System Requirement Management of Urban Maglev Train with "Barrier Free" authentication

Kyung-Ryul Chung, Chun-Ho Choi and Park Chan Young
Korea Institute of Industrial Technology, P.O. Box 1271-18, Sa-1 Dong, Sangrok-gu, Ansan-si, Gyeonggi-do, 426-171, South Korea

ABSTRACT: System Requirement (SR) is reflecting current social environment and demand. The Urban Maglev Train, one of the biggest projects in Korea starting at 2006, is the front edge of system in technically. However it also needs to be recognized as an advanced system in cultural and social aspects in addition to technology. In 2007, the "Barrier Free (BF)" system is going to be expressly stipulated in the text. "Barrier Free (BF)" authentication is a system to evaluate utility's level of accessibility, capability by considering those who have some physical handicap, aged and pregnant women. The range of this regulation is on the city, location, private facilities and something that could be approved its necessity by BF committee.
Urban Maglev Train is composed of vehicle, signal, communication, electricity, station, railroad and base of vehicle. Of them all, the BF applies to two fields of station and vehicle.
There are several steps to acquire BF authentication. It is largely divided into two processes. First step is preliminary authentication that can be obtained by document reviewing and the other is final authentication that can be obtained by actual inspection. And it is very important that BF Requirements have to be reflected into the design before starting the construction or production process to avoid a change of design that could accompany any unexpected cost or time delay.
We have analyzed BF requirements and extract some to make up System Requirements that had been revised though reviewing with relative institutions and many changes were made in the System Requirement (SR). To go to next step of achieving preliminary authentication, design results must be checked with BR requirements. So we have collect some materials from vehicle and station parts and compared with them. As a results of comparison, three types of group were classified Satisfaction, Dissatisfaction and unconfirmed that couldn't check by reviewing document or drawing
For unconfirmed list, they will be checked by producer again and for dissatisfaction list, they will be revised with due regard to present situation.
We can show though this case study about the System Requirement (SR) management by considering not only technology but also social environment.

1 INTRODUCTION

"Barrier Free (BF)" authentication is a system supervised by Ministry of Land to evaluate public facilities and means of transportation's level of accessibility, capability by considering those who have some physical handicap, aged and pregnant women.
The Urban Maglev Train is the front edge System in technology but it needs to be recognized in aspect of passenger and culture. For that purpose, BF is one of the greatest tools. BF authentication is largely divided into two part preliminary authentication that could be achieve by just rev design result validation before manufacturing or construction and final authentication by an actual inspection. Taking care of weak person delicately will give us not only improved transportation environment but also easy maintenance condition at the level of advanced nation.

Essentially, the business proprietor can public it by prints or posters and also can attach a seal on the exterior of facilities. Barrier Free authentication is

very important because we could see its result objectively and maximize business outcome as well as taking the level of Maglev Train System.

2 METHODOLOGY

To get to the goal, starting from market surveys of weak passenger, research/analysis of the Train system status inside and outside of the country and "Barrier Free" analysis have done. As a results, inadequacy facts and make up plans are drew out. Summary of study methodology is as follows

○ Character Analysis of Socially Handicapped Person	· The Present Condition, Character and Considerations · Relative Regulations and laws
○ User focused Analysis of Inside and Outside of the nation Train System	· Design, Collecting and Analyzing Studies · Present condition Analysis
○ "Barrier Free" Authentication Study	· Process, Relative Document, Evaluation Standards, Market Research
○ Creating Checklist compared with "BF" Standards	· Building · Vehicle
○ Present Condition Analysis of Urban Maglev Train	· Construction Work Bidding Guidebook Analysis · Step 1 Report Analysis of Urban Maglev Train · Integrating every Defects and Complement

Table1. Sturdy Methodology

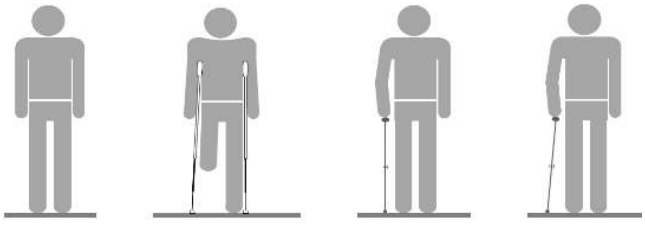
3 STATUS ANALYSIS

3.1 Character Status Analysis of Socially Handicapped Person

Handicapped person need taking care of all aspects. They have physical or mental obstacles or both of them. Especially, mentally retarded person, visual handicapped person, and hearing impairment person are having the biggest problem in transportation.

