

Study on the Index System of Taxi Operation Monitoring Based on Multi-source Data

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Abstract—All kinds of taxi data structure were introduced, and based on multi-source data, proposes taxi operation monitoring index system in charge of the different needs faced on traveler, industry managers and government departments. Finally, taking the multi-source data of taxi in Beijing as an example, some important indexes of the taxi operation monitoring are calculated, and the running situation of city taxi can be mastered accurately. The research results can provide important decision support for the development of taxi development strategy, improve the management of taxi industry, and promote the sustainable development of taxi.

Keywords—taxi; Operation monitoring; Index system; multi-source;

I. INTRODUCTION

As the demand diversification of city traveler, taxi is getting more and more attention as the important part of city transportation. In recent years, the taxi industry also appeared some chaos, taxi management has become a problem that city managers must face. How to establish taxi service quality assessment system and scientific management using the advanced technology is become urgent need. Use of information technology, based on taxi related data from satellite positioning, taximeter, telephone call etc., and the paper establishes the taxi operation monitoring and analysis index system, realizes the taxi operation condition monitoring and analysis, and improves the scientific management and service level of the taxi.

II. MULTI-SOURCE DATA ANALYSIS

A. Satellite Positioning Data

Satellite positioning data has the advantages that the data can achieve real time return, but a large amount of data show that GPS data accuracy is lower as compared with the taximeter. The table structure of satellite positioning data

varies according to the different dispatching center, but its basic structure is shown in Table 1.

TABLE I. TABLE STRUCTURE OF SATELLITE POSITIONING DATA

Field	Explain	Field	Explain
ID	Identifier	LONGITUDE	Longitude
CENTER_ID	Dispatch center	LATITUDE	Latitude
SIM_CODE	Terminal number	SPEED	Speed
VEHICLE_CODE	License plate number	ANGLE	Direction
GPS_TIME	Generating time	STATE	Passenger status

Sample data for satellite positioning data are shown in Table 2.

TABLE II. SATELLITE POSITIONING DATA SAMPLE

UNI T_N AME	SIM_CO DE	VEH_C ODE	GPS_TI ME	LO N	LA T	SP EE D	AN GL E
JKSX	34395098 06	Jing BL9833	2014/5/19 23:01:43	116. 495	39. 93 4	7.2	11
JYJ	13321183 406	Jing BQ0889	2014/5/19 23:57:46	116. 456	39. 85 4	76	134
QH	86136011 40385	Jing BL1452	2014/5/20 0:21:48	116. 521	40. 01 8	53. 6	240

B. taximeter data

The taximeter data includes the basic information of taxi driver, status information, etc. The taximeter data is generally divided into two kinds of real return and regular return. The basic table of the taximeter is shown in Table 3.

TABLE III. TABLE STRUCTURE OF TAXIMETER DATA

Field	Explain	Field	Explain
ID	ID	DAY_NUM	Days on the taxi
DEAL_TYPE	Transaction types	DAY_TIME	Time on the taxi
TRANS_AMOUNT	Transaction amount	CAR_CODE	License plate number
DEAL_TIME	Transaction time	DRIVER_LICENSE	License number
RECORD_NUM	Record number	PRICE	Unit Price
AMOUNT_REC	Receivable amounts	TEAM_CODE	Taxi team number
WAIT_TIME	Waiting time	PICKERS	Collector number
TRAVEL_MIL	Driving Mileage	TAC_TYPE	Taxi edition
UNTRAVEL_MIL	No passengers mileage	CREATEDATE	Create time
DRIVERS_FLAG	Driver signs	UPDATEDATE	Update time

The sample data of the taximeter is shown in Table 4.

TABLE IV. TAXIMETER DATA SAMPLE

ID	TRANS_AMOUNT	DEAL_TIME	TRAVEL_MIL	UNTRAVEL_MIL	DAY_TIME	CAR_CODE
924861053	2900	2014/5/20 11:52:18	115	7	113239	BP3584
924867437	1800	2014/5/20 12:54:54	68	110	124409	BQ7480
924867443	1800	2014/5/20 13:08:17	68	0	125617	BQ7480

C. Taxi Telephone Call Data

Taxi telephone call data is refers to the customer reserving a taxi data information by phone, web and mobile phone software etc., including using taxi time, using taxi location, license plate, destination, taxi types, the order status information. Taxi telephone call data samples are as shown in Table 5.

