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유니버설디자인 개념에 의거한 대학내 학생편의시설 평가 및 개선방향에 대한 연구
- 미국 텍사스주를 중심으로 -

A Study on the Evaluation and Improvement of Student Convenient Facilities at University Campuses, based on Universal Design Concept
- Focused on the university campuses in Texas, U.S.A. -

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Abstract

Student halls and their convenient facilities have been a focal point for various student activities at university campus. It has been for most of the student a place of unique memories and of attachment often associated with those good and bad school days. However, it is questionable whether these facilities are supportive and accessible for all of the students and other users including the handicapped. Therefore, based on the concept of UD(universal design) which was widely applied to U.S. institutions, this study intended to evaluate student hall facilities in U.S. and to provide an improvement direction for Korean UD application. For that purpose, four universities were selected for an in-depth analysis and 76 survey indices were utilized based on previous research. It was found that (1) design consideration without braille sign for VIP(visually impaired person) in student buildings can be differently approached with electronic devices; (2) the best demonstration of UD in student buildings can be seen in spacious flat pathway, easy access through ramp and wide entry area, necessary for people in wheel-chairs, but used by all, implying an increase of the ratio of public space; (3) one of the good UD features is an attractive physical environment rather than institutional appearance, in which they ultimately will support and completely adaptable at optimal levels by everyone; (4) consistent maintenance and management maximize the potential of UD principles and minimize physical limitations.

키워드 : 유니버설 디자인, 미국 장애자법, 접근성, 교육시설, 대학캠퍼스, 학생회관
Keywords : Universal Design, ADA, Accessibility, Educational Facilities, University Campus, Student Hall

1. Introduction

1.1 Research Background and Purpose

Some facilities of colleges and universities are now playing an important role in town area for all the populace who are interested in academic, cultural, and vocational activities. In fact the diverse function of colleges include learning and research, extra curriculum activities, exercising, relaxing, continuing education for regional societies, and so forth.

In the United States, student union hall and adjacent mixed retail and commercial buildings, often located within walking distance of the central area from a university setting have been serving various needs of the students, faculty and staffs. Further, these areas has been

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often associated with those good and bad school days and a distinctive place where most of the students can have a fun and spend their good times. It became for most students a space of memories imprinted by a strong sense of attachment and a sense of belonging by an academic atmosphere of unique group activities or by night light activity that used to take place or just from a gift purchased by someone special.

In order to accomodate these various objectives, student-oriented buildings in campus should be designed in a way to promote easy and convenient access for all users regardless of their age, gender or physical conditions. Consequently, universal design concept is a widely accepted terminology in school facility design with increased supportive accessibility and safety consideration for the general school population and those with disabilities. Student oriented facilities at colleges are especially good examples for the adaptation of universal design concept because they require wide range application of supportive, adaptable, accessible, and safety-oriented design concept which were already defined by the Center for Universal Design, North Carolina State University.

Kim's research (2009)[1] already made an assessment on a few student halls of universities in Seoul area and contended that accessibility to main entry areas, main entry doors, stairs, and handicapped parking were positively evaluated, while information signage for the handicapped, handicapped public toilet, and corridors lacked some notion of supportive and accessible design, implying that a coherent access system needed to implement. Further, based on universal design principles, it is not well known whether student buildings in U.S. provide convenient access for the general public as well as the disabilities. Therefore, based on UD(universal design), this research aims to evaluate student hall facilities in U.S. and the results will provide an useful design guidelines for the students and other users in the future physical design of student hall and wellbeing facilities in Korea.

1) Kim, W.P. A Study on the Evaluation and Improvement of Student Convenient Facilities in University Campus based on Universal Design Concept, Journal of the Korean Institute of Educational Facilities, 19(5), 2012. pp.11-20.

1.2 Research Area and Method

For an investigation of student-oriented facilities in campus through the concept of universal design, four major universities in Texas, of the U.S. were selected

For this purpose, this research firstly reviewed how the current concept of universal design applied to school facilities and their issues in Korea and the United States. In-depth literature review sets the stage for collecting diverse evaluation and checklist for the physical environmental attributes of universal design. For an assessment of student halls, 76 indices were used for universal design concept. Secondly, field survey for US college facilities were performed to investigate what components are influencing on the level of universal design in student halls. Finally, the analyses focused on the cross-cultural effects of the application on the principle of universal design and suggest additional design guideline for UD application to student hall design in Korea.

