effective regulation and reasonable operation; Under the establishment of the relevant provisions of the state, formulate measures suited to the local characteristics in Ju county, aim at make specific provision of taxi passenger transportation industry accession and management order, the balance of rights and obligations, market location, management system and other issues, and guide the taxi passenger transportation industry management into the legal system. [5]

4.2. Rationally planning site

Give priority to the development of a variety of taxi services, set up taxis station in urban road, provide variety services to taxi drivers and commuters. Set reasonable planning of urban taxi stands, gradually change the mode of operation by fixed rent into mode of combination of fixed rent and operation for rent, promote the taxi improve application of satellite positioning and Internet Systems, gradually reduce the taxi empty proportion and the driver's labor intensity, improve the operating efficiency of the taxi.

4.3. Proportion policy

Through in-depth analyze the influence factors of residents' income, market supply and demand level, cost, profit, the condition of similar urban freight proportion, and so on. Reasonable control rental price comparison between passenger transportation and public traffic, according to the level of economic development and residents' disposable income, guarantee the market share of taxi passenger transportation and the interests of the passengers, to achieve a reasonable profit of taxi passenger transport enterprises and employees; closely integproportiond with the local economic level, consider the transportation cost and its changes, taxes, reasonable taxi transport enterprises benefit and driver income, as well as the impact on the society; according to the market mechanism, make full use of price leverage, to adjust the taxi proportion, and then to adjust relation of the transport supply and demand, ensure the balance between supply and demand.

4.4. Improve the quality of the service industry

The level of service quality of rent passenger transportation industry directly relates the overall image of city, and it is the city spirit of benchmarking. Therefore taxi enterprise need to focus on improve the convenience, comfort, standardized service, security, and legal regulation of the taxi.

4.5. Ban illegal operation

With the law to ban illegal business behaviors and improve the monitoring means and measures, can standard taxi passenger transportation industry's market order, safeguard the passenger's legitimate rights, protect the interests of the legitimate operators. Improving the self-discipline and the law enforcement level of the management, can perfect restricted and supervised mechanism, enforce justification of the law. To develop social supervision network, it must strengthen propaganda to improve the passengers' rights and participant awareness.

Reasonable taxi scale can meet the demand of residents of differentiation, and ensure a good order for the development of the urban passenger transportation. Because the small number and the higher flexibility of the city taxi, less people don't give enough importance for it, so led to more taxi problems of the small city over a long period, and seriously block the embodiment of the urban development and urban landscape. Based on the taxi operation condition, the paper use the combinative two steps method of the theory and the actual intention to research the taxi scale's forecast, the result is approved by the relevant department. The paper continue to analyze the travel mechanism of residents and taxi in next step, and discuss the methods and measures of taxi scale forecast apply to small city in China.

5. Acknowledgement

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