COST EFFECTIVE EVALUATION STUDY OF INTELLIGENT PUBLIC TRANSPORTATION SYSTEM BASED ON SOCIAL INVESTIGATION

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ABSTRACT

This paper studies on the cost-effective evaluation of Intelligent Public Transport Systems application in Transit Metropolis in China, which was launched by the Ministry of Transport from 2009 to the present. The study purpose is to provide guidance for future investment of intelligent public transport systems. Five parts are included. The first part is about Intelligent Public Transport Systems equipment installation status. The second part is evaluation index system. The third part is methodology and thinking. The fourth part is case analysis. The fifth part is conclusions and useful suggestions for other regions. This study is based on the social survey, to which the respondents include passengers, public transport enterprises and government administrators in cities of different scales. A case study of intelligent public transportation despatching system is conducted, and the results obtained are close to the actual results. It is feasible and widely used to social investigation to evaluate the cost-effectiveness of intelligent public system.

Keywords: cost-effectiveness evaluation, intelligent public transport systems, social investigation, transit traveller information system, intelligent despatching system

INTRODUCTION

Urban public transport is a public welfare undertaking which satisfying the basic travel needs. It is the basic support for the normal operation of urban functions (Ministry of Transport, 2011). In recent years, with the rapid development of urbanization in China, the cities are growing rapidly and the population continues to grow. The total travel volume and travel distance of urban residents have increased greatly. At the same time, urban traffic structure has changed significantly, the proportion of motorization is rising rapidly, traffic congestion in urban central area is increasingly serious, and the pressure of environmental pollution and energy consumption is increasing.

In order to solve the urban traffic congestion and the environmental pollution of China, The State Council （2012） point out that giving priority to the development of public transport is an inevitable requirement for easing traffic congestion, transforming the mode of urban traffic development, improving the quality of people's lives and improving the basic public service level of the government. It is a strategic choice for building a resource-saving and environment-friendly society and also encouraging the development of intelligent transportation.

In order to implement public transport priority, the Ministry of Transport launched the *Intelligent Urban Public Transport Demonstration Project* in the pilot *transit cites*, which formally started the work of "transit metropolis", and the demonstration project of intelligent public transport systems is one of the important contents. During the China‘s 12th plan of the five-year national development period, the two batches of all 37 transit metropolis demonstration cities had carried out the intelligent public transport systems application demonstration project. In 2016, the China‘s 13th plan of the five-year national development period, "transit metropolis" was started (Ministry of Transport, 2016). In August 2017, a

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list of 50 cities was announced. Now, many cities have entered the acceptance stage, And, more and more medium and small cities start their construction and application of the urban intelligent public transport system.

But these cities do not know how to allocate funds more efficiently, and how to make plan of intelligent public transport systems which include many subsystems. They want to know which system is more economic and how to prioritize system buildings. This paper tried to do these evaluation work to find the answers for them. In this paper an evaluation index system was made. A Method of social investigation was chosen for obtaining evaluation data from all parties. A case study was also done. It is believed that the conclusions and the methods of this study will provide a reference for similar countries and regions in other parts of Asia.

I. INTELLIGENT PUBLIC TRANSPORT SYSTEM

Through literature review and survey analysis of major cities in China, intelligent public transport system includes six parts, namely information sensing system, information service system, intelligent dispatching system, decision support system, signal priority system and bus lane management system (see table.1 for specific description).

Table1. Composition of urban intelligent public transport system

Name of intelligent public transport subsystem	Description on subsystem functions	Main user
Information sensing system	Basic information collection, including vehicle positioning data, passenger flow data, audio and video data, etc.	Public transport enterprise
Data centre	Data access, data processing and integration, data storage and data sharing interface	Competent department of public transport industry/public transport enterprise
Information service system	Providing public transport information query, route planning and other services	Competent department of public transport industry/public transport enterprise
Intelligent dispatching system	Making enterprise vehicle dispatching plan and vehicle and shift assignment, vehicle running monitoring, statistical statement, etc.	Public transport enterprise
Decision support system	Public transport operation monitoring, industry data statistics, analysis and decision-making on operation safety, travel characteristics, driving behaviours and other aspects	Competent department of public transport industry
Signal priority system	Monitoring positions of public transport vehicles in real time and controlling intersection signals to make public transport vehicles first pass	Competent department of public transport industry, public transport enterprise, traffic management department
Bus lane management	Road occupancy snapshot equipment are installed on bus lanes to ensure exclusive road right of public transport	Competent department of public transport industry, public transport enterprise, traffic management department

