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AN INSTALLATION METHOD OF THE OPTINUM ESCALATOR

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Abstract:"Accessible and Usable Transportation Law" was promulgated to improve "smooth movement and safety" for transportation disadvantaged people's public traffic in May 17, 2000. Installation of escalators etc. was also required in train stations. Research aims to devise the method to decrease congestions due to setting up escalators replaced for stairs by simulating the situation. Firstly, in this research, simulation model was developed to represent the usage pattern of escalator and stairs. Then, the combination of escalator and stairs was changed to obtain the optimum. The result shows that a lot of people must stay on platform if the stairs were just replaced to the escalator in busy station. An adequate combination of escalator and stairs is important in design of barrier-free station.

1. INTRODUCTION

Inflow of people to a big city increased by the high economic growth of 1960 - 70's in Japan. Railway users increased remarkably along with it, and congestion during commuting is social issues. In the morning and evening rush hours, the congestion rate exceeds 100% in most routes toward the center of cities and out of cities. It is also very crowded in the station premises.

Moreover, real aging society is starting in Japan now. The senior citizen of 65 years or elder is 19.4% as of June 1, 2004. Japanese consider that the handicapped person should live just like a healthy person, and that barrier-free society is requested.

"Accessible and Usable Transportation Law" was promulgated to improve "smooth movement and safety" for transportation disadvantaged people's public traffic in May, 17, 2000. And measures, such as widening of walkway, leveling of pavements, and improvement of roads, were requested. Installation of escalators etc. was also required in train stations. It is, however, more than before, crowded in stations premises with a lot of passengers getting on escalators.

Asai and Taniura researched situation in station on graduate study when it is crowded. It will be necessary to think about congestion because of the escalator installation in the future.

2. PURPOSE OF RESEARCH

The research aims to devise the method to decrease congestions due to setting up escalators replaced for stairs by simulating the situation.

3. OBJECT OF RESEARCH

We selected Kichijoji Station in JR chuo line and Sobu line as object of research.
This station is in the distance of 15 minutes from Shinjuku and is elevated. Kichijoji station is constituted no.1 and no.2 platform that, where Sobu line and Tokyo Metro Touzai Line (Touzai Line runs straight through into the Sobu Line) stops and no.3 and 4 platform where Chuo Line stops. Average of passengers getting on and off is 13, 6927 person/day. It is the 18th largest user in JR east. Many colleges and high school are located on the peripheral of this station, and connected with Inogashira Line. Therefore, this station is always congested.

This station is installed up-escalator. But it is so hard to get down from stairs for transportation disadvantaged people. We define this case “up only” because escalator is necessary to set up both up and down.