2. Universal Design and Literature Review

2.1 Background of Universal Design Concept

In the United States, designing school facilities requires more expanding concept of specific design guideline, encompassing UD(universal design) and accessibility compliance. If UD recommend design guidelines for the general building throughout their life spans in the United States, the concept of accessibility design is attained through legal compliance with local, state and national building standards that secures a minimum level of universal design necessary to provide specific people with disabilities.

From the technical point of view, the U.S. Congress passed ADA(Americans with Disabilities Act) in 1990 to address a public concern with discrimination against people with disabilities, supported by local enforcement agency with relevant regulations. On the other hand, such a building code as ANSI A117.1 (The American National standard Institute) is a substantial criteria required for legal compliance for a certain type of area.

Therefore, each particular campus in the United States must comply with a variety of federal-level laws and

regulations, depending on the financing resource. Apartment from the application of UD, it is true that ADA(Americans with Disabilities Act) covers all higher education facilities and requires access to programs, facilities, and services that are provided and open to the public.[2] In particular, Title II of ADA Standards for accessible design establishes the criteria for the design of campus facilities which is called the 2010 Standards.

At the same time, the overall goal of UD(universal design) is to create convenient access for the general populace including disabilities. According to North Carolina State University Center, the intent of universal design is to simplify life for everyone by making products, communications, and the built environment more usable by as many people as possible at little or no extra cost. Universal design benefits people of all ages and abilities for Universal Design.[3] As indicated Table 1, each of this principles contributes to basic design and functionality for more people with disabilities and the general populace.

Table 1. Seven principles of Universal Design

Principle	Design definition
Equitable use	The design is useful and marketable to people with diverse abilities.
Flexibility in use	The design accommodates a wide range of individual preferences and abilities.
Simple and intuitive use	Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
Perceptible information	The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
Tolerance for error	The design minimizes hazards and the adverse consequences of accidental or unintended actions.
Low physical effort	The design can be used efficiently, comfortably, and with a minimum of fatigue.
Size and space for approach and use	Appropriate size and space is provided for approach, reach, manipulation, and use, regardless of the user's body size, posture, or mobility.

Source: From North Carolina State University Center for Universal Design, 1997.

2) Salmen, John, Universal Design for Academic Facilities, New Directions for Student Services, no 134, 2011. pp.13-20.
3) http://www.ncsu.edu/ncsu/design/cud/about_ud/about_udhtm

2.2 Previous Research

Previous research in domestic and overseas regarding UD and accessibility of campus facilities mainly dealt with class room, housing, library, public toilets, student hall/retail, and indoor and public outdoor areas. Sui (2011)[4] identified deficiencies in public toilets and suggested evolving concepts of universal design in seven principles for specific improvement. Murray and Lombardi (2010)[5] noted that minimizing barriers and willingness to accommodate and adopt UD principles in their study of university faculty attitude.

In fact, meeting minimum building code and design standard is thought to be the least approach beyond compliance with ADA guidelines. Utilizing UD and creating a welcoming user-friendly campus may appeal to new categories of students with disabilities, contributing to campus diversity and expanding opportunities for many students.[6] Further, Salmen(2011)[7] maintained that universities are especially good facilities for the application of UD because they accommodate a wide range of transient users. He further emphasized that the application of UD needed to be appropriate to the institutional's scale, facility type, and program for it to be completely effective. It is common perception that UD provides a useful understanding of the interrelationships between disability and design that may limit how far inequalities of access to the built environment can be overcome.[8]

In domestic research, Cho(2008) found that the percentage of UD application to university libraries were