By the end of 2015, in China mainland (contains 32 provinces) there were 76.54 billion public transport passengers and 0.56 million bus vehicles (Ministry of Transport, 2016). As the current situation of intelligence public transportation system is concerned, public transportation enterprise information is basically available, the installation of vehicle information terminal equipment is 0.44 million, most cities have more than 65 per cent installation ratio, including 1/3 of the city installation ratio of 100 per cent, the public transport card number is 0.52 billion, and ratio of use public transport card is 44.8 per cent. 37 transit metropolises have established bus dispatching system. In some cities, such as Guangzhou and Suzhou (figure 2 and figure 3), the transformation of "information operation" to "intelligent dispatching" is presented. The management of public transport is from part to whole and the comprehensive decision-making is deeper. Many cities have carried out daily monitoring, service supervision, line network optimization application, and promoted the construction and development of traffic integrated command centre and information data platform. The information monitoring and emergency management are combined. Many kinds of monitoring and emergency equipment such as vehicle video (the installation ratio is 78.4 per cent), engine temperature detection and broken glass equipment are widely used in the daily operation of public transportation.

Figure 1. Intelligent service terminal installation rate

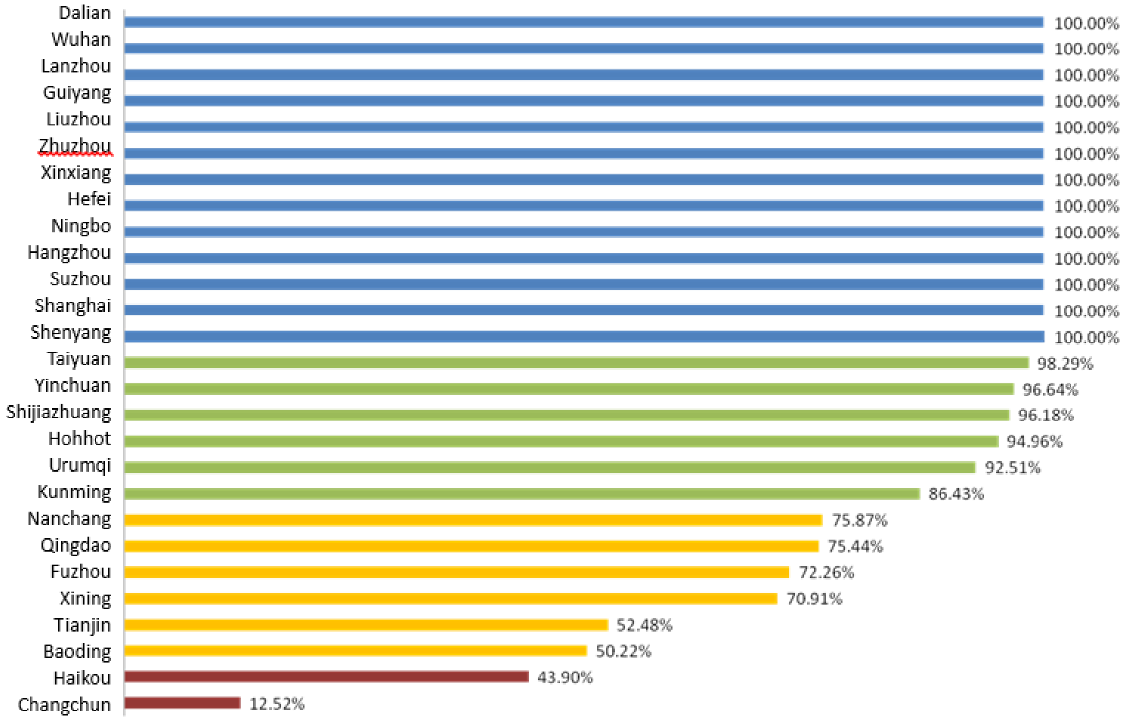
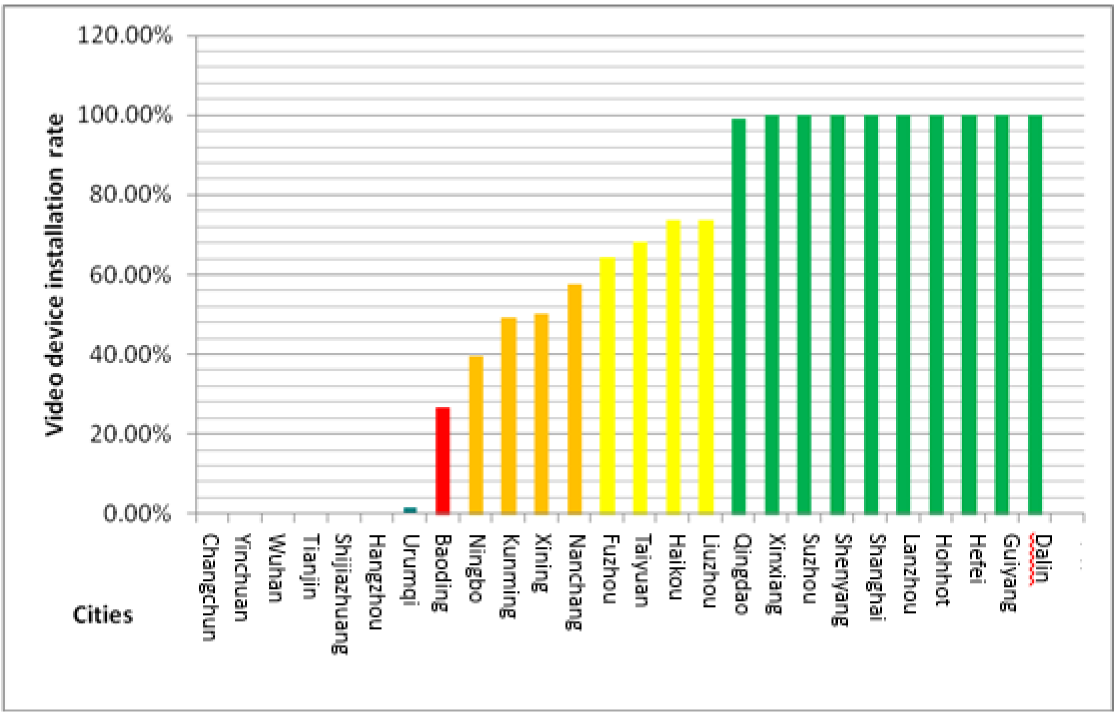