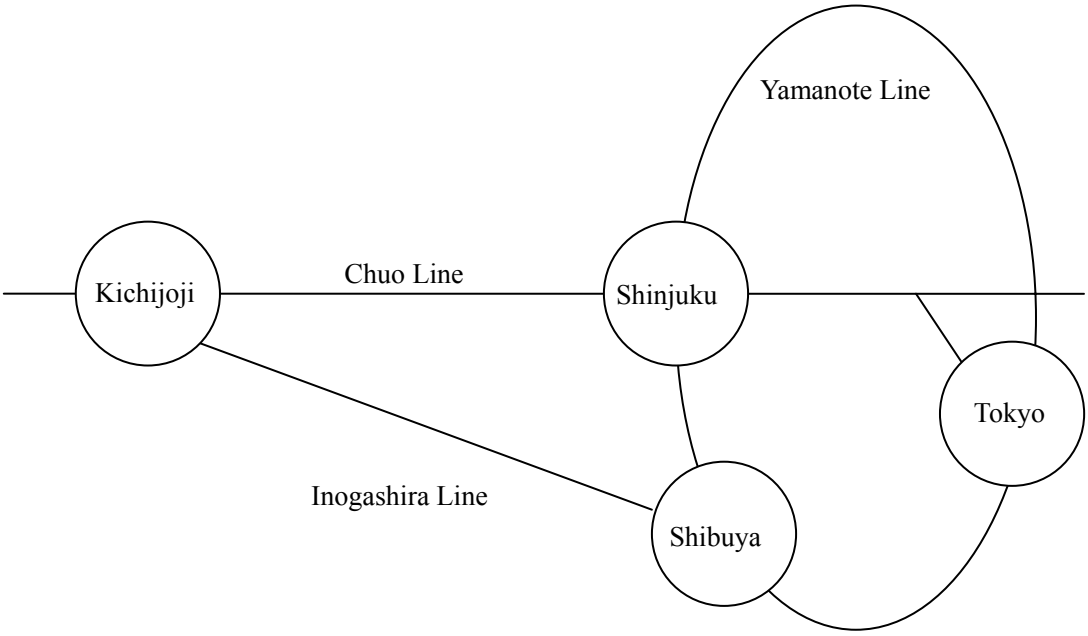

Figure 1. Train Map

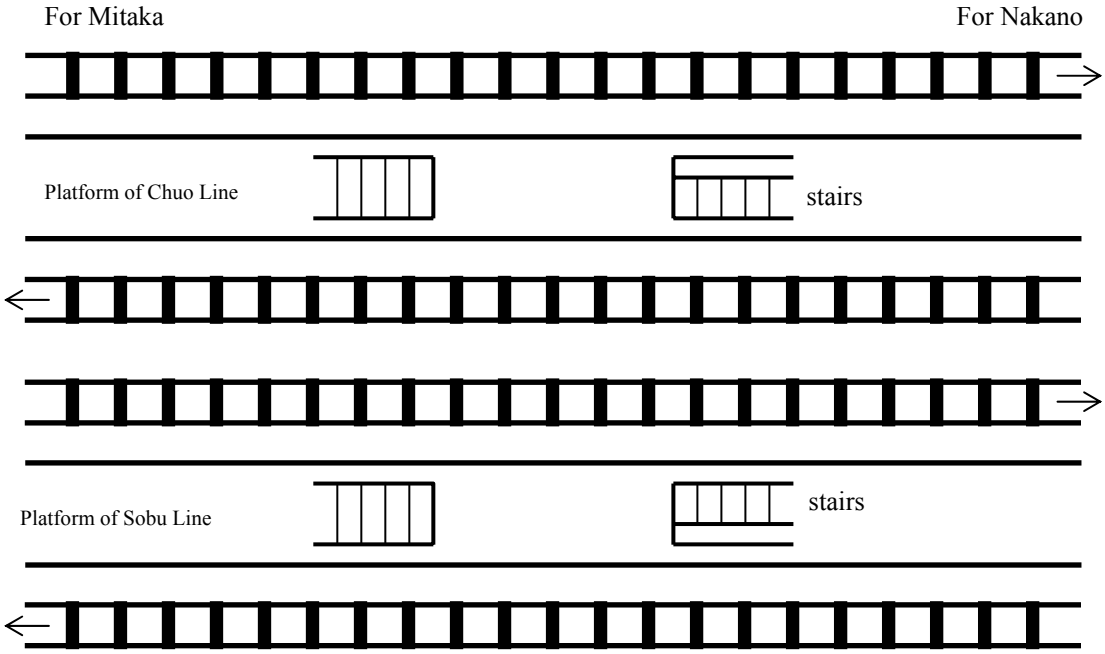

Figure 2. Platform

4. RESEARCH METHOD

Firstly, in this research, the number of user is surveyed on the platform. Secondly, simulation model was developed to represent the usage pattern of escalator and stairs. Then, the combination of escalator and stairs was changed to obtain the optimum. The model applied to the passenger flow to stairs alighted from 4 cars train with 4 doors. We estimated (1) the maximum waiting passenger when the stairs were replaced with escalator, (2) the maximum waiting passenger when both escalator and stairs installed.

The optimal escalator installation method for the number of getting on and off persons is proposed.

5. MODEL

We simulate the situation with MAS (Multi Agent Simulator). Multi Agent is Environment in which many independent agents are. This agent has characteristic that selects action according to his own value criterion.

We research cause of congestion by passengers getting off on to platform. Used data are the 34 case during 17:34~19:30, which is the evening rush hour, on November 16, 2002 from no.4 platform. Items of collected data are time of congestion start, congestion continuance, number of person arrived stairs and number of passengers getting off.

Then, change of level of congestion by escalator installation was simulated with MAS. And level of number of congestion by both escalator and stairs installed was simulated. It is supposed that sum of stairs and escalator with is kept constant.

6. Result of Survey

Passenger counts are shown in Table 1. Distance is from door to stairs.