4) Sui, Kin, Public toilets for visually impaired persons: application of the principles of universal design, The International Journal of Interdisciplinary Social Sciences, 6 (2), 2011. pp.117-126.
5) Lombardi, A. & Murray, C., Measuring university faculty attitudes toward disability: Willingness to accommodate and adopt universal design principles, Journal of Vacational Rehabilitation, 34, 2011.
6) Watson, E., Bartleft, F., Sacks, C., & Davidson, D., Implementing Universal Design: A collaborative approach to designing campus housing, The Journal of College and University Student Housing, 40(1), 2013. pp.158-171.
7) Salmen, p.13
8) Imrie, R., Universalism, universal design and equitable access to the built environment. Disability & Rehabilitation, 34(10), 2012, pp.873-882.

low and did not provide visitors of diverse demographic profiles with convenient access.[9] For his research, he developed UD checklist which consisted of four major UD principles. Kim(2009) investigated classrooms in universities and contended that minimum security for the security and developing detailed guidelines were needed to support accessibility with mid- and long-term perspective.[10] UD is considered as multi-constraint task because of the many requirement and the complexities that are caused by the interaction of principles. Park and Lee (2011)[11], approached barrier free educational facilities in three concept and emphasized on the same conditions both for disabilities and non-disabilities.; A law of conveniency promotion, Manual of barrier free certification, and Universal design.

In the study of classrooms and student halls, Kwon and et al. (2011)[12] asserted that basic accessibility should be provided for students with disabilities in university facilities, and special concern needed to be also given for visually impaired students. In regard to campus facilities, Kim(2012) concluded that accessibility to main entry areas, main entry doors, stairs, and handicapped parking were positively evaluated, while information system for handicapped, handicapped public bath, and corridors lacked some notion of supportive and accessible design in student halls of many university campus.[13] Moreover, he noted that precise application of universal design concept is needed to secure coherent pathway for overall inception of a building.

In summary, review of literature on UD and university facilities mentioned that even though all universal design requirement could not be equally applied to the general populace and people with disabilities, basics and specific design guidelines should be guaranteed at minimum level of standard. Further, it also concluded that UD approach is the most practical way to ensure such code compliance as laws, regulations, standards and certifications, while improving accessibility and usability for the entire academic campus.

3. Data Collection and Analysis

3.1 Overview

For a study on the level of application of UD to student halls, four major university in Texas were selected to investigate on January 2014; Univ. of Texas at Austin, Texas A&M University, University of Houston, and University of Texas at Dallas.

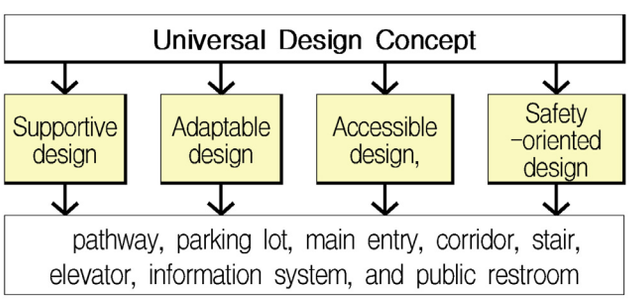


Figure 1. Four major universal design concepts

Based upon the concept of universal design, four major components were used to evaluate academic facilities; supportive design, adaptable design, accessible design, safety-oriented design(see Figure 1). A level of evaluation was established as three-point Li-kert scale; good(3 pts), fair(2 pts), poor(1 pts). This analysis tool of checklist was explored through previous research and the principles of universal design (North Carolina State University Center for Universal Design, 1997; Cho, 2008; Kim, 2009; Ministry of Education and Technology, 2009; Kim 2012). The checklist consists of such major area as pathway, parking lot, main entry, corridor, stair, elevator, information system, and public toilets including the handicapped (See Table 2).

9) Cho, Young-Hang, An evaluation of universal design principles in the university libraries- focused on National universities located in Busan, Journal of the Architectural Institute of Korea, 24 (10), 2008, pp.21-29.
10) Kim, D., Kim S., Lee, H., Won, S., Park, J., & Ha, M. A study on application of the universal design principles to classrooms in universities, Journal of the Architectural Institute of Korea, 25 (2), 2009, pp.123-132.
11) Park, S. & Lee, J, Examination of educational facilities standards for integrated education based on barrier free, Spring conference proceeding, Journal of the Architectural Institute of Korea, 31(1), 2011. pp.97-98.
12) Kwon, O, Lee, Y, & Kim, H. An analysis of space usage and user's needs for improvement of university facilities by students with disabilities, Journal of the Architectural Institute of Korea, 27 (5), 2011, pp.61-71.
13) Kim, Won-Pil, pp.11-20.

