Customer-Oriented Evaluation Method of Railway Performance

Fuminori Tsunoda, Masao Yamashiro, Rieko Otsuka,
Manabu Kato, Hiroko Sukeda, Kazuhiro Ozeki

East Japan Railway Company, Hitachi, Ltd.

Outline

1. Background
2. Motivation
3. Data stored in ticketing gate
4. Definition of SCORE
5. Calculation Flow
6. Case Study
7. Result of SCORE
8. The feature of SCORE data
9. Visualization Tool
10. Demos
11. Conclusion & Future work

1. Background

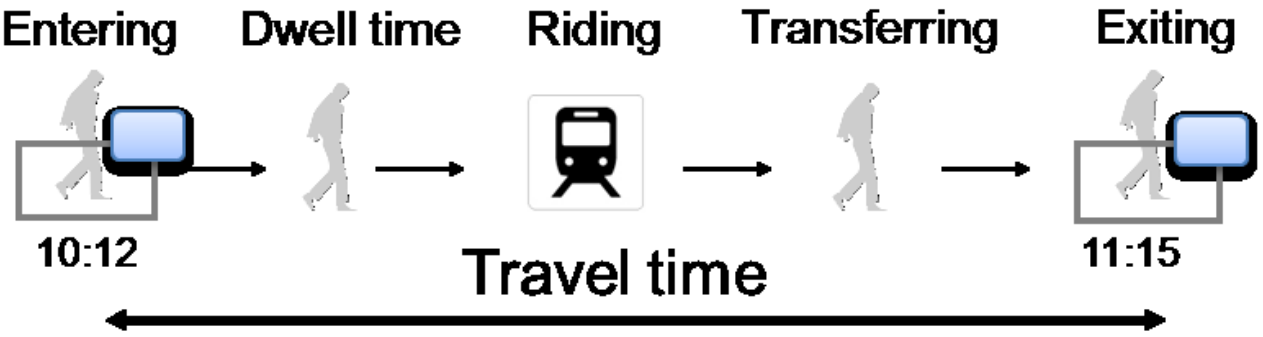
- Transport network is being complex
- Passengers:
  - Demand higher quality service for transport
- Operators:
  - Want to respond passengers' needs
  - Need to evaluate their operation
  - Seek to find a new solution for the train operation
- ICT environment is improving
  - The data of ticketing gates are gathered to the server
  - Smart card user have been increased

2. Motivation

- Improve quality of the transport service
- Establish the Key Performance Index (KPI) for transport operation from the view of passengers
  - Grasp the passengers behavior
  - Understand the effect for disruption
  - Find a new idea for the operation
  - (Praise the dispatcher)
- Obtain an insight of computer algorism for a next generation train control system

3. Data stored in ticketing gate

- Most of stations in Tokyo Metropolitan area installed auto ticketing gate
  - Recoding in and out time to Smart cards and tickets
  - Store the time and ID and transmit to the station server
- The station servers send the data to the center server
- A travel time for each passenger can be calculated