Figure 2. Video device installation rate



In the information service, in addition to traditional websites and hotlines, the public can also get the information through the electronic station board, the mobile APP, the WeChat public number and the micro-blog, so the travel is more convenient and reliable. On the other hand, the information service content is no longer confined to the bus field, but more comprehensive and extensive, such as Shenzhen "traffic in hand" APP, and Beijing traffic APP. At the same time, the internet multi information service is gradually derived, such as Chelaile, Ruyue bus, Didi bus and other bus information services based on mobile interconnection to provide better travel experience.

In addition, the standard specification of intelligent public transport is gradually improved. In June 2014, the Ministry of transport issued the "the Guidelines on Demonstration Project of Urban Intelligent Public Transport Application Construction" (Ministry of Transport, 2014). At the same time, 11 engineering technical requirements for demonstration project of urban intelligent public transport system were compiled, such as "vehicle information terminal of city public transit dispatching". National standard such as “data communication protocol between vehicle information terminal of city public transit dispatching and control centre” was released (Ministry of Transport, 2012), and serial standard of Bus Rapid Transit Intelligent System was released. They all provide the necessary guidance for the application and construction of intelligent public transport and BRT system in each city.

II. EVALUATION INDEX

A. Literature review

We selected the following countries with mature evaluation indicators for analysis, and we have summarized the evaluation indicators of these countries, as shown in the table below.

Table 2. National index summary

Index	USA	UK	Canada	China
Safety	▲	▲	▲	▲
Service level	▲	▲	▲	▲
Energy and environment	▲	▲	▲	▲
Productivity	▲	▲	▲	▲
Mobility	▲	▲	▲	▲
Create ITS market environment	▲			
Innovative infrastructure financing methods			▲	
Integration		▲		
Improving the fairness and equilibrium traffic flow				▲

Source: https://www.benefitcost.its.dot.gov/its/itsbcllwebpage.nsf/KRHomePage; ITS handbook-2nd edition (2007) and Wang, Xiaojing (2004).