Table 2. Evaluation Index of Universal Design for Student Hall/wellbeing facilities

Division		Evaluation Index	Code	Design Criterion	S[a]	A[b]	A[c]	S[d]
Inter-mediate facility	path way & access	pathway width	a-01	more than 1.2m of pathway			●	
		pathway slope	a-02	less than 1/18 (if less than 1m, 1/12)			●	
		difference of height	a-03	height difference range: 6-12cm			●	
			a-04	less than 5cm between manhole and surface of pathway				●
		securing pathway	a-05	less than 3cm between main entry and pathway			●	●
			a-06	installation of ramp and lift			●	
		material of pathway floor	a-07	demarcation between pathway and road				●
			a-08	installation of fence and handrail				●
			a-09	non-slip finish				●
		obstacle component to pathway	a-10	connection of paving brick (less than 2cm of gap)			●	●
			a-11	installation of street lighting, utility pole, sign board			●	●
			a-12	pruning more than 2.1m not to affect passage			●	●
	handi-capped parking	recognizable location	b-1	install parking stall at recognizable place			●	
		valid width to entry	b-2	more than 1.2m from parking to main entrance			●	
		parking stall	b-3	more than 3.3m×5m for right angle , more than 2m×6m for parallel			●	
		guiding to parking	b-4	indication of guiding to entry of parking lot			●	
		signage	b-5	surface marking of exclusive parking for handicapped			●	
Interior facility	Main Entry	valid width of entry	c-1	more than 0.8m for valid entry width			●	
			c-2	more than 1.2m from the front entry			●	
			c-3	remove obstructive bottom sill			●	●
		type of door	c-4	prohibit revolving door			●	
			c-5	maintain more than 3 seconds during opening door			●	
		door handle	c-6	located at 0.8m~0.9m from the bottom	●			
			c-7	type of door handle	●			
		etc	c-8	attach braille room sign	●			
			c-9	install detecting indicator at main entry (embossed block)	●			
	corridor	valid width of corridor	d-1	more than 1.2m of corridor width			●	
			d-2	more than 1.5m of corridor width if there are rooms both sides			●	
		corridor floor	d-3	remove difference of corridor floor level			●	●
			d-4	non-slip floor finish			●	●
		corridor handrail	d-5	install continuous riser	●			
			d-6	located at 0.8m~0.9m from the bottom floor level, located at 0.65m~0.85m, if double handrail	●			
			d-7	less than 3.2cm~3.8cm diameter of handrail	●			
			d-8	less than 5 cm between wall and handrail	●			
			d-9	attach braille sign for handrail	●		●	
	stairways	stair landing area	e-1	install horizontal stair landing per 1.8m rise	●			
			e-2	more than 1.2m for stair width and recess area			●	
		stair rise	e-3	less than 0.18m	●			
		stair width	e-4	more than 0.28m	●			
			e-5	install non-slip band on stair			●	
		side handrail of stair	e-6	located at 0.8m~0.9m from the bottom	●			
			e-7	less than 3.2cm~3.8cm diameter of handrail	●			
			e-8	more than 0.3m for extended horizontal handrail	●			
			e-9	attach braille sign for horizontal handrail	●			
			e-10	install embossed block spaced 0.3m from the front	●			
	lift	front area of lift	f-1	more than 1.4m×1.4m			●	
		gap	f-2	less than 3 cm between lift &and shaft			●	
		inside area	f-3	more than 1.1m×1.35m			●	
		entry width	f-4	more than 0.8m			●	