TABLE V. TAXI TELEPHONE CALL DATA SAMPLE

Using taxi time	License plate number	Taxi reservation channel	Taxi reservation types	Order status	Using taxi location	Destination
2014/3/31 21:15:05	BP9422	telephone	Immediate	Complete order	Cao-Qiao east road	Capital Airport
2014/4/2 10:09:00	BM1136	telephone	Immediate	Complete order	Shunyi Zhongjia Xinyuan Hotel	Capital Airport
2014/4/2 10:16:00	BP0675	telephone	Immediate	Complete order	Shunyi Zhongjia Xinyuan Hotel	West Station

D. Other related data

Other related data of taxi includes the operation approval, complaints, illegal, etc..

Operating approval data includes taxi companies, company addresses, operating status, license plates, taxi models, single and double shift, etc..

Complaints data includes the source of the complaint, the complainant's name, complaint time, the taxi company, the license plate, complaint content, etc..

Illegal data includes taxi companies, inspection time, inspection sites, parties, license plates, illegal behavior, etc.

E. Data preprocessing

In order to analyze the operation monitoring of taxi by using multi-source data, the multi-source data preprocessing is needed. Firstly, all kinds of data is respectively processed, such as satellite positioning data cleaning, map matching, single passenger time is too long, single passenger kilometer is too short and so on, then will be a match between the various types of data, and finally form a better quality of taxi sample library. See Figure 1 for specific processes.

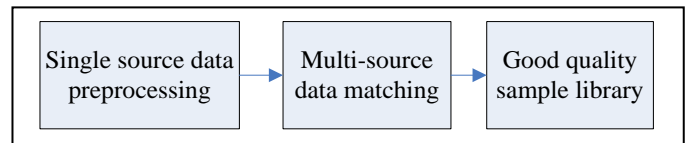


Fig. 1. Multi-source data preprocessing procedure

III. TAXI OPERATION MONITORING INDEX SYSTEM

Based on existing multi-source data and the key indicators, such as dispatch taxi rate, dynamic dispatch taxi rate, complaint rate, illegal rate, telephone call success rate, taxi no passengers rate, taxi spatial agglomeration, the study establishes the taxi operation monitoring index system, monitors and analyzes the taxi operation status, service quality and spatial agglomeration etc.. For different user groups, the taxi monitoring index is divided into 3 types, respectively faced on the taxi service level monitoring indicators of traveler, taxi operation level monitoring indicators of industry managers, and taxi development level monitoring indicators of government department.

A. The taxi service level monitoring indicators faced on traveler

The taxi service level monitoring indicators faced on traveler include four aspects: the convenience, the shortcut, the reliability and the safety of the taxi. Its role is to monitor and improve the taxi service level, provide high quality service for travelers.

TABLE VI. THE TAXI SERVICE LEVEL MONITORING INDICATORS FACED ON TRAVELER

Status index	Basic index	Status index	Basic index
convenience	possession rate in 1000 people of taxi	reliability	Taxi passenger speed fluctuations
	difficult index of taking a taxi		Taxi time fluctuations
	Taxi reservation success rate	safety	Integrity rate of taxi GPS
shortcut	Passenger speed		Complaint rate
	Average taxi time		illegal rate

B. The taxi operation level monitoring indicators faced on industry managers

The taxi operation level monitoring indicators faced on industry managers mainly include dispatch taxi rate, taxi distribution density, have passenger rate, operational efficiency and operating speed etc.. Its role is to monitor and improve the taxi industry management, master the taxi operations condition provide support for formulating and adjusting the trade policy related to the taxi industry.

TABLE VII. THE TAXI OPERATION LEVEL MONITORING INDICATORS FACED ON INDUSTRY MANAGERS

Status index	Basic index	Status index	Basic index
dispatch taxi rate	dispatch taxi rate in five minutes	Operation benefit	Mileage utilization
	dispatch taxi rate in an hour		Time utilization
	dispatch taxi rate during peak period		Average daily passenger mileage
	dispatch taxi rate of a day		Average daily passenger time
Distribution density	Distribution density in five minutes	Operating speed	Taxi demand intensity
	Distribution density in an hour		Passenger speed
	Distribution density of no passenger taxi		no passengers driving speed
Have passenger rate	Have passenger rate in five minutes	Number of no passenger taxi in key station	
	Have passenger rate in an hour		
	Taxi time utilization		

C. The taxi development level monitoring indicators faced on government department

The taxi development level monitoring indicators faced on government department mainly include four aspects, such as development scale, overall situation, travel characteristics and profit characteristics and so on. Its role is to help the government departments monitor and manage taxis better, provide important support for government decision-making.