The width of platform, stairs and down escalator is 9m, 3.6m and 1.6m. Alighting person's average walking speed is 1.2m/s. The speed of a basic escalator is 30m/min. Average number of alighting passenger is 122.2 in the 20 case.

Table 1. Number of Passenger Getting Off

door number	1	2	3-1	3-2	3-3	3-4	4-1	4-2	reel point	total
distance / time	67.4~53.6	47.8~34.0	28.2	23.6	19.0	14.4	8.6	4.0	(-)0.6~	
17:44	47	58	13	22	18	26	29	28	70	311
17:48	5	28	2	2	4	6	5	4	16	72
17:50	13	13	5	3	3	10	12	10	40	109
17:53	24	26	3	7	5	6	13	15	33	132
17:55	7	20	8	11	6	7	8	7	44	118
18:00	13	22	4	7	8	4	16	14	49	137
18:02	9	21	5	5	5	9	4	9	21	88
18:04	11	43	3	6	2	4	14	12	49	144
18:08	16	38	7	3	9	6	16	13	45	153
18:25	14	35	3	3	5	6	7	11	31	115
18:39	10	16	7	3	9	15	18	22	36	136
18:43	26	38	11	7	19	20	13	25	63	222
18:49	14	36	9	5	10	9	11	11	38	143
18:57	1	6	2	1	0	3	3	6	17	39
19:14	6	9	2	4	5	4	4	6	15	55
19:16	3	9	3	5	2	4	4	4	14	48
19:21	9	19	3	5	4	6	11	25	43	125
19:29	17	34	4	9	8	10	10	25	47	164
19:32	7	19	6	6	5	1	11	9	16	80
19:34	3	9	4	5	3	2	2	5	20	53

7 ANALYSIS BY SIMULATION

7. 1 Structure of Platform

Figure 3 shows model of no.3 and no.4 platform of Kichijoji station. There are several obstacles such as shop, bench, trash box and signpost. Square in the figure 3 is 60cm×60cm. Average walking speed is set to 1.2m/s. Escalator's speed is set to half of walking speed. Three cases of (1) only stairs, (2) only escalator, and (3) escalator and stairs, are simulated.

This simulation model expresses that alighting passengers left each door for escalator or stairs after door opened. Figure 5 shows movement of passengers.

Passengers basically choose the the shortest distance toward the escalator and/or stairs. However, when the obstacles and other people are in front, they proceed for the empty space.
"Change in length of queue in the vicinity of the stairs" and "Time that queue continues" are examined.

We defined congestion as passengers are occupying more than 45% of grid.