Intelligent Transportation Systems Joint Program Office (Browse Resource Databases), it concludes knowledge database, technical analysis, socio-economic, impact analysis, legislative administration and public acceptance of evaluation index system. In ITS handbook-2nd edition (2007) it concludes evaluation manual, efficiency, safety and environmental assessment index system. In England, it concludes evaluation of direct benefit of engineering economics, and social benefits evaluation.

In China, "10th-5Y" national science and technology "Research on Intelligent Transportation Cost Benefit Evaluation Method and Database Establishment" (WANG Xiaojing, 2004), concludes knowledge database, safety, mobility, efficiency, productivity, energy and environment, customer satisfaction, etc. and evaluates "Beijing bus hub operation scheduling management and passenger information service system demonstration project construction "and so on Tongji University (YANG Xiaoguang, 2005)

We have developed detailed indicators for six subsystems of the intelligent public transport system such as information sensing system, information service system, intelligent dispatching system, intelligent dispatching system, decision support system, signal priority system, bus lane management system. They are in the following B to G part. Each system has its evaluation index.

B. Information sensing system

Information sensing system is the basis for construction and application of intelligent public transport system. It is the important precondition for determining the overall system intelligence. The system consists of most sensors. Therefore, the evaluation of this system mainly focuses on the following aspects:

- Main work performance: positioning accuracy, communication functions, basic information, image information, video information.

- Electric performance: withstand voltage adaptability, withstand power polarity reverse connection, withstand power source overvoltage, power-off protection performance, low-voltage protection performance.

- Electromagnetic compatibility: electrostatic discharge interference rejection, instantaneous disturbance rejection, vehicle ignition interference resistance

- Environmental adaptability: The vehicle-mounted intelligent service terminal is suitable for an open application environment therefore it should possess the following environmental suitability: climatic environment adaptability, mechanical environmental adaptability, protective properties, and disaster recovery unit.

C. Information Service System

- Performance requirements: The system update cycle should not exceed 60 seconds (from the one data starts computation to the one data completes computation). Every computation speed should be <5 seconds. The time from the one data computation completes to the one data is pushed to the terminal and displays on the terminal should be <3 seconds.

- Demands on stability and robustness: Meeting the system to run for 18 hrs. Minimally everyday (stop working from 11 p.m. to 5 a.m.). Annual fault rate: <98.8 per cent

- Information accuracy requirements : The arrival station number forecast error should not be more than 1 station. Station arrival time estimate accuracy: >78 per cent. Accuracy for degree of congestion of passengers in bus: >75 per cent

- Interface requirements: The interface is simple, generous, understandable, readable, and has good user experience. The service classification is clear, and the service navigation is quick and convenient.

D. Intelligent Dispatching System

The costs of industry management department include industry policy and fiscal subsidies, and the public costs are the public transport cost. The benefits of intelligent public transport dispatching system can be analyzed in aspects of public transport companies, passengers and industry management department as follows:

- Public transport companies: operational efficiency, vehicle operating costs, energy consumption data etc.

- Passengers: time savings and satisfaction are the main benefits;

- Industry management department: dynamic regulation, improvement in social benefits, etc.

Through the above analysis, the cost-benefit analysis indicators of intelligent dispatching system are created as shown in table3.

Table 3. Cost-benefit analysis indicators of intelligent dispatching system

<table>
<tr><th>Interested parties</th><th colspan="2">Costs</th><th colspan="2">Benefits</th></tr>
<tr><td rowspan="4">Public transport companies</td><td rowspan="3">Direct</td><td rowspan="3">✧ Construction costs:
✧ Initial expenses of the project
✧ Project implementation, construction and installation costs
✧ Other expenses of the project
✧ Operation and maintenance costs:
✧ Update and maintenance of equipment and system</td><td>Management cost savings</td><td>✧ Transport costs reduced by per cent
✧ Operation and maintenance costs reduced</td></tr>
<tr><td>Management capacity improvement</td><td>✧ Dispatching capabilities enhanced
✧ Emergency response capabilities improved
✧ Resource utilization increased</td></tr>
<tr><td>Operational efficiency improvement</td><td>✧ Line capacity control
✧ Dispatching time
✧ Departure capability</td></tr>
<tr><td>Indirect</td><td>✧ Time investment of enterprises in development stage
✧ Technology accumulation of enterprise development</td><td>Employee satisfaction</td><td>✧ Job content (mainly working mode and intensity).
✧ Working environment;</td></tr>
<tr><td rowspan="2">Passengers</td><td>Direct</td><td>✧ Time</td><td colspan="2" rowspan="2">✧ Travel time saved
✧ Convenient travel, improved accessibility
✧ Travel safety improved</td></tr>
<tr><td>Indirect</td><td>✧ Psychological feelings
✧ Security risk</td></tr>
<tr><td rowspan="2">Government and society</td><td>Direct</td><td>✧ Currency support</td><td colspan="2" rowspan="2">✧ Dynamic regulation achieved
✧ Road resource utilization increased
✧ Public transport delay reduced by per cent
✧ Fuel consumption reduced by per cent
✧ Emissions reduced by per cent</td></tr>
<tr><td>Indirect</td><td>✧ Policy support</td></tr>
</table>