Figure1. Clutch User

- Clutch User



Crutch is an assistant appliance helping walking. There are kind of crutches in accordance with its way to use. In case of passage, it must consider effective width and the minimum effective width is as followed table.

Table2. Effective Width and Space

Type of crutch		Effective width and space(mm)	
Crutch(One side)		700~800	
Crutch		700~1200	
Armpit crutch		900	
Crutch (2 or 4 legs)		1000~1200	
Stand and wagon	4 legs	1200~1200	
	2legs and 2wheels	Rotation 90 degree	1200×1200
		Rotation 180 degree	1200×1650

- Status of wheelchair user

Effective width for wheelchair user is going to be set up by considering wheelchair's total width and motion space (Handrim). According to the ISO, Handrim effective width for wheelchair is recommended to add 50~100mm to left/Light sides of wheelchair. 800mm is presented for a wheelchair in domestic.

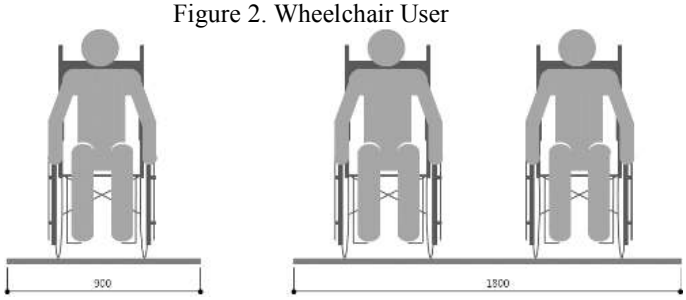
Table 3. Minimum Effective Width

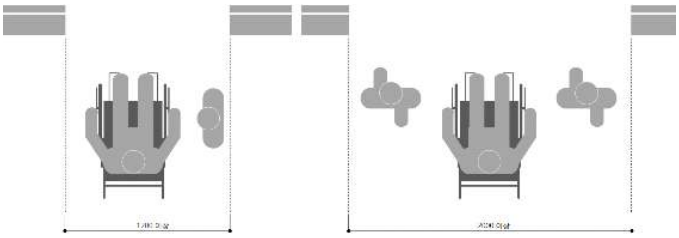
	USA	Japan	England	German	Sweden	Korea
Minimum Effective width (mm)	815	800	750~850	700~850	750~800	800

Besides, in case of interactive movement, the effective width needs to be wider because of limitation of rectilineal motion.

A wheelchair user with a walker,
A walker beside a wheelchair user------ more than 1,200mm
Two walkers ----------more than 2,000mm
A wheelchair user with clutch user------ more than 1,800mm

Figure 2. Wheelchair User





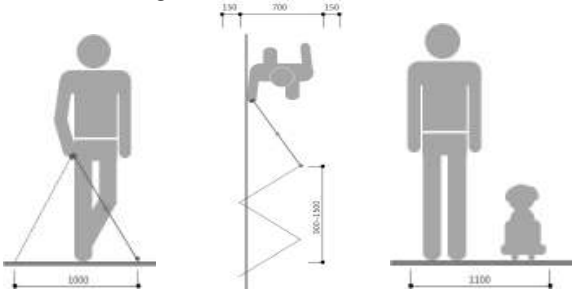
In addition to above all, study on the floor effective width rotation activity width, foot and knee effective width, height for moving to another place, arm's moving range, slant and law in many countries were progressed for wheelchair user.

- Status of visual handicapped person

1) Effective width of floor

Most of visual handicapped persons are using a white walking stick and effective width could different from its perception range. Picture3 is showing the effective width as contacting floor. In case of a visual handicapped person (VHP) with a guide dog, the size of dog could determine effective range.