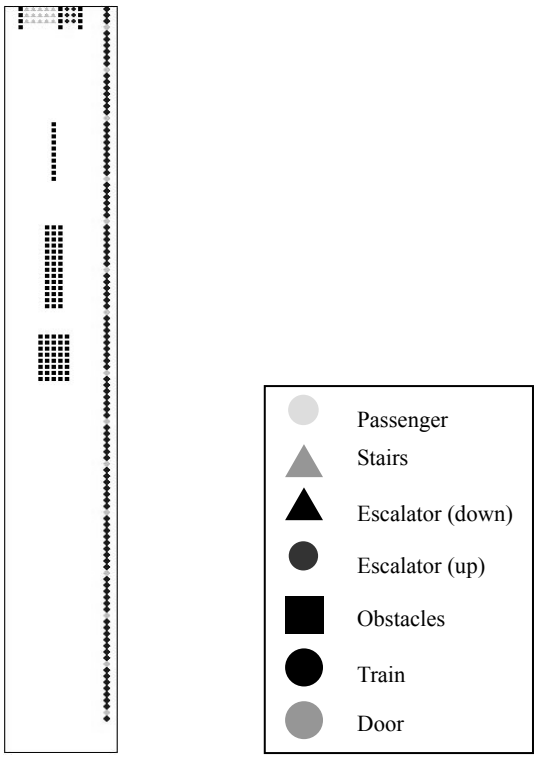

Figure 3. Platform Model on The Second Dimension Space

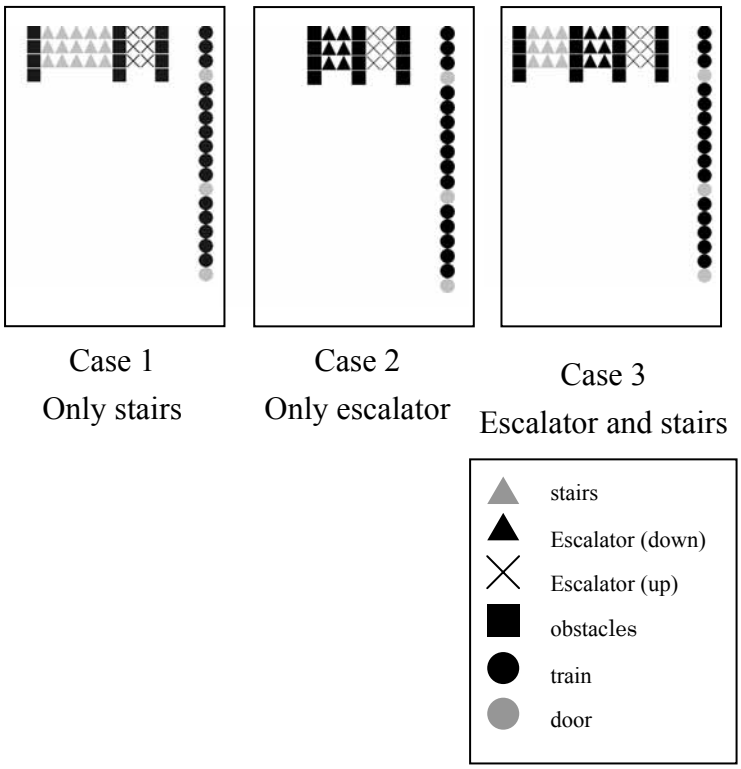

Figure 4. Close up of Platform Model

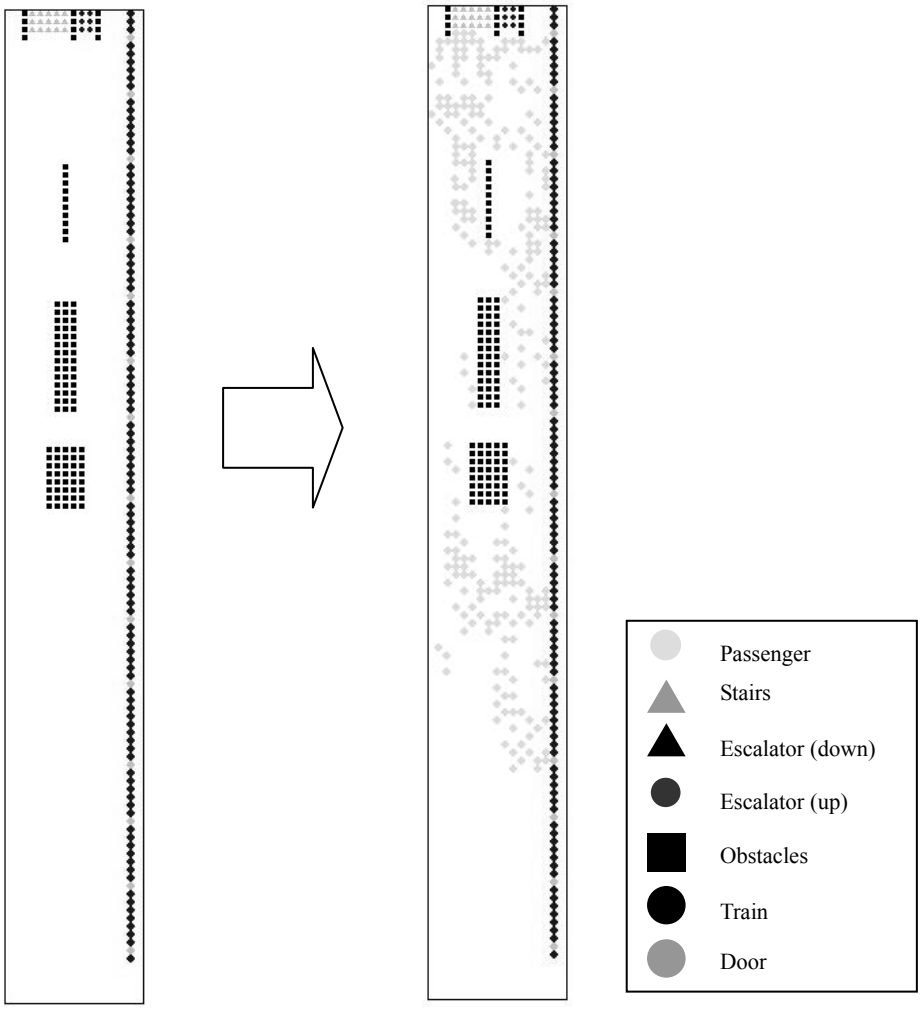

Figure 5. Getting Off Passenger's Movement

7.2 Result of Simulation

Figure 6 shows that relations between times after door opened and congestion ratio in the vicinity of stairs. “Congestion ratio” is a ratio that the guest occupies to the space in the vicinity of the stairs.

Congestion rate is larger in case 2 than other cases.

Figure 7 shows congestion continuance time. It is understood that congestion continues very long time in case of the escalator.

The result shows that a lot of people must stay on platform if the stairs were just replaced to the escalator in busy station. An adequate combination of escalator and stairs

is important in design of barrier-free station.

The number of passenger from each door is changed, and is simulated.
The result is shown in figure 8. When the number of passengers alighting increases, not only the congestion ratio but also congestion time increases.

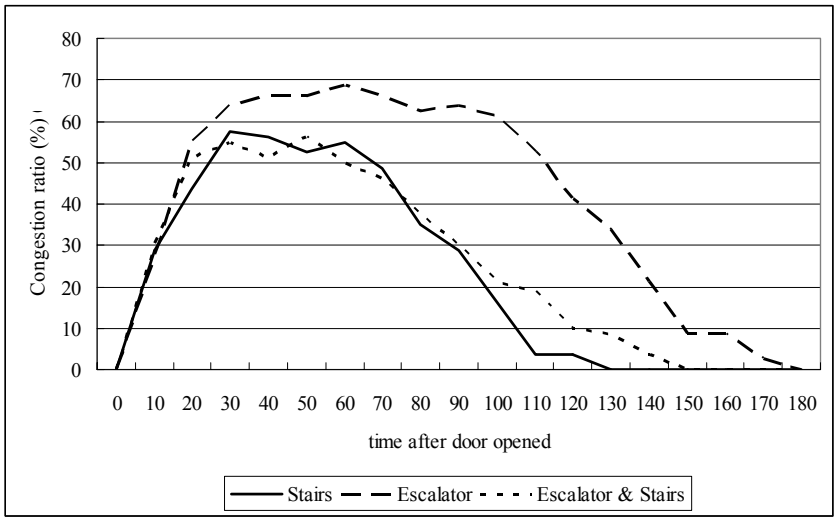

Figure 6. Relations Between Time After Door Opened and Congestion ratio in the vicinity of the stairs

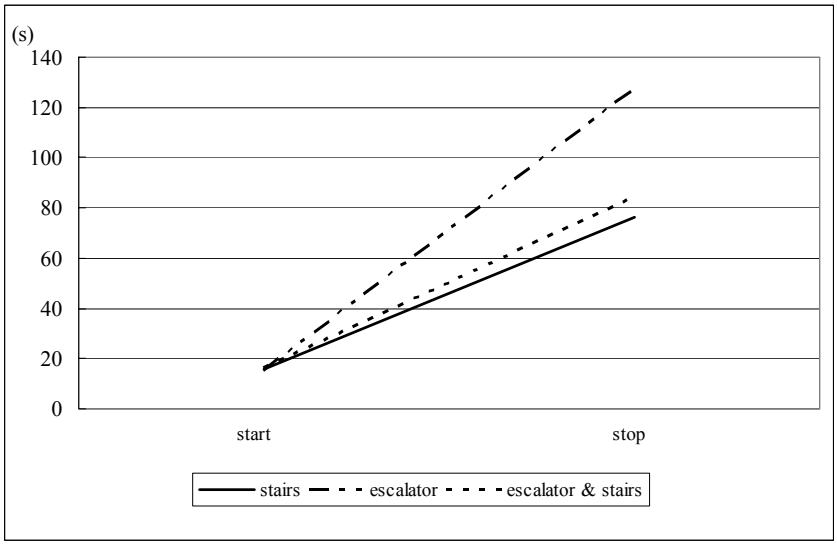

Figure 7. Congestion Continuance Time

Figure 8. Relation between congestion ratio
and number who gets off each door

REFERENCE

KOZO KEIKAKU ENGINEERING Inc.,http://www2.kke.co.jp/index.html