E. Decision support system

Decision support is mainly statistics and analysis data and provides initial support for the transit network adjustment. In recent years, with the construction and promotion of transit-oriented cities of the Ministry of Transport, some cities such as Beijing, Shanghai, Guangzhou, Shenzhen, Suzhou and Foshan have gradually built the transport decision support systems, which are being optimized in the aspects of initial basic business management, daily operation monitoring, transit network optimization, service level evaluation, and data mining and analysis. Different regions have different construction and development levels, and different problems in construction and applications, such as incomplete data collection and inadequate support for decision support. There is also experience such as accurate grasp of the needs of city level decision support and gradual construction promotion, which can provide practical experience and reference value for the construction of decision support systems in other cities.

In the context of the internet, decision support is not only the work of government departments. More and more internet companies and research institutions rely on advanced technology and massive resources, mine big data value through multilateral open sharing platform, and provide richer data analysis results and decision support.

Public transport industry decision support can really do in the internet context such as analyse user group travel behaviours based on massive traffic data, internet and mobile network user data, mine traffic information valuable for industry management departments, play an auxiliary role in decision support, and provide services to government departments.

F. Signal priority system

The effect of implementation of the transit signal priority system is represented mainly by the improvement of the bus operation efficiency. The following indexes can serve as references for the assessment of the specific implementation effect.

- Number of stoppages: The number of stoppages is a very important index for assessing the signal control effect. As a matter of fact, the number of stoppages of the vehicles travelling on a smooth and well-controlled road is small; whereas on a crowded and badly-controlled road, the number becomes bigger. The increase in the number of stoppages indirectly reflects the increase in delay. With the signal priority system, the lower the number of stoppages at an intersection exist, the better the optimized effect is.

- Per Capita Delay: The per capita delay at an intersection reflects the average waiting time of bus passengers. The purpose of public transportation is the movement of people. Measuring the benefit of the signal priority system based on per capita delay has certain scientific. After transit signal priority is implemented, the per capita delay at an intersection should be reduced by 10~20 per cent.

- Interval running speed: The interval running speed is an import index to reflect the operation efficiency of buses. The interval running speed of the route buses to which transit signal priority is given can be increased by 10~15 per cent.

G. Bus lane management system

For cities with bus lane management system, main attentions should be paid to the following aspects in system evaluation and appraisal after construction:

- Scale of bus snapshot equipment: Scale of bus snapshot equipment should be considered centrally on the basis of bus lane mileage and bus line mileage. For example, Beijing has 394 km bus lane, the on-board snapshot equipment scale is of 1410 sets. Chengdu has 387 km bus lane, the on-board snapshot equipment scale is of 1115 sets. The layout scale of monitoring equipment in these two places can be well approximated to seamless monitoring of bus lanes in order to guarantee the right of bus driving.