Figure3. Effective width of floor

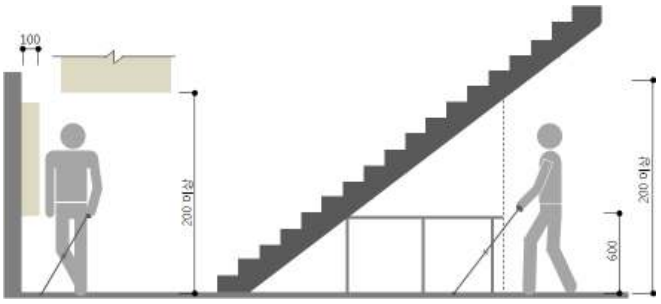


		USA	JAPAN	GERMAN	SWEDEN
White Stic		1000	1200	1000	-
Guide dog	Width	-	900	-	1100
	Length	-	1200	-	-

1) Obstacles

While visual handicapped person can easily recognize some obstacles in the range from floor to

Figure4. Effective Width of Space



grip of white stick, obstacles above shoulder is not easy to perceive. Therefore obstacles at the height of head is the most dangerous

- Status of hearing impairment person

Hearing impairment would be judged by average pure-tone threshold value (Decibel) or the criteria of audiometry through hearing test.

- Status of elderly

Basically, we usually called elderly who aged more than 65 years but the condition of physical function may different from individual and some people have both impairment and disease.

According to the definition of UN, if the proportion of elderly people is over 7%, it is called elderly society and over 14%, it is called aged society and over 20%, it is called a super- aged society.

Korea has already entered into elderly society in 2000 and it will arrive at a super-aged society in 2026.

France, already got into the stage of elderly society in

Nation	1950	1970	1980	1990	2000	Rate of Increase	Annual Average
Australia	8.5	8.3	9.6	11.2	12.3	39.8	8.0
Canada	7.5	7.9	9.4	11.3	12.6	56.0	11.2
France	11.6	12.9	14.0	14.0	16.0	34.0	6.8
Italy	9.3	10.9	13.1	15.3	16.1	72.5	14.5
Japan	5.7	7.1	9.0	12.0	17.2	128.0	25.6
Korea	3.3	3.3	3.8	5.0	7.1	88.7	17.7
Netherland	9.0	10.2	11.5	12.8	13.7	44.4	8.9
Norway	11.1	12.9	14.8	16.3	15.4	35.6	7.1
Sweden	12.0	13.7	16.3	17.8	17.4	40.1	8.0
England	11.1	12.9	15.1	15.7	15.8	37.9	7.6
USA	9.2	9.8	11.2	12.4	12.3	30.7	6.1
Mean	8.7	10.0	11.7	12.4	13.7	51.2	10.2

Table4. Status of elderly

1900, it has been taken 115 years to increase elderly people rate from 7% to 14%. Italy has taken 61 years. England has taken 47 years and German has taken 40 years. In case of Korea, it will be taken just 19 years to be aged society after elderly society.

- Status of pregnant women

The number of pregnant women is assumed by using the population census forecasting data. Pregnant woman is supposed to be danger by stairs, slippery road or uneven floors. The number of pregnant women is decreasing as much as birth rate.

According to the research conducted by Statistical Office, the main reason of decreasing birth rate is attributed to decreasing childbirth under the thirties especially, 25 ~ 29 years old women. It is may coming from social phenomenon of the increasing career women.

(%)

Year	Number of pregnant women	Increase or decrease comparing last year	Increase or decrease rate
2008	475,000	-	-
2009	469,802	-5,198	-1.09
2010	463,363	-6,439	-1.37
2011	456,169	-7,194	-1.55
2012	448,342	-7,827	-1.72
2013	440,420	-7,922	-1.77
2014	432,640	-7,780	-1.77
2015	425,031	-7,609	-1.76

Table5. Status of pregnant women

• Status of Child

Child is smaller and slower than adult and also they are showing low understanding and judgment power. Based on the population census forecasting data in 2008, the number of child is getting decreasing.

(%)

Year	Number	Increase or decrease comparing last year	Increase/ decrease rate
2008	2,806,805	-	-
2009	2,662,102	-144,703	-5.16
2010	2,490,015	-172,087	-6.46
2011	2,338,833	-151,182	-6.07
2012	2,255,097	-83,736	-3.58
2013	2,206,695	-48,402	-2.15
2014	2,169,312	-37,383	-1.69
2015	2,154,259	-15,053	-0.69

Table6. Status of Child

• Character of Foreigner

More than a million of foreigners are settled in Korea at the rate of 2.2% and it is getting increase every year.