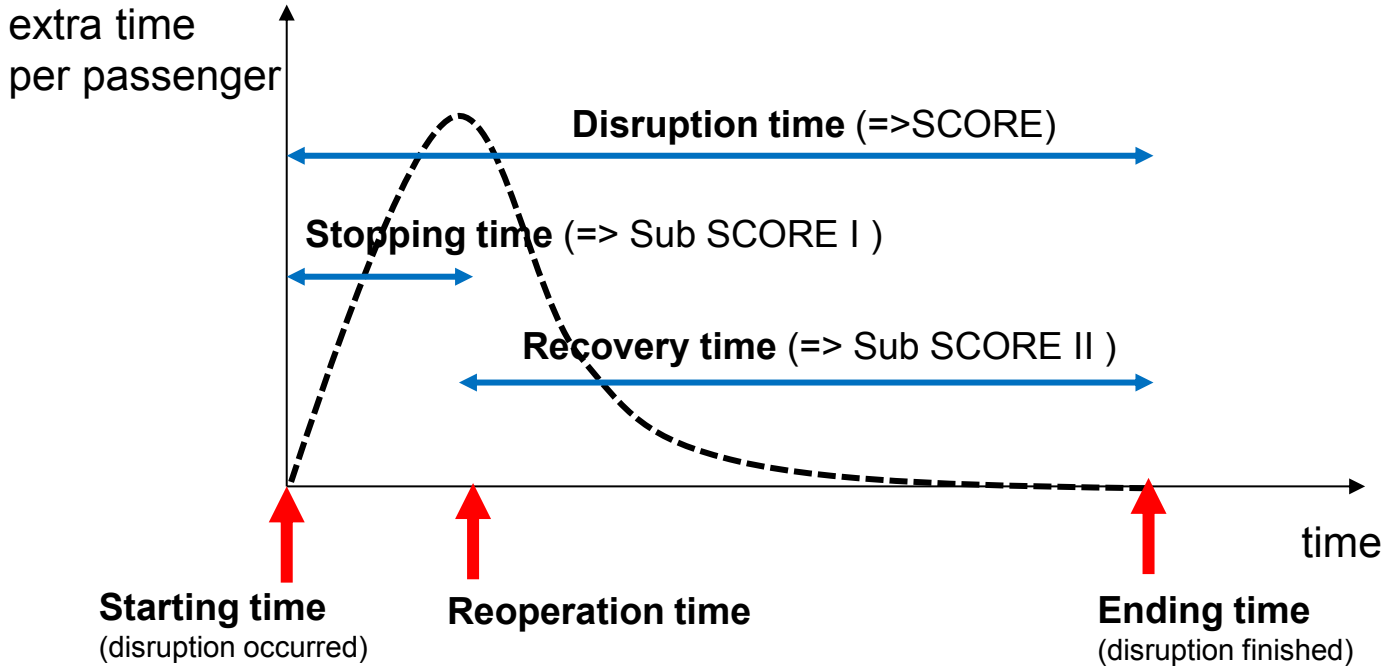


4. Definition of SCORE [1/3]

SCORE (Scale for Customer-Oriented Railway Evaluation)

Before the definition…

The distribution of passengers' total extra time (additional time by the accident)



4. Definition of SCORE [2/3]

SCORE (Scale for Customer-Oriented Railway Evaluation)