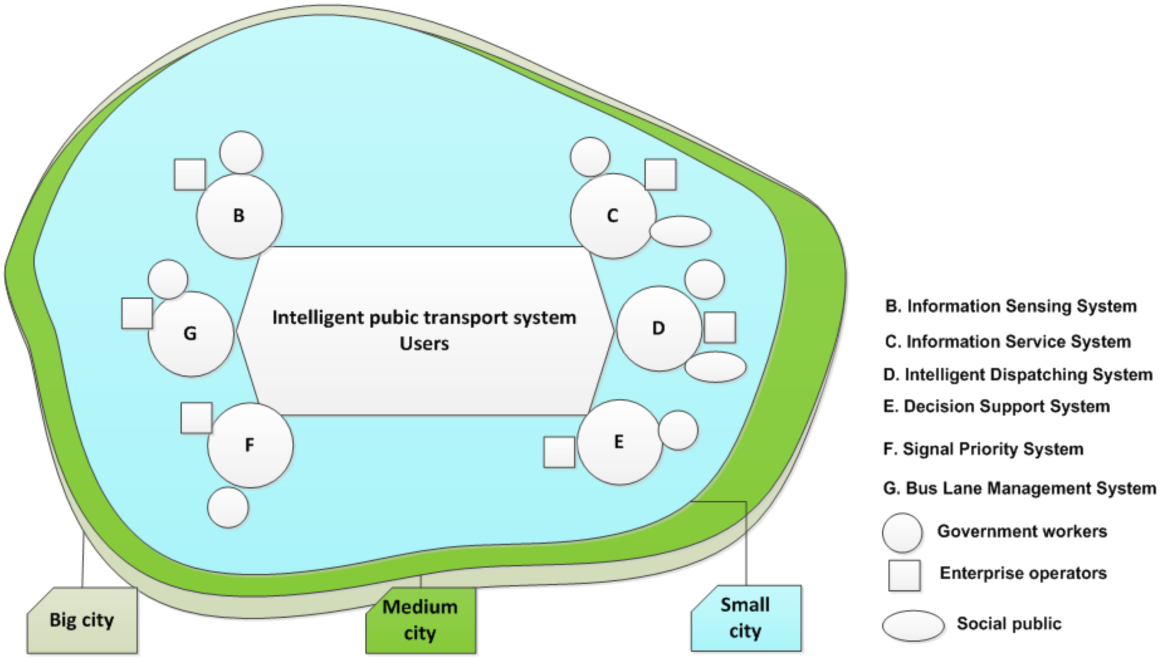
- Driving speed of buses on bus lane: Driving speeds of buses on bus lane can improve clearly due to the system construction. For example, in Beijing urban area, Tong Zhou bus corridor, bus driving speed improves obviously, and travel time by bus becomes clearly shorter. In Chengdu, after construction of the system, buses can move faster by 9 per cent.

- Number of violation according to bus snapshot and penalty: Evaluation on effect of bus lane can be reflected by number of violation according to snapshot after construction of bus lane and by penalty. For example, number of violation by snapshot in Beijing in 2014 stood at about 30,000.

III. METHODOLOGY AND THINKING

In the face of such a complex smart bus system, the cost-benefit evaluation method is mainly based on the multi-index survey (see figure 3). Based on the above research, we know that the corresponding evaluation indexes of so many systems are very detailed and complex, so the entire survey needs to be designed. We decompose the cost-benefit survey of the whole intelligent public transportation system into several small questionnaires for the survey, and at the same time, we respectively face different objects. This makes the respondents easy to accept, and at the same time, filling in information more effective.

Figure 3. Intelligent public transport system user correspondence



To design a questionnaire, the questions for different objects also need to be developed, and the indicators cannot be used to ask, sometimes the respondents cannot understand. Therefore, we combined fuzzy evaluation methods, for example, we divided users' feelings into three levels to make inquiries, such as good, medium-good, very good, they are easier to understand. There are many of such transformations involved in the entire questionnaire, which require a large number of experiments and summaries.

Different types of cities of different sizes are considered in different objects, for example, big city, medium city and small city. Different objects of system use are considered, such as government workers, enterprise operators, social public, etc. The enterprise users also include the public transportation enterprise users and the internet information service enterprise users, such as Baidu, Gaode, Chelaile and so on.

Taking the survey of enterprises as an example, the questionnaires design includes: i) the cost and benefit of the enterprise's investment in bus information service; ii) the investment cost of the enterprise to the scheduling system and; iii) the use of the enterprise employee to the scheduling system including the friendly interface, improving work efficiency, the vehicle fuel consumption before and after the application of the scheduling system and the change of the overall vehicle running time.

Taking the survey for the government sector as an example, the questionnaires design includes: i) the cost and benefit brought by the government to the bus information service; ii) the government's input cost and staff use of the bus decision support system include the friendly interface situation, the use effect, and the relevant business efficiency improvement before and after the system, such as whether the financial subsidies work balance financial funds and; iii)The changes of road operation before and after the use of intelligent bus system.

IV. QUESTIONNAIRE AND CASE STUDY

A. Questionnaire

Questionnaire design should follow several important principles:

(1) Necessary background description: It can not only make the respondents willing to participate in the survey organized by the surveyors, but also improve the effectiveness of the questionnaire.