According to a precedent study, the foreigners visiting in Korea mainly use in order of taxi, subway and bus and most of them experience inconvenience in communication or guidance

(%)

Year	The number of foreigner
2006	536,627
2007	722,686
2008	891,341
2009	1,106,884

Table7. Status of Foreigner

3.2 'Barrier Free' Authentication Analysis

Vehicle and station are supposed to 'Barrier Free' authentication. Vehicle has totally 23 assessment items and station has 75 assessment items. All of items have their own evaluation criteria and divided 3 levels. We internally evaluate our system by reviewing execution drawing and biding guidance.

Figure 5 is a example to show the check list describing our system's status under the 'BF' requirements

Division		Code	Items	Criteria	Satisfied	Unsatisfied	Unknown	Others
1, Facilities	1,1 Approaches	F1-01-01	1,1,1 Approaches from walkway to street	Evaluation walkway and street separately	√			
		F1-01-02	1,1,2 Access to information desk	Evaluation for the preparation of devices and information facilities to lead to information desk	√			
		F1-01-03	1,1,3 Effective width	Evaluation for effective width for wheelchair user		√		
		F1-01-04	1,1,4 Gap	Gap evaluation if there are gaps around approaches	√			
		F1-01-05	1,1,5 Grade of degrees	Evaluation for grade of degrees			√	
		F1-01-06	1,1,6 Floor-finishing	Evaluation for nonslip material and flatness	√			
		F1-01-07	1,1,7 Obstacles on the road	Evaluation for continuous safety without obstacles		√		
		F1-01-08	1,1,8 Drain cover	Evaluation for the height of hole that has risk to fall into	√			
		F1-01-09	1,1,9 Slip road	Evaluation for floor-finishing and elevated place			√	
				Total	5	2	2	

Table8. 'BF' Analysis

4 SUPPLEMENT OF SYSTEM REQUIREMENT AND SPECIFICATION

4.1 Case study for international train system

The Urban Maglev Train System would get satisfaction of passenger in aspect of its convenience, safety and reliability. In addition, specified System Requirements are needed to increase its international

Type of train	Features	UFD Concept Code
ICE	- Antenna for mobile phon -Broadcasting prohibition in the Silence Car -Ticket holder installation instead of Ticket check	①②③
ICE Ideen Zug	- Service counter installation - Guidance for next train - Die Bahn merchandising - Front view broadcasting during operation	①②③⑦⑨⑪
ICE 2	- Changeable area of the car	④⑦⑧
ICE 3	-Lounge bar installation at the front - Curved doors, extra space - Clothes chest and locker in the middle of guest room - Family room - Rotary chair and table - Meeting room - Conductor, Stall	①②③④⑤⑥⑦⑧⑨⑩⑪
X2000	- Large table - Using wood in the interior - Changeable area of the car	①②③④⑤⑨⑩⑪
AVE	- Refund in case of late - TV on the wall - Standing type buffet - 3 Level /Club, Preferential, Tourist	①②③④⑤⑥⑨⑩⑪
Eurostar	- Cold meal service/ Premium first class(champagne and newspaper) - Large room	①②③④⑤⑥⑨⑩⑪
TGV Duplex	- Diaper tables and thermos - Family room	①②③④⑤⑥⑦⑨⑩
TGV Atlanta	- long seat, Salon room - Semi compartment	①②③④⑤⑨⑩⑪

* Concept Code : ①Useability ②Dignith ③Creativity ④comfortableness/Pleasure ⑤Convenient ⑥ Reliability ⑦Cognition of info ⑧Operation ⑨Declining fatigue ⑩Improving efficiency ⑪Extra space

Table9. International Status of Train System

competiveness. We analyze some cases to see international status of train system showing Table9

4.2 Case study for domestic train system

For 10 people, an interview to the passenger using subway mainly and station employee has done and the results is showing at table 10