$$SCORE = \log\{ \sum_{ts=tss}^{tse} [T_{extra}(ts)] \} \quad (*)$$

$$T_{extra}(k, ts) = pn(k, ts) \times [tm(k, ts) - st(k, ts)] \quad (1)$$

$$T_{extra}(ts) = \sum_{k=1}^{n} [T_{extra}(k, ts)] \quad (2)$$

$$Total\_T_{extra} = \sum_{ts=tss}^{tse} [T_{extra}(ts)] \quad (3)$$

4. Definition of SCORE [3/3]

Other Effective Indicators

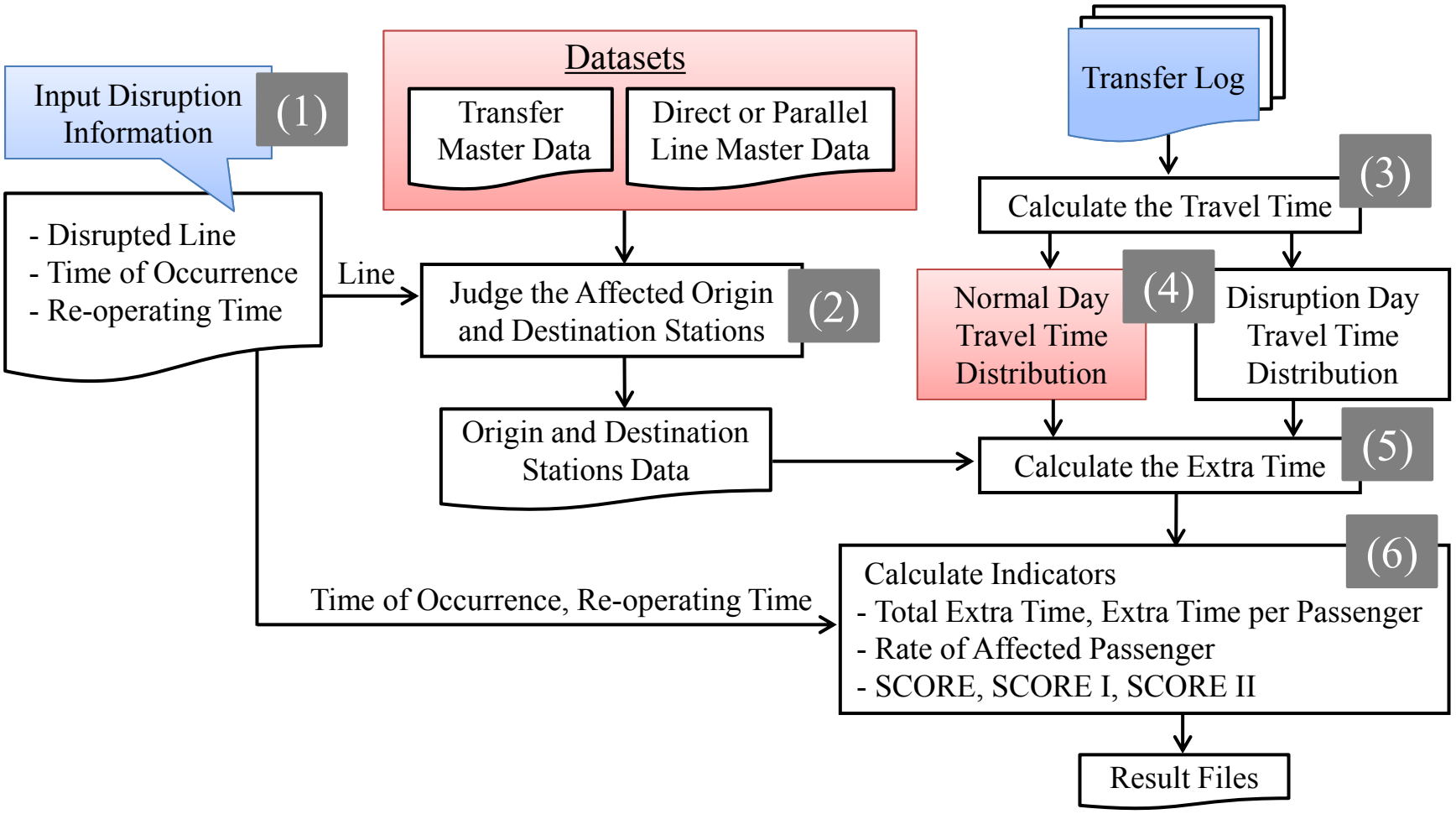
$$T_{extra}(ts)_{\mathrm{pp}} = T_{extra}(ts) \,/\, pn(ts) \qquad (1)$$

