A Design for a Public Transport Information Service in China

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Abstract. This paper presents the initiative design research and projects of developing a public transport information service in China based on big data analysis technology and ubiquitous computing. Follow the blooming of information technology; Artificial Intelligence begins to intervene deeply into people's ordinary life in China. The cities need new design to solve urbanization issue, improve the well being of its citizens. In this paper, we put the emphasis on the introduction of our information model and the information service system. The information service model will create new design thinking and opportunities for solving the complicated urban problem. We design a public transport information service system that includes Tidal-waiting line, Dynamic station board, APP called "TravelMate" and so on. The public transport information service design project based on the information service model is showed as examples, and hope to provide a new framework for the further design research in urban media design.

Keywords: Information service · Public transport
Smart cities and public service design

1 Introduction

China is currently developing at a rapid pace, with social and economic development alongside continuous urban expansion exerting tremendous pressure on urban public transport. As living standards have gradually increased, private car ownership raised year by year. Meanwhile, traffic congestion, air quality has dropped significantly, contributing to environmental degradation, and making travel more difficult for city dwellers. The government has begun attaching great importance to and advocating for low-carbon green living and greater ecological consciousness in society. This has involved encouraging greater use of buses, although bus congestion, inefficiency and long waiting times have seriously hampered the implementation of the national bus priority strategy. Making public transport "more convenient to travel, more comfortable to ride, more convenient to transfer, and safer to operate" is a central theme to new urban society.

Taking Beijing, China as an example: Beijing has 913 public transport lines, including 894 public bus and 19 rail traffic. From January to July 2017, passenger traffic in Beijing reached 4,068,579,400, including 1,908,978,000 public bus. In July alone, passenger traffic reached 607,938,100 passengers, including 272,375,100 public bus. It is evident that public bus are an important component of Beijing's public transport

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network, as well as the principal means of transport for most Beijing residents. Therefore, improving the experience of taking public bus will not only improve public bus' environment, but also entice more citizens to use public transportation, hence remedying the issue that arise with public transportation as caused by rapid urbanization.

This project uses large data technology and perception technology to collect and analyze urban public traffic data so as to establish a city information service model. Through this model, the system of the urban public transport service department is designed. The system creates an intelligent bus service system using Tidal waiting lines, dynamic stop signs, data dispatching, platform swipe cards and other service points, so as to enhance the urban public transport experience, while simultaneously optimizing bus resources and reducing urban traffic pressure.

2 Research Context and Concepts

At present, the traditional Chinese urban transportation system is the primary bottleneck restricting sustainable urban development, meanwhile, traffic congestion and the associated environmental pollution and safety problems have become more urgent on the urban planning agenda. According to Brenda Dervin's Sense-Making Theory, there is a vast gap between passengers' application situation and the existing traffic information service. A stakeholder-based information service for cognition and habits is needed to bridge this gap, which in turn will help to balance the demands of passengers, bus companies, government supervision and public security.

In the context of artificial intelligence and the big data era, data mining and information visualization have enabled network resource sharing and real-time data availability, which will change how public transportation is serviced and how people go about their daily lives.

2.1 The Main Problems of Urban Public Transportation

In recent years, the number of motor vehicles and road traffic in China has increased dramatically, especially in big cities. Moreover, increasing levels of public transport vehicles, line extensions and raw vehicle numbers mean that traffic congestion is still a very serious issue, which is worsening in its severity. Using the GAD map in combination with an open data platform, Ali cloud ODPS released "2015Q3 urban traffic analysis report in China". This report's data show that traffic congestion has also resulted in direct economic losses, with the highest opportunity cost being in Beijing, where commuters waste on average 808RMB per month due to congestion. Furthermore, congestion emissions contain a large number of carbon dioxide, oxide, particles and sulfur dioxide, which ultimately worsen the already severe air pollution causing frequent fog and haze.

Declines in bus speed and uneven traffic intervals are common in major cities. Situations such as too many buses arriving at once and large periods with no buses seriously affect the quality of public transport service. Due to the lack of modern managements practices, the operation process of Chinese public transport is lagging, officials are "invisible and unable to listen", often completely oblivious to the shortcomings. Bus

waiting times are long and running speeds slow, especially for bus users. Moreover, vehicle operation information and route details are not being provided to passengers in time. For the government, the actual bus company operation cannot be obtained, and effective supervision cannot be realized. For the bus enterprise itself, operating data is inaccurate and the processing cycle long, meaning operational analysis and decision support cannot be provided.