Type of Facilities		Problems	Alternatives
Mediation Facilities	Access to main door	- Crossing vehicle and walker - Unsafe to visual handicapped person	-secure safety footpath and leading method for visual handicapped person
	handicap parking	-Ignorance of location	-Guidance and penalties -Make indication of continuous guidance compulsory
	Elimination height difference of the main door	-Excessive number of stairs	-No stairs at the gate if possible -Observe the degree of slope must be less than 1/12 -Provide comfortable service to all users by separating the roads as visual handicapped person, wheelchair user and ordinary person
Interior Facilities	Door	- Insufficiency of guidance facilities for visual handicapped person	-Expanding braille at the gate for visual handicapped person -Reserving effective width -Installation vertical shaft
	Floor	- Many obstacles	-Elimination obstacles -Installation the continuous shafts that only installed in Association of The Welfare Institute for the Disabled(Public establishment, Elderly, Child, etc)
	Stairs	- Insufficiency of leading facilities	-Certificated continuous shaft -Raised block(0.3m) installation at the edge of stair or differentiated color application
	Elevator	- Elevator button's height	-Review regulations on the location of the buttons
Sanitation Facilities	Rest room	-Insufficiency of space in the room of toilet -Inappropriate location of closet's valve -Uncomfortable basin design to wheelchair user	-Reserve a rest room which allow the rotation of wheelchair -Alternation of closet's location -publicize correct installation method of mirror and reserve under the sink
Guidance Facilities	Raised Block	-Lack of relationship between blocks -Damaged blocks due to not using certificated prodect	-Continuous installation around main gate -Using non-slip material
	Leading and guide facilities	- Lack of cognition for leading and guide facilities	-Publication of the necessity of guide facility for visual handicapped person -Make indication of installed amenities compulsory
	Warning and refuge facilities	-Lack of refuge facilities for hearing impairment person -Lack of refuge direction cognition	-Expansion of visual warning divice -Installation to the direction of refuge
Other Facilities	Ticket office, Vending machine	-Too low exit of vending machine	-Researching appropriation height of gate of vending machine

Intended for	Passenger using subway Num1~8 in Seoul and station employee
Sample size	10
Sampling Method	At least one person every station (Using subway to commute)
Research Method	1:1 interview with guideline
Result Analysis	Abstraction of Keywords

Table10. Case study for domestic train system

4.3 Summary of status analysis results

- The subway has many complex dangers to prevent such as escape way, prevention of disaster and gas. Frequent malfunction of subway and arson lead the necessity of safety
- Taken together of all subway user's opinion, the safety is the most important thing and then comprehensive consideration on the safety is needed to Urban Maglev Train System.
- Safety facilities installation like screen door is required to minimize human victims.
- Main circulation sturdy and analysis is needed
- A trial to change the range of subway's use not only transportation but cultural space through research is needed

4.4 Supplement of system requirement

Through 'Barrier Free (BF)' authentication criteria, we evaluate a system whether handicapped person can use our Maglev train and facilities without inconvenience. Therefore we analysis BF criteria

Code	Subject	Sentence	Orign	System
SR.6.	Useability and Convenience	Maglev system provides physical, physiological, psychological convenience to every passenger	Second TFT	Vehicle, Station
SR.62.	Consideration of passenger	Be lower the physical, physiological, psychological institutional barrier for handicapped person	SR	Vehicle, Station
SR.63.	Friendship with passenger	Minimize inconvenience and difficulties in all process from entering the station to going out	SR	Vehicle, Station
SR.64.	Passenger's culture	Consider passenger's culture and environment such as preference and habit	SR	Vehicle, Station
SR.65.	Satisfaction of sensitivity	Maximize passenger's satisfaction of sensitivity	SR	Vehicle, Station
SR.66.	Pleasant environment	Provide pleasant environment to passenger	SR	Vehicle, Station
SR.66.	Convenience	Provide physical, physiological, psychological convenience to passenger	SR	Vehicle, Station
SR.67.	Appreciation of the beautiful	Provide familiar and polished beautifulness to all people	SR	Vehicle, Station
SR.68.	Consistency	All objects and stuffs have consistency in beautifulness	SR	Vehicle, Station
SR.69.	Human enthusiasm	All facilities are considered human engineering	SR	Vehicle, Station
SR.70.	Eco-friendly	Consider eco-friendly aspects through all manufacturing processes (Manufacturing, Logistic, Consumption, Discard)	SR	Vehicle, Station

