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IMPROVEMENT OF THE TRANSFER PATH USING A MOVING FLOW SEPARATION SYSTEM AND A TRANSPORTATION VULNERABLE ESCALATOR SYSTEM

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ABSTRACT: Traffic demands have increased rapidly, and traffic congestion has been raised due to the urbanization in Seoul. Most of the metro stations of commuting time have a moving speed and a density corresponding to the E or F grade in LOS(Level of Service). In particular, Jongno-sam-ga Station has a geometric structure because it is the transfer station of the 3 lines located in the center of Seoul. So the long transfer distances and the complex transfer system of Jongno-sam-ga Station induce an increment in transfer time and a decrement in public transportation demands. Therefore, this research was investigated the present conditions of the movement and transfer path on Jongno-sam-ga Station through a site inspection, and it presented the improvement plan through the analysis on the movement and transfer path for the general public, the disabled and the elderly. Based on the results, the improvements of the transfer paths by separating the moving flow and the transfer paths and applying the transportation vulnerable escalator system are suggested.

Keywords: Transfer Path, Traffic Congestion, Moving Speed and Density, Moving Flow Separation System, Transportation Vulnerable Escalator System

1. CONSIDERATION OF TRANSFER SYSTEM

1.1 Domestic Public Transportation Transfer System

It is estimated that usage time on public transportation is average 48.0 minutes and transfer time is 9.9 minutes in table 1 by the survey on public transportation status research [1]. It means 21.6% of usage time is needed by moving and waiting for transfer. This is because the existing transfer facilities are installed for the operators, not users. As age increases, the utilization rate decreases because of the inconvenience for walking up and down the stairs in the case of more than age 65 in table 2 [2].

The select rate of urban railway is 10.4% as transportation method for the disabled. On the other hand, the select rate of bus is 35.8% in table 3 [3]. It is investigated this gap is due to the lack of amenities.

Table 1 Transfer time

Division	Metropolitan area	Busan, Ulsan	Daegu	Gwangju	Daejeon	Total
The number of cases	7,120	2,350	1,780	1,250	1,880	14,380
Transfer time (min.)	10.5	10.2	8.1	9.1	9.7.	9.9
Boarding time (min.)	42.8	53.2	20.7	33.3	35.0	38.1
Total time (min.)	35.3	45.5	23.3	42.4	44.7	48.0
Transfer rate (%)	39.9	37.9	22.3	22.3	22.1	21.6

Note: Transfer rate (%) = Transfer time/Total time, Infrastructure and Transport, “The Survey on public transportation”, 2009.

Table 2 Transportation methods of the elderly

Division	Total	Age 65 ~ 69	Age 70 ~ 74	Age 75 ~ 79	Age 80 ~ 84	Age over 85
None	0.5	0.2	0.3	0.5	0.9	1.6
Bus	48.9	47.6	50.9	53.2	46.0	34.0
Metro	***19.3***	***21.3***	***22.3***	***16***	***17.4***	***9.9***
Taxi	6.7	3.5	4.3	8.9	12.2	16.4
Car	18.4	21.5	14.7	14.9	18.3	35.2
Bicycle	2.0	2.1	2.3	1.9	1.9	1.0
Motorcycle	3.1	2.8	4.1	3.2	2.1	0.7
Electric Wheelchair	0.4	0.3	0.3	0.5	0.3	0.7
Cultivator	0.2	0.1	0.1	0.3	0.1	0.0
etc.	0.6	0.6	0.6	0.6	0.8	0.5
Sum (People)	100.0 (10,543)	100.0 (3,150)	100.0 (3,229)	100.0 (2,389)	100.0 (1,163)	100.0 (614)

Note: Ministry of Health and Welfare, “The Survey on the elderly conditions”, 2011.