$$Sub\ SCORE\ I = \log\{ \sum_{ts=tss}^{tsr} [T_{extra}(ts)] \} \qquad (2)$$

$$Sub\ SCORE\ II = \log\{ \sum_{ts=tsr}^{tse} [T_{extra}(ts)] \} \qquad (3)$$

5. Calculation Flow

- There are six steps to calculate the SCORE data

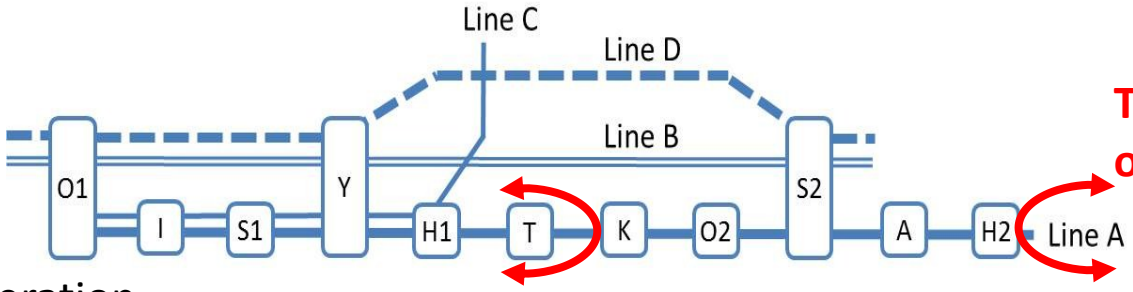


6. Case Study

- Disruption Case

Case	Date	Time of Occurrence	Re-operating Time	Line	Disruption Section
1	4th Feb 2010	10:30	11:50	A	b/w sta. K and sta.O2
2	15th July 2011	13:34	14:32	A,B	sta. T
3	23th May 2011	7:12	8:17	A	sta. A
4	21th June 2011	6:22	7:48	A,B,C	b/w sta. K and sta.O2

- Line Map



Turn around operation

- Dispatchers' Operation

Case	Operation Details
1	- Stopped all sections on line A (No turn around operation)
2	- Turn around operation at sta. K (7 trains) - Turn around operation at sta. I (2 trains) - Operated b/w sta. S2 and sta. Y on line D instead of line B (8 trains) - Direct operation from line C b/w sta. H1 and sta. S1
3	- Stopped all sections on line A (No turn around operation)
4	- Turn around operation at sta. K on line A (4 trains) - Turn around operation at sta. H2 on line A (6trains) - Turn around operation at sta. O1 on line B (1 train) - Extra train departures from sta. H2 (6trains) - Extra train departures from sta. K (4 trains)

Turn around operation conducted

Turn around operation conducted

7. Result of SCORE

Case	Duration Time of Disruption	Actual Duration Time	SCORE	Sub SCORE I	Sub SCORE II
1	1:20	2:00	6.08	6.00	5.32
2	0:58	0:48	5.64	5.64	-
3	0:56	1:33	6.63	6.61	5.37
4	1:26	3:44	6.79	6.52	6.46

- Comparing Case 1 and Case 2, the SCORE of Case 1 is higher than the one of Case 2

⇒ **Turnaround operation is effective for the passenger**

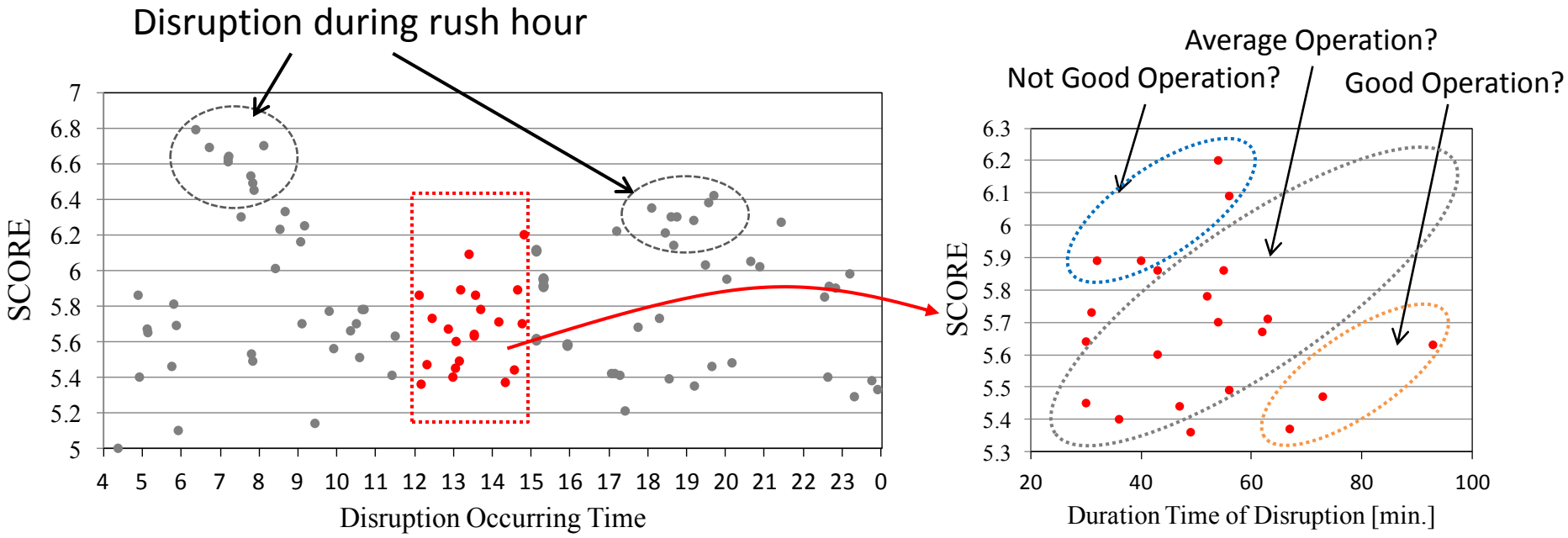
- Comparing Case 3 and Case 4, the SCORE of Case 3 is lower than the one of Case 4