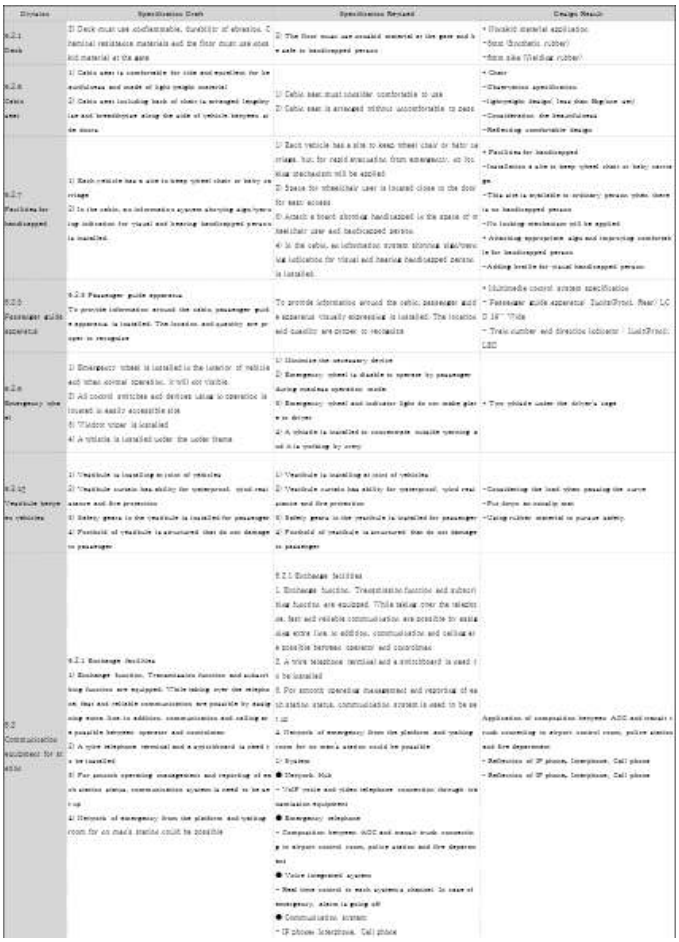
Table11. Supplement of system requirement

with system requirements and some of key words and sentences are added to the SRs. The figure is showing revised SRs reflected BF criteria.

4.5 Supplement of specification

To keep pace with BF requirements many specifications have revised or added. The table 12 is an example to show some specification that has reflecting BF requirements.

Table12. Supplement of Specification



5 CONCLUTION

The Urban Maglev Train is going to use as a fast and safe transportation. If ordinary people feel uncomfortable in using Maglev Train that means that handicapped person have more difficulty. These facts would make increasing of the accident possibility as well as additional cost by design alternation.

Especially for handicapped person and elderly people have more chance to be injured considering its unfamiliar environment of Maglev system.

Since getting increase activity of handicapped person and elderly people, the inconvenience in transportation is one of the top social issues. But the improvement rate can't catch up its demand so even from now on, a design reflecting its demand is required.

Although 'Barrier Free' authentication is rising as a topic, there are no facilities applying for it. BF is divided into two steps preliminary authentication and real authentication. In our sturdy, it is our purpose to evaluate Urban Maglev train and facilities comparing with BF requirements and serve in design and acquisition of BF authentication.

In this study we comprehensively figure out the status of handicapped person and analysis 'Barrier Free' authentication's requirements. As a result of analysis the system requirements and specification are complemented.

Before the progress of this study, system requirement and specification have had many absences on the BF requirements. From now on, consideration and application of 'Barrier Free' requirements is needed to various sectors.

6 REFERENCE

BLKim, Guide of Wheelchair Lift design for mobility rights of the mobility handicapped, The Korea Society for Railway, 2003

Hyeong-Keun Kweon, Yeon-ho Choi, Myeong-Jun Kim, In-hwan Yeom, Joon-Woo Lee, "Development of Certification Program for Barrier-Free in Forest Trail", Journal of Agricultural Science, June 2010

Universal Design Research Center, Universal Environment Design, UDRC, 2008.06

Rentzsch Manfred, Seliger Denis, Meissner Thomas, Wessner Claudia: International journal of railway 1(4) 143-148 1976-9067, The Korea Society for Railway, 2008

Shihiru DATE, Kaname TAJIRI, Takao HASHIMOTO, BARRIER-FREE PUBLIC TRANSPORTATION IN JAPAN: THE NECESSITY OF SOME FUNDAMENTAL CHANGES,

Manfred Rentzsch, Denis Seliger, Thomas Meissner, Claudia Wessner, Barrier Free Accessibility to Trains for All, The Korea Society for Railway, 2008