Table 3 Main transportation methods of the disabled

Division	Physical disability	Brain lesions	Visual impairment	Hearing impairment	Speech impairment	Low intelligence	Autism.	Mental disorder
Bus	35.9	22.7	38	41.2	51.2	33.9	23	47.4
Taxi	7.0	13.3	6.8	5.3	5.2	2.6	2.7	3.1
Metro	***8.0***	***9.2***	***15.8***	***15.3***	***14.4***	***7.9***	***6.2***	***16.4***
Minicab	0.2	1.8	0.4	0.0	0.0	0.0	0.2	0.0
Center Bus	0.2	1.3	0.7	0.0	0.3	1.4	1.3	0.3
Car	37.1	34.3	26.7	24.3	16.6	22.6	43.2	9.1
Shuttle Bus	0.0	0.7	0.2	0.0	0.2	3.0	2.5	0.0
Electric Wheelchair	1.0	3.5	0.0	0.2	0.0	0.0	0.0	0.0
Motorcycle	0.9	2.9	0.8	0.2	0.0	0.0	0.0	0.0
Walk	3.7	3.3	5.3	5	6.6	10.2	6.0	9.7
etc.	6.0	6.9	5.4	8.4	5.5	18.3	14.8	14.0
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: Ministry of Health and Welfare, “The Survey on the disabled”, 2008.

Table 3 Main transportation methods of the disabled –cont'd

Division	Kidney disorder	Heart disorder	Respiratory disorder	Hepatopathy	Facial disorders	Urinary fistula	Epilepsy	Total
Bus	30.7	34.1	31.8	20.9	28.8	40	52.2	35.8
Taxi	10.8	7.4	11.4	6.0	2.5	6.3	4.4	6.9
Metro	***14.4***	***14.7***	***11.3***	***18.3***	***11.8***	***20.6***	***16.8***	***10.4***
Minicab	0.7	2.8	0.0	0.4	0.0	0.0	0.0	0.3
Center Bus	0.1	0.0	0.0	0.0	0.0	0.0	0.3	0.4
Car	33.9	30.1	35.7	43.8	42.9	24.2	14.9	32.2
Shuttle Bus	0.9	0.1	0.0	0.0	0.0	0.2	0.0	0.3
Electric Wheelchair	0.0	0.3	0.5	0.5	0.0	0.0	0.0	0.9
Motorcycle	0.1	0.9	0.2	0.6	0.0	0.0	0.0	0.8
Walk	2.3	4.7	2.4	6.1	5.3	4.0	5.7	4.6
etc.	6.3	5.0	6.8	3.4	8.8	4.6	5.6	7.4
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: Ministry of Health and Welfare, "The Survey on the disabled", 2008.

1.2 Transfer System for the Disabled

The more layer to transfer and moving system, the much times and inconvenient for the disabled. It especially takes over 7 minutes to move by wheelchair lift, which means it takes too much time for transfer. As the results on the comparison of the transfer time from Gwanghwamun station to Hyehwa station for the disabled and the general public, there are many differences.

In case of the disabled, it needs to use a wheelchair lift in 4 times and an elevator from Gwanghwamun station to Hyehwa station. And it takes 12 minutes 36 seconds from Gwanghwamun square to Gwanghwamun station platform. On the contrary, it takes only 2 minutes 30 seconds for the general public to go same route by walking or using escalator. At Dongdaemun History & Culture Park Station which is the transfer station, it takes only 3 minutes 30 seconds for the general public by stairs and escalator. However, it takes 19minutes for the disabled to transfer from Line 5 to Line 4. Because it needs to use a wheelchair lift twice and also the disabled needs to wait for former user to finish using it. It takes 3 minutes for both cases from Hyehwa station to exit by using an elevator. Consequently, total transfer time takes 9 minutes for the general public; on the other hand, it takes 34 minutes for the disabled. Hence, it is necessary to secure moving convenience for the disabled.