=> But, the Sub SCORE I of Case 3 is higher than one of Case 4,
the Sub SCORE II of Case 3 is lower than Case 4,

⇒ **Turnaround operation is effective!**
Especially, during the time of train operation stopping, the turnaround operation is much more effective
But, after re-operating, **it is more difficult to recovery when the dispatcher conduct a turnaround operation.**

8. The features of SCORE data

- SCORE data becomes higher during peak time
- Compared in the same time period, the distributed SCORE data means a difference of the disruption influence and/or operational result.



Scatterplots of SCORE data

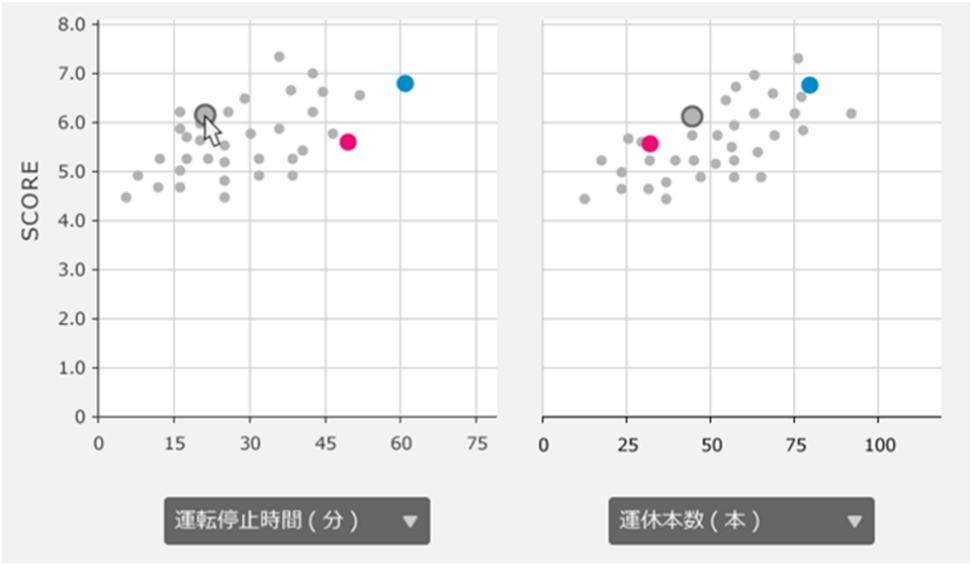
9. Visualization Tool

- The impact of the disruption can be seen as a heat map
- The SCORE data set by the selected conditions can be compared with previous data

Heat Maps

Left: Passenger traffic

Right: Extra time per passenger



Scatteprlots of SCORE

Left: SCORE vs Duration Time of Disruption

Right: SCORE vs Number of Train Cancellations

10. Demos

How does the dispatcher review disruptions?

11. Conclusion and Future Work

- A new evaluation method for railway operation “SCORE(Scale for Customer Oriented Railway Evaluation)” proposed.
- SCORE enables the operator to enhance their operational quality from the viewpoint of passengers with the scientific skill.
- The visualization tool for understanding the train disruption was developed.
- SCORE has an enough potential for marketing, planning, making strategy and so on.

Fin.

Thank you!