		height of controller	f-5	less than 0.8m～1.2m			●	
		location of controller for wheelchair user	f-6	right side & forward, horizontal type	●			
		height of controller for wheelchair user	f-7	less than 0.85m	●			
		embossed block	f-8	install embossed block front side at call button(0.3m)	●			
		front mirror	f-9	inside of lift	●			
		voice information	f-10		●			
		handrail	f-11	installed continuous handrail inside	●			
		braille sign board	f-12		●			
Sani-tation facility	rest room for the handi-capped	general toilet for handicapped	g-1	install exclusive handicapped toilet	●			
			g-2	install location sign of handicapped toilet			●	
			g-3	remove floor level difference of toilet			●	●
			g-4	braille sign of gender differentiation on the wall/door			●	
			g-5	easily usable type faucet	●	●		
		valid floor area	g-6	each space of toilet should be 1.0m×1.8m			●	
		front width of toilet	g-7	1.4m×1.4m			●	
		side width of toilet	g-8	more than 0.75m			●	
		entry door of toilet	g-9	more than 0.8m for passage			●	
		toilet vertical bar	g-10	height of vertical grab bar be between 0.6m～1.5m			●	
		toilet grab bar H	g-11	horizontal grab bar located under 0.6m～0.7m from FL			●	
		toilet grab bar	g-12	horizontal grab bar both side within 0.7m			●	
		toilet height	g-13	less than 0.40m～0.45m			●	
		lavatory horizontal H	g-14	height be less than 0.8m～0.9m			●	
		lavatory vertical rail	g-15	between 1.1m～1.2m			●	
		lavatory guide rail	g-16	both side be within 0.6m			●	
		projected width	g-17	vertical handrail be within 0.25m from the wall			●	
		sink upper height	g-18	less than 0.85m			●	
		sink bottom height	g-19	more than 0.65m			●	
		bottom space of sink	g-20	enough space for knee deep and wheelchair		●	●	

✞ Note 1: S^a indicates Supportive design, A^b indicates Adaptable design, A^c indicates Accessible design, S^d indicates Safety-oriented design
✞ Note 2: This checklist was based on the modification of Kim's (2012) results, Cho's checklist(2008), and M.E.T.(2009).

3.2 Analysis and discussion

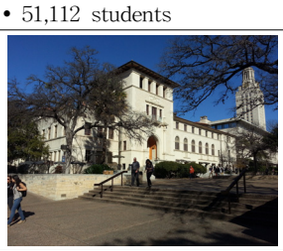
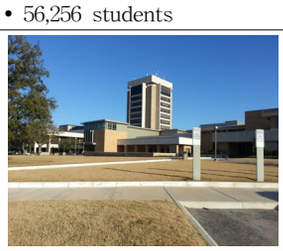
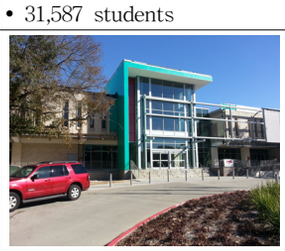
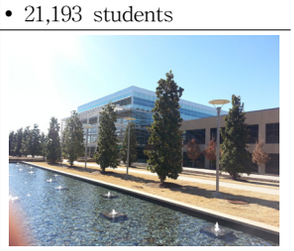
Physical characteristics of selected student hall/retail facilities are as followings;

Major components of evaluation on the level of UD application to university student hall and adjacent facilities were as followings.

1) Pathway and access path

As shown in Table 2, among 12 elements regarding pathway and access condition, most of the design

Table 3. Physical Characteristics of Student Hall/Retail Center, Texas, U.S.

Division	Univ. of Texas, Austin	Texas A&M University	University of Houston	Univ. of Texas, Dallas
Bldg. name	• University Unions	• University Center	• Univ. Center(Book store)	• Student Services Bldg.
Main usage	campus store, food court, theatre, show room, copy center, catering,	honor lounge, food court grill, guest suite, ATM, copy center, campus store	food court, club room, copy center, student office lounge, office,	food court, health center, student office, fitness center, campus store,
Project scale	• 5 story, basement	• 14 story, basement	• 2 story, basement	• 3 story, basement
Enrollment	• 51,112 students	• 56,256 students	• 31,587 students	• 21,193 students
Overview				

principles were fully complied to UD concept; good (96%) and fair (4%). Every school has spacious pathway and provided easy access to main entry area, while some of sub-entry did not have access ramp.