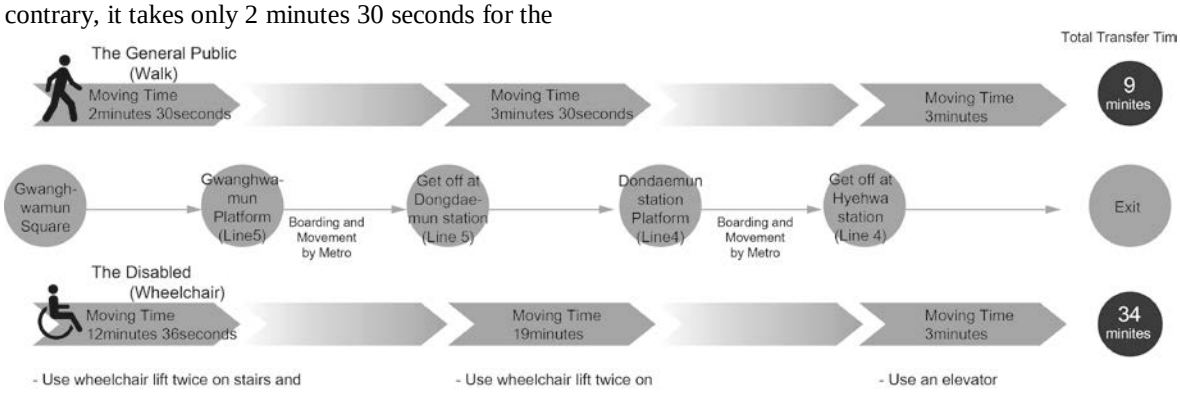

Fig.1 Comparison to transfer time of the general public and the disabled

2. TRANSFER MOVING FLOW IN JONGNO-SAM-GA STATION AND IMPROVEMENT SUGGESTION

2.1 Present Conditions of Transfer Moving Flow in Jongno-sam-ga Station

Jongno-sam-ga Station is the transfer station of Line 1 (the 2nd basement), Line 3 (the 4th basement), and Line 5 (the 5th basement). It is used for 55,193 public, 34,084 the disabled and 230,258 transfer passenger per day by a Study on the Survey of the Transportation Transfer Facilities and the Level of Service Analysis [4]. Jongno-sam-ga Station has a geometric and layered structure because it is the transfer station of the 3 lines located in the center of Seoul. Transfer time is about 4.07 minutes and transfer distance is about 273m for the general public. And transfer time is about 39.26 minutes and transfer distance is about 415m for the disabled.

There are 5 transfer moving flows for the general public as shown in figure 2. But it is difficult to find the direction guide in Line 1 and it is crowded because of the narrow width of stairs. It is necessary to suggest the directions for the improvement of the moving flows to the transfer passage which has width 4m and length 80m. It is necessary to separate moving flows because of the superposition between the transfer flows and exit flows. And it takes long time to pass the transfer passage because moving walkway is installed in the center of the transfer passage.

There are 6 transfer moving flows for the disabled as shown in figure 4. There is the only way for wheelchair users. But it is difficult to move because of many users and narrow width of passage. It is also difficult to transfer because there is no elevator for the disabled. Since there is the elevator on the exit flow in Line 1, it is convenient to transfer. And also there is the new plan to install elevators in Line 3 and Line 5.