(2) The questionnaire should be as colloquial as possible so that people of all levels of education can understand it. For example, "how many minutes did it take you to wait for the bus during your recent trip?

(3) The questionnaire is logical: For example, it investigates the public's evaluation of intelligent bus, and the design questions are set with corresponding options according to "whether take bus", "To take which bus", and "How long to wait for bus".

(4) In the survey, select questions should be set as much as possible, and the amount of questions should not be too large, otherwise users will lose patience and may give up answering questions, or they may answer questions in time, which cannot reflect the real situation. In order to avoid too large amount of questions in this research, so that the required information can be fully displayed in the same topic without making users feel the word redundancy and aversion of the topic.

Take the public transportation information service evaluation survey as an example：

Table 4. Sample form of public information service system evaluation questionnaire

	Satisfied	**general**	**Not satisfied**
[Q1] The overall impression	○	○	○
[Q2] The convenience of the route	○	○	○
[Q3] Accuracy of information services	○	○	○

[Q4]How many minutes did it take you to wait the bus? [Single choice questions] [Compulsory questions]

○ 5-10min ○11-15min ○ 16-20min ○ >20min

In order to carry out the research, we have carefully designed the questionnaire. And the received questionnaires including oriented public (3022 copies), public transport enterprises (22 cities) and industry management (13 cities). The following cities are included: Beijing, Jinan, Zhengzhou, Wuhan, Changsha, Chongqing, Xian, Suzhou, Liuzhou, Guiyang, Xining, Yinchuan, Chengdu, Nanjing, Qinzhou, Xiaogan, Enshi, Huanggang, Hezhou, etc.

And we also interview Chelaile, Baidu and Gaode companies, which have comprehensive transport big data open platform.

Table 5. Questionnaires analysis summary

System	Questionnaire	Quantitative calculation	Literature reference	The analysis
Transit Fixed-Route Operations	√	√	-	√
Transit Safety and Security Management	√	-	-	√
Transit Traveller Information	√	√	-	√
Transit Decision Support Systems	√	√	-	√
Bus Lane Management(BLM)	-	-	-	-
Transit Signal Priority(TSP)	-	-	√	√
Card Payment Systems	-	-	-	-
Passenger Flow Collection System	-	-	-	-
Customized Bus Support System	√	-	-	√
Tourism bus support system	-	-	-	-
Multi-modal Cooperation Management	-	-	-	-
PT Open Big data and application systems	√	-	-	√

B. Case study

Take Bus dispatching system for example. This system reverts the relevant information to the dispatching centre by detecting the system information, information of bus routes transit operation dispatching and hub monitoring information. Afterwards, the relevant base information management and operation monitoring & statistical analysis module will generate the relevant dispatching scheme, which will be transferred to the implementation terminal by relevant devices and communication technology; afterwards, dispatcher will adjust and manage the corresponding vehicle plan, vehicle schedule and dispatching need, release dispatching instructions, and finally complete the dispatching flow.

The direct users of the system are mainly bus enterprise users, benefit users for the public, and supervise users for government workers. In the questionnaire, the user experience is classified into three feeling levels according to Good-very good, Medium-very good, and very good. From this tab, we can see the function of bus dispatching system is good - very good, and the intelligent bus scheduling system to enhance the degree of 10-30 per cent.

Table 6. The use of bus dispatching system in different cities of China

Dispatching system	System	Big city	Medium city	Small city
Use experience	Basic information management	Good-very good	Very good	Good-very good
	Vehicle operation monitoring	Good-very good	Very good	Good-very good
	Video surveillance	Good-very good	Medium-very good	Good-very good
	card data	Medium-very good	Medium-very good	Good-very good
	statistical analysis	Good-very good	Medium-very good	Bad-very good
	Operation plan	Good-very good	Good-very good	Medium-very good
	Bus scheduling	Good-very good	Good-very good	Medium-very good
	Intelligent dispatching	Good-very good	Good-very good	Good-very good

And from this table6, we can see intelligent bus dispatching system to enhance the degree: Average passenger waiting time reduced 2-5 minutes, delay time reduced below 5 minutes.