Table 4. UD application of pathway and access path (%)

Index	Code	Good	Fair	Poor	Total
pathway width	a-01	12(100)	0(0)	0(0)	12(100)
pathway slope	a-02	12(100)	0(0)	0(0)	12(100)
difference of height	a-03	12(100)	0(0)	0(0)	12(100)
	a-04	12(100)	0(0)	0(0)	12(100)
securing pathway	a-05	12(100)	0(0)	0(0)	12(100)
	a-06	9(82)	2(18)	0(0)	11(100)
material of pathway floor	a-07	12(100)	0(0)	0(0)	12(100)
	a-08	12(100)	0(0)	0(0)	12(100)
	a-09	12(100)	0(0)	0(0)	12(100)
obstacle component to pathway	a-10	9(82)	2(18)	0(0)	11(100)
	a-11	9(82)	2(18)	0(0)	11(100)
	a-12	12(100)	0(0)	0(0)	12(100)

Figure 2. Main entry of every school provided easy access, while some of sub-entry at UH(left) and UTD didn't provide ramp.

2) Handicapped parking stall

Handicapped parking is major design issue in U.S. school facilities, because of the scarcity of mass transportation in automobile-oriented culture. Field survey indicated that most of off-site parking lot for disabilities were spaciously well installed, while many of them were located far away from the student hall buildings, resulting in recognizing problem of the space location. It is found that good application of UD was 90%, fair 4%, and poor 6%.

Table 5. UD Application of Handicapped Parking Stall (%)

Index	Code	Good	Fair	Poor	Total
recognizable location	b-1	0(0)	2(40)	3(60)	5(100)
valid width to entry	b-2	12(100)	0(0)	0(0)	12(100)
parking stall	b-3	12(100)	0(0)	0(0)	12(100)
guiding to parking	b-4	12(100)	0(0)	0(0)	12(100)
signage	b-5	12(100)	0(0)	0(0)	12(100)

Figure 3. Handicapped parking tend to be spacious, but far from the student buildings.(UTD, left; UT, Austin, right)

3) Main Entry

Most student building have provided supportive size, and enough space for passage at main entry area. Valid width, door type, and door handle were assessed to be useful and safe, except detecting indicator at main entry (installation of embossed block) and braille room sign. As shown Table 6, UD Application of main entry shows 91% of good level, and 9% of poor level. The reason why they do not consider braille room sign for visually impaired persons is due to their possessions of portable electronic GPS navigation system.

Table 6. UD Application of Main Entry (%)

Index	Code	Good	Fair	Poor	Total
valid width of entry	c-1	12(100)	0(0)	0(0)	12(100)
	c-2	12(100)	0(0)	0(0)	12(100)
	c-3	12(100)	0(0)	0(0)	12(100)
type of door	c-4	12(100)	0(0)	0(0)	12(100)
	c-5	12(100)	0(0)	0(0)	12(100)
door handle	c-6	12(100)	0(0)	0(0)	12(100)
	c-7	12(100)	0(0)	0(0)	12(100)
etc	c-8	0(0)	0(0)	4(100)	4(100)
	c-9	0(0)	0(0)	4(100)	4(100)

Figure 4. The entry door at most buildings has wide enough, but do not provide braille signage(UTD).

4) Corridor

Except for corridor handrail and its accessories, valid width of corridor and corridor floor showed easily accessible environment; good (80%) and poor(20%). It is analyzed that spacious width of corridor and wheelchair dependence do not require additional supportive handrail as shown in Figure 5.

Table 7. UD Application of Corridor Area (%)

Index	Code	Good	Fair	Poor	Total
valid width of corridor	d-1	12(100)	0(0)	0(0)	12(100)
	d-2	12(100)	0(0)	0(0)	12(100)
corridor floor	d-3	12(100)	0(0)	0(0)	12(100)
	d-4	12(100)	0(0)	0(0)	12(100)
corridor handrail	d-5	0(0)	0(0)	4(100)	4(100)
	d-6	0(0)	0(0)	4(100)	4(100)
	d-7	0(0)	0(0)	4(100)	4(100)
	d-8	0(0)	0(0)	4(100)	4(100)
	d-9	0(0)	0(0)	4(100)	4(100)

Figure 5. Most corridors are wide (TAMU) and had no handrail on the wall nor braille sign (UTD).

5) Stairways

Building code standard in U.S. is ≥ 4″(10.16cm) and ