Universal Design of the Way-finding System in Transportation Environments

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Abstract: This study aims to practically represent the possibility of realization of Universal Design Methods through the design proposal of the New Taipei City Banqiao Station, to provide design improvement of Personal Pedestrian Guiding Device and In-Station Sign System. And the following Universal Design elements were used when designing proposals: (1) reasonable dimension and placement; (2) indicative shape; (3) material chosen with safety consideration; (4) sufficient indicative lighting; (5) real-time dynamic display; (6) content of information display; (7) integration with surrounding environment; (8) application of multiple perceptions information; (9) modulated design. For Sign System design improvement aspect, a new sign system was redesigned according to the problems of searching target facilities by using existing sign in Banqiao Station by different pedestrian groups. , And the effectiveness was validated by Universal Design evaluations to fulfill the requirement of Universal Design. For Pedestrian Guiding Device design aspect, a personal pedestrian guiding device fitted to Universal Design principles has been completed, and the effectiveness of Universal Design process and method used in the research has also been confirmed

Keywords: Universal Design, Transportation, Way-finding System, Pedestrian Guide

1. Introduction

The major problem which travelers faced in transportation environment is way finding on an unfamiliar environment. Not only the confused guiding information could make travelers lost, but also the poor design of sign system makes people not easy to find their way. Some travelers depend on Pedestrian Guiding device for solving the way-finding problem. But in-station guiding still cannot fulfill the way-finding requirement since the technology limitation. In fact, transportation environments should provide integrated guiding information and sign system and also personal guiding information which travelers can access on their demand. In short, to create traffic environment fitted by the spirit of Universal Design, and is usable and accessible by all people, regardless of their genders, ages or capabilities.

2. Investigation

2.1 Identify the Problems on Way-finding in Stations

This study observes the pedestrians' behaviors of way-finding and interview the users at Banqiao Station, The pedestrians' groups include: (1) Without special considerations (2) Elderly (3) Wheeled users (4) Hearing

disability (5) Visual impaired (6) Color blindness (7) Pregnant women (8) Users using stroller (9) Users carrying heavy objects (10) Foreigners.

The way-finding problems are made into structure with similarity matrix and cluster analysis into 6 group, including: (1)Cannot recognize location and directions;(2) Insufficient and discontinuous guide information;(3) Poor Accessibility;(4) Poor sign system design resulting poor recognition;(5) Construction structure and exhibition space at the station affecting sign system recognition;(6) Obstructions in walking.

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Figure.1 Similarity Matrix





2.2 Identify the Problems on Sign System of New Taipei City Banqiao Station

This study also observes the problems on sign system of Banqiao Station, the sign system can be divided into 6 requirements: (1) Clear Guide Information; (2) Less Visual Interference; (3) Intuitive Sign System Design; (4) Integration of Sign System; (5)Environment Illumination; (6) Direction positioning.

2.3 Identify the Universal Design Elements in Stations

This study follows 9 universal design elements in transportation environments when designing proposals in this study: (1) reasonable dimension and placement; (2) indicative shape; (3) material chosen with safety consideration; (4) sufficient indicative lighting; (5) real-time dynamic display; (6) content of information display; (7) integration with surrounding environment; (8) application of multiple perceptions information; (9) modulated design. The relationship between Universal Design Principles and Design Elements shows as Table 1

Universal Design	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Principles in Transportation Environments	Facilities easily located	Equality	flexibility	Operability	Information	Error tolerance and safety	Low physical effort	Assurance	Reasonable planning	Maintenance	Comfort	Aesthetic	Environmentally friendly an energy saving	Durability	Economy
Design Elements													д.		
Reasonable Dimension and Placement	0	0		0	0			0							
Indicative Shape	0		0		0	0		0				0			0
Material Chosen with Safety Consideration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Sufficient Indicative Lighting	0				0		0					0			
Real-Time Dynamic Display	0		0		0				0						
Content of Information Display		0		0	0	0	0	0	0						
Integration with Surrounding Environment	0	0	0	0	0	0	0	0		0	0			0	0
Application of Multiple Perceptions Information	0	0	0	0	0	0	0	0	0		0	0		0	0
Modulated Design.	0	0	0		0	0	0	0	0	0	0	0	0	0	0

Table 1. Relationship between Universal Design Principles and Design Elements

3. Design the Way-finding System

3.1 Setting the way-finding Process

This study plans on sign system of Banqiao Station from TRA to MRT Bannan Line. The following shows current system features, and pedestrian guide system features and design are explained below:



Figure.3 The scope of investigation at Banqiao Station



Figure.4 Features of the System and Process Setup

3.2 Design the Pedestrian Guide Device.

This step designs the guide interface by using morphological analysis. Main problem groups on way-finding are transferred into design requirements to define acceptable design projects. An acceptable partial solution is selected in each design principles. The 6 problem groups on way-finding are transferred to design requirements to have specific design objectives as Table 2

Main Problems			ign Requirements	Assistive Guide System Partial Solutions						
P1	Cannot recognize Location and Directions	А	Information on positioning and guide	Built-in e-compass, e-map, 3D holograph guide system						
P2	Insufficient and Discontinuous Guide Information	в	Guide information with continuity and universality	Real time update and display of indicator and guide information						
Р3	Poor Accessibility	С	Facilities with voice assistance and guide	Voice guide, enlarged application programs on screen						
P4	Poor Sign System Design resulting Poor Recognition	D	Indicator design with good recognition and guide system correspondence	Guide interface principle same as indicator design in coordination with gravity sensor gyration display						
P5	Construction Structure and Exhibition Space at the Station affecting Sign System Recognition	Е	Information in consideration of station space layout and user guide needs	Guide information of 2D and 3D holograph interface with voice system transmission						
P6	Obstructions in Walking	F	Prevention from obstruction due to objects and terrains	Various model route guide subject to needs						

Table 2. Define the Guided System Design Principles and Partial Solution



Figure.5 Define the Guide Device Design Principles

3.3 Re-design the Sign System in Banqiao Station

The design of sign system shows as below:







Figure.6 The Re-design of the Sign System in Banqiao Station

4. Evaluation of the Way-finding Design

Evaluate achievement rate of pedestrian guide information and sign system design by universal design evaluation system. Evaluation in five levels (disagree very much, disagree, O.K. agree and agree very much) on product hardware and interface based on evaluation principles and actual description of traffic transportation environment evaluation table. A total of 39 participants (including: (1) 4 without special considerations pedestrians (2) 3 Elderly pedestrians (3) 7 Wheeled users (4) 4 Hearing disability pedestrians (5)4 visually impaired pedestrians (6) 3 Pregnant women (7) 4 Users using stroller (8) 4 Users carrying heavy stuff (9) 2 Foreigners (10) 1 Facilities manager (11) 4 Experts); Evaluation process shows as Figure.7results of evaluate achievement rate show as Figure.8



Figure.7 Evaluation Process



Figure.8 Results of UD evaluate achievement rate

By using the UD evaluation, result of way-finding system shows agreement over nearly agreed or agreed. The subjects were satisfied with the function of the pedestrian guide device and sign system, the new way-finding system significantly improved way-finding needs, especially in higher satisfaction on the project of "error tolerance and safety" and "comfort", especially enhance the UD achievement of "information", "error tolerance and safety", and "comfort", it shows the importance of consistency in terminology. The sign system integrate the station environment as a guide, pedestrians can follow the right direction intuitively. But QR Code position is too high for wheelchair users, makes the "flexibility" agreement lower than other design approach.

5. Conclusion

After universal design evaluation on traffic transportation environment, results show the guide system design of this study achieve universal design ideas and solve current problems as feasible solutions to future problems on way-finding.

Most of problems on way-finding are resulted from insufficient or interrupted guide information. In light of system, in addition to supplement of guide information, way-finding system shall be integrated with station guide information to provide a complete guide system.

Universal design evaluation system requires constant modification. In addition to help examine whether design does meet universal design, design cases required repetition in evaluation and review to meet optimal universal design.

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