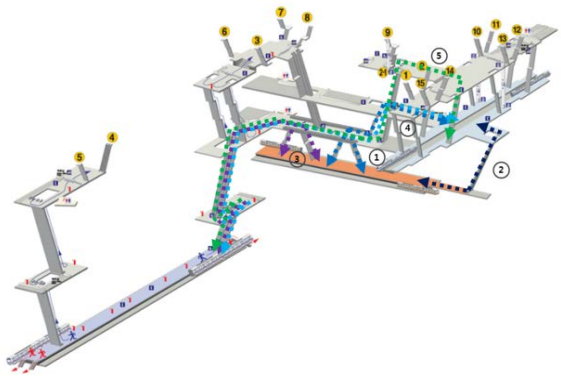

Fig.2 Transfer flows of the general public in Jongno-sam-ga Station

Fig.3 Transfer flow status of the general public in Jongno-sam-ga Station

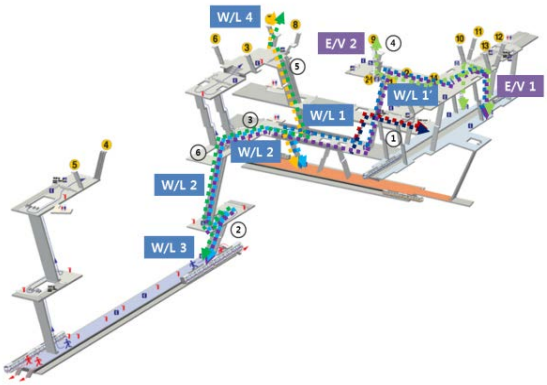

Fig.4 Transfer flows of the disabled in Jongno-sam-ga Station

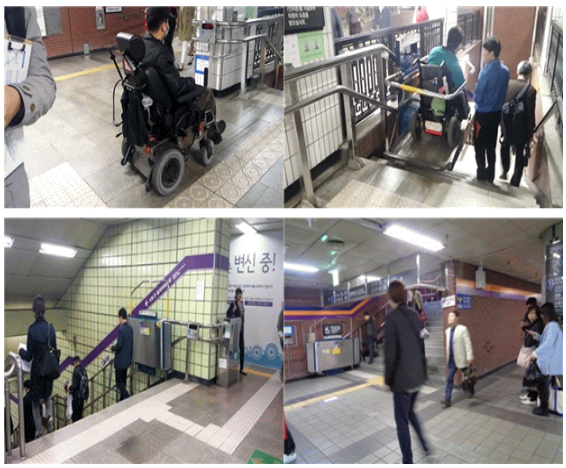

Fig.5 Transfer flow status of the disabled in Jongno-sam-ga Station

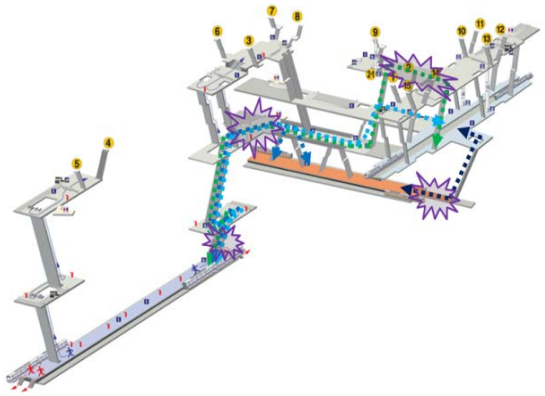

Fig.6 Improvement of the moving flows for the general public in Jongno-sam-ga Station

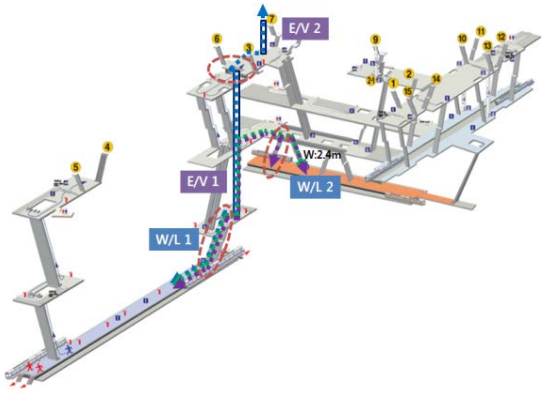

Fig.7 Improvement of the moving flows for the disabled in Jongno-sam-ga Station

2.2 Improvement of the Moving Flow for the General Public

It is possible to improve the traffic congestions by separating the moving flow and the transfer paths. Among the parts that flows are congested in figure 6, it is possible to improve LOS grade when the system is applied [5], [6]. It is required to separate the flows because of the superposition of the moving flows and the transfer flows and narrow width of stairs. And also, it is possible to improve the flow by utilizing the unused area in waiting room in Line 3.

2.3 Improvement of the Moving Flow for the Disabled

If the escalator that can accommodate both the general public and the disabled at the same time is installed, it can reduce the risk of an existing wheelchair lift and connect the place where it cannot be installed on the elevator.

If the system for both the general public and the disabled is applied, it is possible to shorten the transfer distance and time.

In case of being installed between the waiting room and platform in Line 5(the 4th basement), it shows the improvement rate on approximately 23%. However it is difficult to install because of the location of the beam and insufficient front space. When the wheelchair lift in platform of Line 3 is replaced, it shows the improvement rate on approximately 27%. However it is difficult to install because of the location of the beam and the column.

Lastly, in case of being installed between platform in Line 5(the 1st basement) and platform in Line 3, it is possible to improvement rate on approximately 68%.

2.4 The Analysis of the Space and Structure Interface

In order to judge whether it is possible to install the system, it was carried out the analysis of the interface. It is the stairs with the width 8.2m, height 2.56m from the waiting room of Line 3(the 1st basement) to the waiting room of Line 5(the 1st basement).

There are 3 places for the new elevator plans. One is the place from waiting room of Line 5(the 4th basement) to waiting room of Line 3(the 1st basement). Two is the place from platform of Line 3 to waiting room of the 3rd basement. And the last is the place from waiting room of the 3rd basement to exit 8.

Through these plans, it is possible to connect all flows between platform, exit and transfer

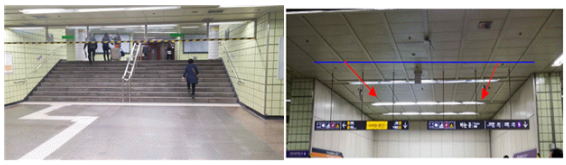

Fig.8 Inspection of structure interface status in situ

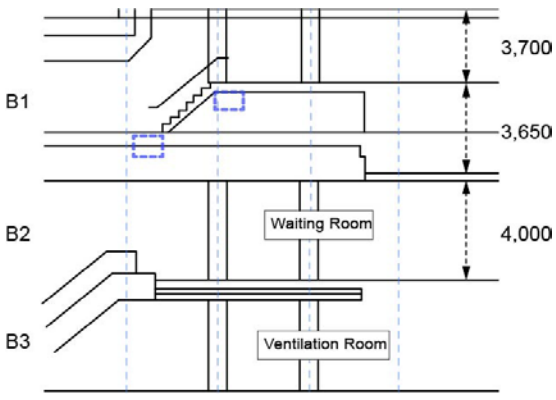

Fig.9 Check of structure interfaces in situ

passage in Line 1 and Line 3. But it is necessary to connect the flows in Line 5, so it is needed to install the system. The width of stairs is length 8.2m by the analysis on the interface. So it can be installed and the general public is also available at the same time. It is necessary to secure more than height 2.3m for installation of the system. The height of stairs is 2.56m. In addition stairs floor height is also satisfied by depth 1.65m. In case of the bottom space, it is possible to secure ceiling 0.40m, ceiling height 4.0m. Besides it is possible to install sprinklers, CCTV, fluorescent lights.

3. CONCLUSIONS

This research was investigated the present conditions of the movement and transfer path on Jongno-sam-ga Station through a site inspection, and it presented the improvement plan through the analysis on the movement and transfer path for the general public and the disabled.

Conclusions of this research are as follows:

1) It is necessary to suggest the directions for the improvement of the moving flow by reflecting the behavioral characteristics of the general public and the disabled.

2) In case of the transportation vulnerable escalator system, it was estimated 68% of improvement rate compared with the transfer time of an existent wheelchair lift by connecting the new elevators and waiting room.

3) It was confirmed to be expressively reduced the traffic congestions by separating the moving flow and the transfer paths and changing the positions of the obstructions as well.

4. ACKNOWLEDGEMENT

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