To reduce train delay by thoroughgoing operation in the Tokyo metropolitan railway

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Background

- A massive number of passengers uses trains for commuting.
- During morning rush hour, 25 to 30 trains run hourly in each direction.
- For most subway lines, a headway of 2 to 3 minutes is maintained.
Background

The mechanism of delay propagation

1. Trains and platforms are very congested.
2. Dwell times become longer.
3. Stop!
4. Running times become longer and trains are delayed.
5. Dwell times become longer.
6. The subsequent train has to wait outside the station or slow down if the platform is occupied by the preceding train.
Background

In morning rush hour

- In order to operate trains frequently, dwell times are planned to be as short as possible.

- If scheduled dwell time of Train A is exceeded, Train B has to stop outside a station or slow down.
- This process is repeated over and over again, and delays increase more and more.

Therefore, we have to reduce delay factors
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Overview of Chiyoda Line

- 10-car (200-meter) trains are used.
- A single train transports about 2,500 passengers during the morning rush hour.
- Chiyoda line has the second highest congestion rate in the Tokyo Metro lines.
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Causes of delays on Chiyoda Line

Recognition from the delay graph in June 2012

- We recognized increase of train delay time.
- There are two reasons for train delays, one is exceeding dwell time and another is exceeding running time.

We concentrate especially on the causes of exceeding dwell time.
## Causes of delays on Chiyoda Line

### Causes of exceeding dwell time

The classification of delay factors

<table>
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<th>Cause</th>
<th>Passenger flow factors</th>
<th>Train crowded factors</th>
<th>Operation factors</th>
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<tr>
<td>Cause A</td>
<td>(Cause A) Terminal congestion</td>
<td>(Cause C) Convenient position</td>
<td>(Cause E) Differences of individual operation</td>
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<tr>
<td>Cause B</td>
<td>(Cause B) Change between cars</td>
<td>(Cause D) Not regular train intervals</td>
<td>(Cause F) Last stop station operation</td>
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<td>Cause C</td>
<td></td>
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</tbody>
</table>

### Remark
- Terminal station
- Transfer to another line
- Try to exit one car and enter another (Because of convenient position)
- Platforms are very narrow
- Passengers concentrate on one car
- Headway becomes disorder by delayed train
- Unification of operation (announcement, confirmation signs etc..)
- At the intermediate station, all passengers have to get off
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Introduction of delay reduction measures

Education and information sharing

At first, we educated staff about following things.

i. The mechanism of delay propagation

ii. The cause of exceeding dwell time

iii. The necessity for the dwell time management

We update actual delay data of weekday morning rush hour on the following weekday. Thereby all involved staff can check and grasp the delay situation.
Introduction of delay reduction measures

Dwell time management

→ Time

Management strictly

Arrival〜Buzzer start
Buzzer ringing
Buzzer stop〜Door close signal
Door close signal〜Door close
Door close〜Safety signal

Safety confirmation

Crew operation
Station staff operation
## Introduction of delay reduction measures

### The staff members

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<td>Correspondence</td>
<td>Cause A, B, C, E, F</td>
<td>Cause B, C, E</td>
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<tr>
<td>What to do</td>
<td>Announcement</td>
<td>Announcement (in the car)</td>
<td>Adjustment of train interval (disperse congestion)</td>
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<td></td>
<td>Train door close signal</td>
<td>Buzzer ringing</td>
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<tr>
<td></td>
<td>Confirmation of safety</td>
<td>Handling door</td>
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</table>

For all involved staff

1. To be very conscious about reducing delays
2. To do delay reduction measures

If even one staff member doesn't do them enough, delay reduction measures are not completed.
Introduction of delay reduction measures

Station section

(A) Guidance announcement at a platform
(Cause A, B, C)

(B) Prevention of getting caught in doors
(Cause A, C)

(C) Unification of operation
(Cause E)

(D) Reallocation of station staff and extra staff
(Cause A, F)
Introduction of delay reduction measures

Crew section

(A) Guidance announcement during running (Cause B, C)

Get on the cars which are not crowded. / Don’t rush onto the train. / Don’t change between cars during dwell time.

(B) Buzzer operation for the dwell time management (Cause E)

Ring a buzzer for 3 seconds after 5 seconds from arrival

(C) The abbreviation of the announcement in the car at Ayase Station
Introduction of delay reduction measures

Control center section

http://www.tokyometro.jp/corporate/enterprise/passenger_rail/transportation/adjustment/

Control center staffs order adjustment of train interval. If it is not adjusted, the train congestion and train delay are increased.
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Results of delay reduction measure

These results were achieved thanks to staff member’s great energy and patience. Owing to the efforts to reduce by at least one second, exceeding dwell times and exceeding running times were decreased.

Since delay propagation became small

Delay of direction A excluding problematic day (Comparison between in June, 2013 and in June, 2012)
At Ayase station, the guidance announcement during dwell time was abolished, then the announcement was carried out after the train departure instead.
Results of delay reduction measure

The case of Kasumigaseki station

Some trains turn back at Kasumigaseki Station. In this case, it took a long time to confirm getting off completely empty. This was a cause of the subsequent train’s exceeding running time.
Results of delay reduction measure

The case of Kasumigaseki station

We have allocated four extra staff members to speed up confirmation of getting off at Kasumigaseki station.
Results of delay reduction measure

The staff member’s comments

i. “I did not think that delay time was shortened by the time management of a buzzer ringing.”

ii. “I thought that an announcement to prevent moving between cars was effective.”

iii. “I thought that trains slowed down or stopped less between stations.”

iv. “I thought that reducing delays alleviated irritation.”
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Conclusion

We have presented the measures against exceeding dwell times on Chiyoda Line.

It is important for this activity that all staff conscious of the problem of delays and tackle are them every day.

It is possible that additional ideas for delay reduction measures will come out in the future, and we should implement such measures as they arise.

Although the measures discussed here were regarding operations, in the future it will also be necessary to discuss delay reduction measures on the hardware side.
Thank you for your attention.