Research on a System for Information Linkage between Railways, Local Areas, Buses, and Taxis

In this paper, we describe the development and evaluation of an information linkage system for public transport. In 2015, field testing of the developed public transport information linkage system was conducted in Tokyo Station and Musashi-Koganei Station. We confirmed the service improvement effect and are promoting the effects of linkage with public transport.

Keywords: Public transport, Information linkage, ICT, Navigation, ITS

1 Introduction

Innovation in methods of providing information has been progressing in the transportation sector in recent years as ICT devices such as smartphones have rapidly become commonplace. Particularly, communications functions of smartphones have enabled easy provision of real-time information; and excellent image rendering, GPS, and other functions of smartphones also have been propelling day-to-day advances in navigation services.

Under these circumstances, technical development and the like with an aim of advancing transport systems using ICT devices is underway in the intelligent transport system (ITS) field. In the area of private automobile transportation, in particular, there have been many cases of development leading to practical use of car navigation systems, electronic toll collection (ETC) systems, and the like.

The target in efforts in ITC for public transport has been to provide seamless mobility through linkage between railways and end means of transport. Various examples of seamless mobility in Europe and Asia were introduced at the 2015 World Congress on Intelligent Transport Systems, but there are few examples in Japan, even at the proving test stage.

In the research covered in this paper, we conducted proving tests of a system for linking railway, other transport operator, and local area information with a goal of improving convenience of railways and other public transport by sharing information seamlessly. With the cooperation of various operators, we bundled and provided to users information on a trial basis and conducted proving tests at two areas (Tokyo Station and along the Chuo Line) to evaluate effectiveness and identify issues ahead of applying the findings of our study as a service for the public.

2 System Development

We adopted a composition of information sources that allow integrated information to be delivered to users’ smartphones, digital signage, and the like (Fig. 1). With that, information from dynamic information delivery servers held by or newly developed by individual operators is consolidated and integrated and static information is housed in individual servers.

Information imported is…
- Railway (JR East, other operator) information
- Bus information
- Taxi information
- Rental bicycle information
- Local area information (tourism, facilities)

2.1 Smartphone Display Screen Composition

For the display screen composition, we provided information in the JR East App smartphone app released in March 2014 in order to enable as many users as possible to try the system in the limited time of the proving tests. More than a million people had downloaded the app at the time of the proving tests.

2.1.1 Top Screen

From the “Participate in Experiments” banner on the JR East App, participants were directed through a landing page to a screen for an area of the field tests (Fig. 2). Areas were Tokyo Station for the Tokyo area and Musashi-Koganei, Higashi-Kogane, and Musashi-Sakai stations for the Chuo Line area.

2.1.2 Railway Information

Railway information was displayed in the same layout as departure boards set up on platforms and other locations. It had a composition whereby tapping a tab at the top the screen where railway information is first displayed jumps to individual information such as that of buses and rental bicycles (Fig. 3).

The following items were included in the information provided:
- Scheduled departure time (timetable)
- Destination and type of train
- Delay time and operational information

Operational information was also delivered in the operational information field at the bottom of the page.
2.1.4 Taxi Information

The taxi information screen (Fig. 5, left) was composed taking into account situations such as difficulty in finding out at which exit there is a taxi stand at stations one is unfamiliar with and having trouble with tasks such as searching for a taxi company serving the area when needing to call a taxi while out on the town.

The following items were included in the information provided:
- Operator list (telephone numbers)
- Taxi stand location information
- Fare search URL links

At the time of the proving tests, apps were starting to come out that enabled viewing of taxi location information and directly dispatching and reserving taxis, and we considered linkage with those. We put off including such functions, though, as some taxi companies could not be supported and due to the difficulty of developing in line with the intent for tests to be for limited areas.

We did equip the app with a function to jump to a screen that allowed searching for reference fares from the station to specified locations.

2.1.3 Bus Information

Bus information was displayed as guidance for the next departing bus by individual boarding platform, with the station as the starting point.

The following items were included in the information provided:
- Boarding platform number (with station exit direction)
- Departure time
- Route name and destination
- Bus location information (link)

The screen had a composition where, to search for later times or stops for a specific route, the user taps on a boarding platform number or route name to jump to that information (Fig. 4). Assuming situations such as the user knowing the name of the destination bus stop but not the route or boarding platform number, a search function was provided where searching for a bus stop name displays the route and departure time list. While bus locations could be displayed directly on the screen, we chose not to display that information in the experiments because there was a risk of information not being accurate due to operational changes and the like. A decision was therefore made, upon discussing with partner operators, to enable easy viewing by providing locations as reference information using URL links for individual routes.
2.1.5 Rental Bicycle Information
For the rental bicycle information screen (Fig. 5, right), we first provided information on how to use the service and where to rent bicycles due to the low recognition of that service compared with railways, buses, and taxis. Then, information on real-time availability was displayed.

The following items were included in the information provided:
- How to use rental bicycles (URL link)
- Number of rental bicycle available
- Location information of places to rent bicycles

2.1.6 Local Area Information
For the local area information screen, we partnered with local government, leisure facilities, and commercial facilities to consolidate and deliver information on leisure and tourism destinations in order to create new movement of people (Fig. 6). The screen was equipped with features such as ability to save information of interest and jump to information on bus departures and routes.

2.2 Composition of Digital Signage Display Screens
The same information provided to smartphones was also provided on signage in the proving test areas according to features of locations where signage could be set up (Fig. 7).

Signage was set up at the following locations:
- Musashi-Koganei Station ticket gate exit (three devices)
- Musashi-Koganei Civic Center (Miyaji Gakki Hall)
- Tokyo Station Marunouchi south ticket gate exit
- Inside Tokyo Station Yaesu central ticket gate
- Information was provided in line with needs of users of those locations according to features of the individual locations.

3 Field Tests
Field tests were held from November 19, 2015 to February 26, 2016 for the Tokyo Station area and Musashi-Koganei Station area.

3.1 Structure of Field Tests
The Frontier Service Development Laboratory at the Research and Development Center of JR East Group was in charge of conducting field tests, and those tests were conducted with the cooperation of the following transport operators (alphabetical order): JR Bus Kanto, KANTO Bus Co., Ltd., Keio Dentetsu Bus Group, Odakyu Bus Co., Ltd., Seibu Bus Co., Ltd., SEIBU RAILWAY Co., Ltd., Tokyo Metro Co., Ltd., Tokyo Metropolitan Bureau of Transportation (Toei Bus), Tokyo Bus Corporation.

Data gathering, system linkage coordination, and the like were done with the cooperation of Tokyo Hire-Taxi Association for taxi information, of East Japan Marketing & Communications, Inc. and JR Chuo Line Mall Co., Ltd. for rental bicycle information, and of Koganei City (Kogane no Sato), and JR Group companies for local area information.

3.2 Questionnaire Responses
We linked to a questionnaire from the smartphone app and evaluated service during the field test period. There were a total of 519 responses to the questionnaire. From an evaluation perspective, questions included those on service acceptability (impression, frequency of use), evaluation of individual functions, and requests for future expansion, as this was a new effort.

3.2.1 Service acceptability
Respondents had a favorable impression of the effort in linking railway, other mode of transport, and local area information, at a rate of more than 95% (Fig. 8). For intent to use, more than 95% (total for normal operation and at transport disorders) responded that they intended to continue using, confirming that service was rated highly.

3.2.2 Evaluation of Functions by Individual Content
Content that was rated highly was bus information and other private railway information (Fig. 9). The scores for convenience of bicycle rental and local area information were low because the
number of people actually viewing those was low. Cross tabulating
the view rate and convenience score showed that more than 80%
of people viewing those responded that they were convenient,
demonstrating that while overall score was low, the score among
those who viewed the content was high.

3.2.3 Survey of Impact on Behavior Modification
For behavior modification, we provided options and asked about
the possibilities for changes in lives and mobility to occur from
introducing this system. Results showed that the highest score
was for increase in bus usage of lines not ordinarily used, and the
second highest was for expanded area of activity (Fig. 10). Those
results showed that achieving the system would not only increase
service levels, but also possibly promote further use of public
transportation as well.

3.2.4 Function Enhancement
For function enhancement, we provided options and asked about
what demand there is for functions not provided in the field tests.
Results showed high demand for route search functions that
include railways and buses and for real-time information on buses
(delays, traffic congestion, etc.) (Fig. 11).

4 Conclusion
Through system development for field tests and through proving
tests, we confirmed that efforts and the system itself were rated
high. The three issues discovered are summarized in 4.1 to 4.3
below.

4.1 Insufficient Data and Functionality
As described in Chapter 2 for the screens the system is composed
of, linkage of train and bus location information with reservation
service is at a level where proving tests can be done, but inclusion
of many functions was put off for the time being. Demand for
real-time data and route search functions is high as shown in
Fig. 11 from user questionnaire responses. We therefore need to
secure comprehensiveness in linkage with operators in the future
and continue making adjustments with a goal of achieving the
demanded functions.

4.2 Method of Data Management
We aimed to provide information as accurately as possible in the
proving tests through the cooperation of participating companies,
but timetables in bus information are often revised at irregular
intervals unlike with railways, so adjustments needed to be made
manually for route changes and bus stop changes when events
are held in the operating area. In the future, we need to study a
method of data management where changes to outside data can be
made automatically and without time lag.

4.3 Consideration of a Linkage Scheme
In future introduction of the system, we need to work out items
to be linked between the companies and where to divide cost
allocation and responsibilities for accuracy of information. We
also need to unify joint development schemes and platforms in
order to achieve more useful functions from a user perspective
(4.1) and more accurate information (4.2).

4.4 Future Efforts
In the future, we will consider a wide range of issues, including
linkage with operators outside the area of the proving tests and
operators making other related efforts. We will also study how
to overcome technical issues and introduce the system as soon as
possible with a sufficient level of service. Our aim is to develop a
system that will allow railways and other public transport to be used
with greater convenience and peace of mind at the opportunity
provided by the 2020 Olympic and Paralympic Games in Tokyo.