Table 7. The use of bus dispatching system in different cities of China

Dispatching system	City		Big city	Medium	Small city
Benefit	Improve system efficiency	Increased capacity	More 10-30 per cent, some > 50 per cent	More 10-30 per cent, some >50 per cent	More 10-30 per cent
		Vehicle turnover increased	10-30 per cent	More 10-50 per cent, some >50 per cent	10-50 per cent
	Improve economic efficiency	Operating costs decrease	10-30 per cent	More10-30 per cent, some >50 per cent	10-50 per cent
		Dispatcher reduction	30-50 per cent	More10-30 per cent, some > 50 per cent	Some <10 per cent and some >50 per cent
	Improve passenger satisfaction	Passenger satisfaction improvement	More10-30 per cent, some > 50 per cent	10-50 per cent, some >50 per cent	some10-50 per cent, some >50 per cent
	Enhance environmental benefits	fuel consumption Reduced	10-30 per cent	10-30 per cent, some >50 per cent	10-50 per cent, some <10 per cent
		Emission reduction	More 10-30 per cent, some <10 per cent	10-30 per cent, some >50 per cent	More <10 per cent
	Increased mobility	Accident detection and cleaning save time	> 10 min	> 10 min	5-10 min
		Delay time reduced	2-10 min	More < 2min, some > 10 min	2-10 min

Note: percentage statistics refer to the percentage of people who tick the item in the survey as a percentage of the total number of people in the survey.

Table 8. Intelligent bus dispatching system – quantitative calculation

Bus dispatching		Big city	Medium city	Small city
Cost		More than 100 million	30-80 million	5-10 million
Economic benefit		More than 300 million	80-200 million	9-50 million
Environmental benefit	fuel save	25-75 million	6-18 million	0.8-4 million
	Emission reduction	20-62 million	6-17 million	0.6-3 million

It can be seen from the above analysis that the intelligent bus dispatching system, excluding environmental benefits, enable the cost-effectiveness ratio of the quantifiable part about 1:3. In addition, the hardware construction has a large impact on cost. The selection of the scheduling mode directly affects the size of the dispatcher, and the difference of the dispatching personnel in different cities is greatly different. For example, the development and application of dispatching software is very mature in big cities, and user feedback is very easy to use, while in small cities, the effect of user feedback is general. It needs to improve the sharing of road information and the application of IC card data analysis.

Similar social investigation studies on various subsystems of smart bus were done, and the following evaluation summary table is made:

Table 9. Case evaluation summary

Intelligent Urban Public Transport Systems	Conclusions
Information sensing system	+++
Intelligent dispatching system	
Information service system	+++
Decision support system	+ + ?
Bus lane management system	/
Signal priority system	++
Public Transport big data open and application system	+++

+ = positive ; ? = unproven ; / = not covered in this study

About 43 per cent in the survey evaluation range were fully positive. 29 per cent were generally effective and 28 per cent were not shown to be effective.

Based on the above study, we can see that the application effect of the systems such as information sensing system, intelligent dispatching system, information service system, big data open and application system are better, and can be recommended for construction. The application effect of the systems such as Transit Decision Support Systems is required but the benefits need to be observed and evaluated for a longer time.

CONCLUSION

We can draw the following conclusions:

1. According to the construction basis and the user requirements, the construction can be divided into three stages, i.e. Stage A, Stage B and Stage C. Stage A is the stage for the construction of base systems, Stage B is the stage for the construction of integrated systems, and Stage C is the stage for the construction of custom systems for different users in the support of the Internet and big data. Different users can select appropriate construction according to the actual demand and the local construction situation and with reference to the specific implementation at different stages.

2. Due to the influence of urban scale, geographical features, recognition degree of local governments and other factors, the overall public transport development level among the domestic cities is discrete, and there is significant difference in the actual needs and development maturity of intelligent public transport system. If the construction of intelligent public transport system in different areas is required and restrained by the same standards, system application may be out of line with the actual needs of industry, thus resulting in the waste of human and financial resources as well as the decrease in management and operation efficiency.

3. Therefore, it is the key for guaranteeing that urban intelligent public transport system can play its due role to take actual needs as the orientation of intelligent public transport, gradually promote information technology system construction by stages, as well as continuously explore and improve the system application results.

Finally, it is effective to use questionnaire to evaluate the application of intelligent public transportation system, and the effect can be basically consistent with people's practical experience. Of course, the research in this paper is only a stage investigation, there are still many deficiencies, and further follow-up research is needed, in particular, another 41.7 percent of systems are not covered. The limitation of future work is how to design a more perfect questionnaire system to make the questions more scientific. Another is to increase the number of survey areas to cover the whole system.

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