2.2 The Main Problems of Urban Public Transportation

Bus platforms are a critical component of bus service systems, which govern waiting times, rest periods, inquiry management as well as social and other functions. In order to satisfy fundamental human needs as they relate to waiting in accordance with the concept of service design, it is imperative to provide better coordination and balancing of informational and emotional needs.

Most Chinese bus stations are serviced by 3 bus lines or more, but narrow platform space, numerous bus routes and one-way information transmission can cause doubts and worries for passengers, making them take the wrong bus, sit in the wrong direction, stand in overcrowded buses and getting caught in conflict. For example, passengers waiting for different buses are mixed together, but in order to avoid being overlooked, those waiting typically enter the driveway, occupying the bus lane. Given this, most drivers do not drive directly into the station so as to avoid being blocked by the crowd, meaning they instead stop on the main road with no fixed stopping point. Taking buses as an example, passengers wait in the mixed group, with passengers in the driveway taking the lead in obtaining information so as to board the bus more quickly, thus causing riots and cutting off those waiting for the bus engendering further chaos [1]. Information transmission is untimely, uncertain and random. Passengers have to retrieve the stopping information themselves, sometimes running to catch up with the buses, which causes security risks and traffic chaos (Fig. 1).

Fig. 1. The situation of waiting bus

2.3 The Main Problems in Urban Public Transportation Information

Information release procedures for urban public transportation affect urban dweller mobility to a great extent. However, in most Chinese cities, public transport information

is too weak to release, the lack of real time dynamic information (such as arrival times and traffic densities) has caused serious information asymmetry, weakening passengers' sense of participation in and the reliability of public transport. According to the survey of the project, the most frequently used, and most trusted method for obtaining information is still asking passers-by.

According to practical experiences at home and abroad, it is clear that the best manner for solving urban traffic problems is the further development of public transport, and the establishment of an Advanced Public Traffic System so as to improve road traffic capacity and the operation and management of public transport. At the same time, this can improve living conditions and promote sustainable urban development.

3 Design Framework and Process

The smart public transportation service system we designed is based on Internet of things technology, and is an innovative service mode transforming intelligent buses through perception, transmission and application [2]. This mode establishes a new interactive service platform for passengers, bus drivers and bus dispatchers. This information service transforms the bus service into a known, visible and controllable service system. Urban residents are hence provided with new means and experiences for travel, thanks to the Internet, radio frequency identification, smart phones and big data analysis platforms. Passengers now have access to different travel modes, travel times, route selection, passenger flow analysis and efficiency analysis (Fig. 2).

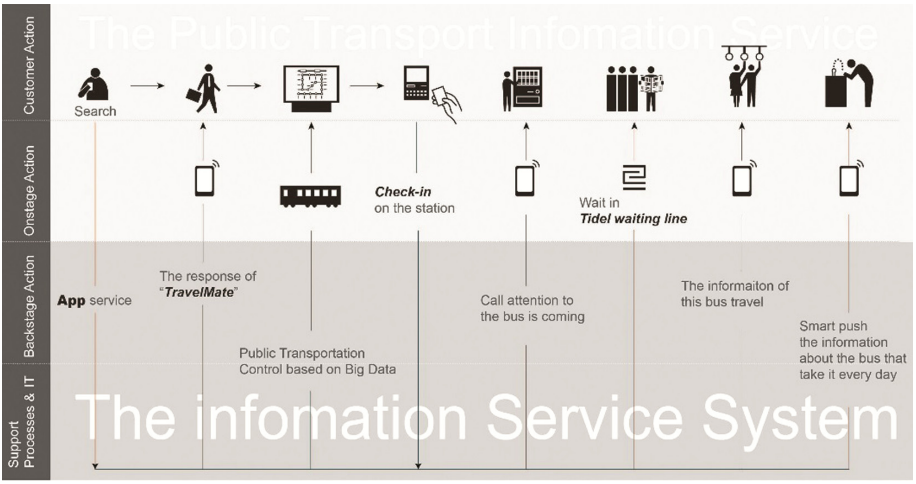

Fig. 2. The Blueprint of the public transportation service system

3.1 The Design Principle for an Urban Public Transport Service System

For a large number of commuters, the public transportation system is their first contact with society on a daily basis. The first place they go every morning is the bus stop. Therefore, an all-round enhancement and promotion of the public transport experience can not only entice more passengers to take the bus, but can also solve problems relating to urban traffic and safety concerns. By improving commuters' travel experience, urban livability and residents' well-being are improved.

The design of the public transport service system in accordance with the service design concept mainly follows the following principles:

1. A human-centric approach, which includes passengers, platform cooperators, public transport drivers, operation and dispatch personnel, as well as government supervisory departments.
2. Using large data and data mining technology to correctly guide stakeholders in the public transport service system.
3. Using artificial intelligence to forecast preferences and behavioral habits, while offering personalized recommendations and guidance.
4. Simplifying the information transfer process using information visualization, hence shortening the information transmission duration, and accurately conveying timely and effective public transport information.
5. Establishing sustainable development for the public transport service system, thus improving the service experience and solving urban problems.

3.2 The Information Service Model

Sense-Making Theory divides the information search into the following three stages: 1. SITUATION, which refers to information query; 2. GAP, which refers to better understanding the gap formed by information discontinuity; 3. HELP, which refers to the meaning of information to the individual, each person's use for information is based on their situational response, while the use of information for everyone is a response to the situation, with the purpose of filling the gap or solving the problem. Passenger demand for information is closely related to the pertinent scenario, and hence a new information service model has been formed for the public transport service system, which is centered around passengers. This model is made up of five rings [3]:

1. "Situation" refers to passenger travel circumstances and the information demand. Passengers inquire with regards to travel routes, arrival time and congestion.
2. "Orientating" refers to information feedback and guides passenger behavior. In response to passenger requests, the system feeds back the answer to users and guides their travels.
3. "Action" refers to passengers being led to form behavioral habits. Passengers arrange travel according to the information available. Passenger information is then stored on the system and analyzed to form a portfolio for each passenger.

4. "Influence" refers to the provision of active assistance to passengers through notifications and tips. Based on passenger data analysis, the system can anticipate user needs and make suggestions for further travel.
5. "Reverberating" refers to passenger feedback on helpful information provided. Passengers provide feedback on system notifications and hints, and offer suggestions to help the system better learn passenger habits, in order to more accurately anticipate individual users' needs (Fig. 3).

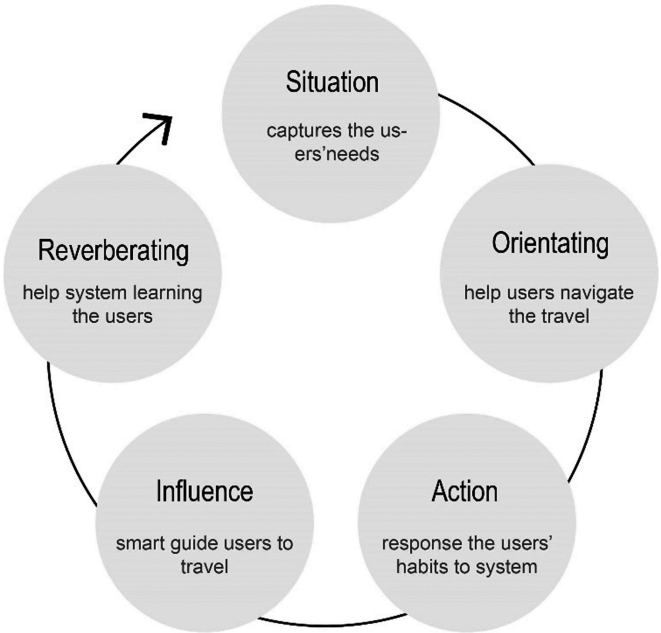

Fig. 3. The information service model

This information service model employs information lookup and an intelligent data platform, transferring urban public information to urban residents through 5 links in order to help people lead easier lives.

3.3 The Design Touch-Point of Urban Transport Service System

Our public transport service system design [4] is centered on passengers and stakeholders. Moreover, the information service, through 5 service contact points, is able to solve practical problems, improve service quality and provide a comprehensive urban public transport experience, which helps urban dwellers have smooth, comfortable and pleasant trips. The service contact points are designed as follows (Fig. 4):

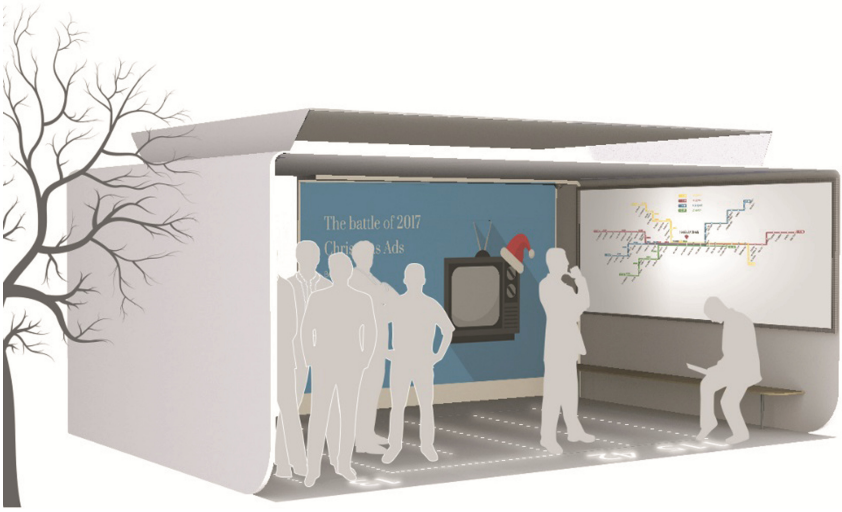

Fig. 4. The design of the bus station

1. Tidal waiting line [5]: Adjust different bus line waiting space on the same platform according to real time circumstances. The data platform uses ground sensors to

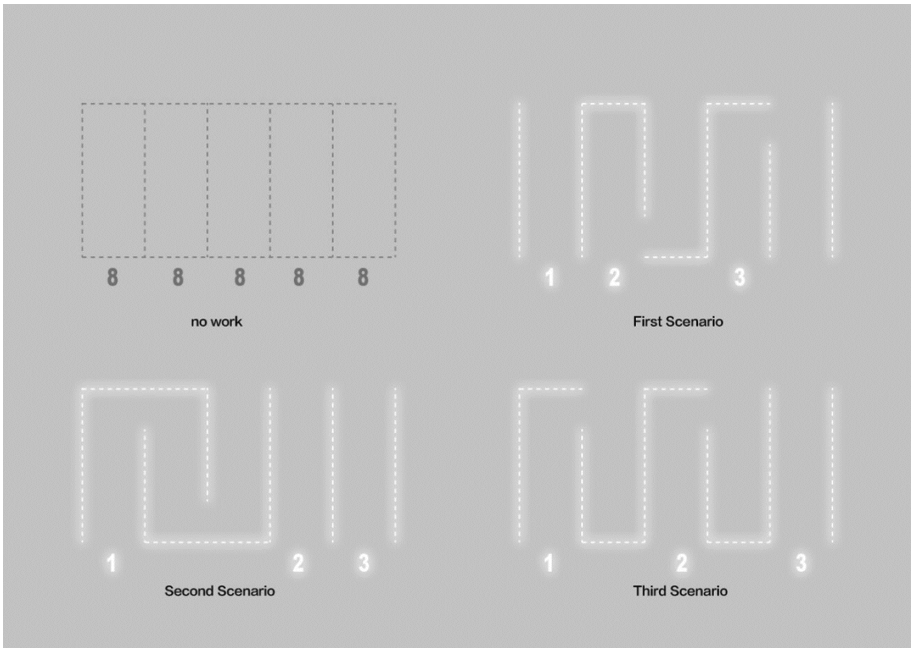

Fig. 5. The design of Tidal waiting line

measure user flow in real time, which is combined with previous data mining to analyze passenger flows at various times on the same platform so as to control ground LED lamps for the waiting lines. Further combining this with traffic volume and waiting time data for different points in the queue can help resolve the issue of inefficient space allocation as caused by early morning and evening peaks. At the same time, this reduces passenger anxiety while waiting, and allows user to adjust their routes based on real time data (Fig. 5).