TABLE VIII. THE TAXI DEVELOPMENT LEVEL MONITORING INDICATORS FACED ON GOVERNMENT DEPARTMENT

Status index	Basic index	Status index	Basic index
Development scale	Total number of taxis in the city	Travel characteristic	Average time consuming of single passenger
	possession rate in 1000 people of taxi		Average distance of single passenger
	Taxi platform density		Daily passenger number
	Taxi daily emissions	Profit characteristic	Business income
Overall situation	Average taxi dispatch rate		Average amount of single passenger
	Daily operating mileage		Operating costs
	Daily operating time		

IV. APPLICATION EXAMPLES

Taking taxi in Beijing city zone as the analysis object, a part of above indexes are calculated and analyzed. To analyze the daily data on March 25, 2015, the number of taxi operations was 63.2 thousand; daily dispatch taxi rate during peak period was 87.02%, the dispatch taxi rate of early peak was 60.75%, the dispatch taxi rate of late peak was 68.82%; diurnal hours operation taxi number peak was 52.9 thousand, appeared at 11:00-12:00; taxi telephone call success orders was 238.3 thousand, the success rate was 67.99%.

March 16-22, 2015, the daily average operating taxi number was 62.2 thousand, among them, the daily average operating taxi number within five rings was 58.3 thousand; the weekday daily peak dispatch taxi rate was 78.92%, early peak dispatch taxi rate daily was 60.00%, late peak dispatch taxi rate daily was 61.95%; in weekend, daily average late peak dispatch taxi rate was 86.72%, early peak dispatch taxi rate daily was 59.52%, late peak dispatch taxi rate daily was 69.17%.

March 2015, the single taxi passenger mileage of 156 kilometers, the average taxi no passenger mileage was 84 kilometers; double shift taxi passenger taxi mileage was 208 kilometers, the average taxi no passenger mileage was 106 kilometers. The number of single shift average taxi having passenger was 17 times; The number of double shift average taxi having passenger was 23 times.

V. CONCLUSION

The multi-source, such as satellite positioning, taximeter, telephone call etc., has more abundant and more accurate information than the traditional single data source. Through preprocessing and analyzing the multi-source data, the taxi operation monitoring index can be accurately retrieved, including dispatch taxi number, dynamic dispatch rate, telephone call success rate, no passenger taxi rate, operational mileage and so on. Based on the available static and dynamic indexes, the taxi operation monitoring index system is built faced on traveler, industry manager and government department, which analyzes operation, service and

development level of taxi. On the basis of it, taking the data of Beijing City as an example, some important indicators are calculated, which provide an important decision support for accurately grasping the operation of urban taxi, drafting taxi development strategy, improving the taxi industry management, promoting the sustainable development of taxi.

References

- [1] HU Xiao-wen, Feng Jun-jia. Research on characteristics of taxi traffic based on GPS data[J]. Urban Transport of China, 2007,5(2) , pp. 91-95.
- [2] WENG Jian-cheng, RONG Jian, YU Quan, REN Fu-tian. Optimization on estimation of travel speed based on the real-time floating car data[J]. Journal of Beijing University of Technology, 2007,33(5) , pp. 459-464.
- [3] ZHANG Xiao-liang, CHEN Zhi-hong, LIU Dong-mei, et al. A Taxi Travel Forecasting Method Based on Multi-source Data[J]. Journal of Road Traffic & Safety, 2015, 15(1) , pp. 47-51
- [4] WENG Jian-cheng, Liu Wen-tao, CHEN Zhihong, RONG Jian. Research on Floating Car Data Based Taxi Operation and Management[J]. Journal of Beijing University of Technology, 2010,36(6) , pp. 779-784.
- [5] CHI Guang-hua. Analysis of taxi operational features based on floating car data [J]. Journal of Transpo Worldc, 2011(20) , pp. 84-85.
- [6] BAI Zhu, WANG Jian, HU Xiao-wei. Operational Efficiency Evaluation of Urban Taxi System[J]. Journal of Transportation Systems Engineering and Information Technology, 2014, 14(3) , pp. 227-233.
- [7] BAI Zhu, JIN Xiao-hong. Research on the application of taxi GPS data[J]. Journal of Heilongjiang Institute of Technology, 2014(2) , pp. 50-54.