2. Data-based scheduling: According to real-time information on tide waiting lanes and vehicle traffic, data analysis is conducted to guide bus dispatchers in vehicle adjustment, so as to manage urban public transport resources at the macro level, efficiently dispatching vehicles and personnel, and reducing wasted manpower, space and energy.
3. Dynamic station boarding [6]: Stations which use LED display technology expand the visual range and amount of information available, including stop names, driving direction, fares, expected arrival time, the location of late vehicles, the congestion levels facing said vehicles and the flow of said vehicles among other information. At the same time, passengers scan the two-dimensional code for their selected line using their mobile phone, providing real-time information customized to the user. Passengers can hence sensibly arrange their spare time before the vehicle is expected to arrive, and also choose the most suitable line. Through the transmission of key information, the bridge is formed, and the informational gap plugged, thereby reducing passenger anxiety, enabling them to make an informed decision (Fig. 6).

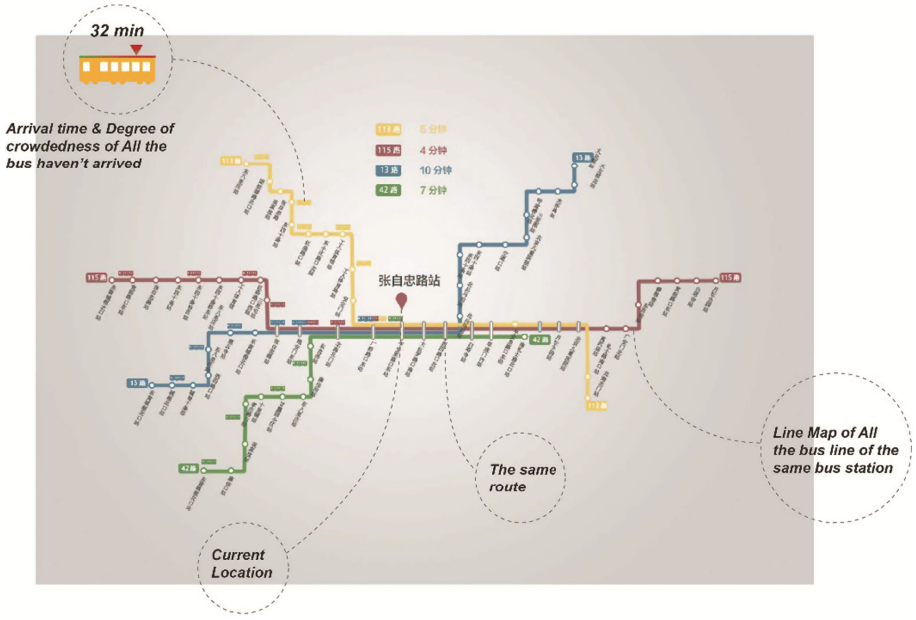

Fig. 6. The design of dynamic station boarding

4. Station check-in: Instead of swiping their card on the bus, passengers can swipe at the station, using either their mobile phone or bus card to check-in. This will helped reduce passenger crowding at the doors because of card search and swipe times, thus reducing vehicle waiting time and congestion near stations.
5. Public Transportation App: The integrated development of the public transport information app, TravelMate., in addition to current bus app query lines and other functions, will allow passengers to collect real-time information. Users are alerted to real-time changes in route plans through TravelMate anytime and anywhere, and can query related information. For example, when passengers are getting ready for work in the morning, they receive a system notification: "there is a traffic jam this morning, please leave 20 min early or consider an alternative route". Moreover, when passengers are waiting for a bus on the platform, TravelMate can prompt users. Based on the time analysis, passengers know whether they have time to buy a drink at the supermarket, and can then get a vehicle entry warning when the vehicle is arriving. When getting to the station, the user knows the arrival time and whether there have been any traffic jams through TravelMate. In congestion, TravelMate can provide passengers with information related to estimated arrival time, so that passengers can optimize their journey.

4 Conclusion and Future Work

In our proposed work, we sought to establish a framework, which adequately represents information flow, different elements and their relationships, in a manner accessible to various audiences. The Information Service Framework is a result of this vision.

Furthermore, we shortly introduced the Public transport information service system based on the information service model we designed in order to improve the travel experience in smart cities and to satisfy passengers, variety, and dynamic requirements. Then, we presented our real-time public transport information service based on tidal waiting lines, resulting in the front-end Android application, TravelMate, which provides more personalized, rich and clear information.

For future work, we plan to further develop the information service model, while enhancing the different services of all app features. Moreover, we intend to accrue a noticeable user base and carry out field experiments with these real users. Their feedback is important to identify future improvements for the service.

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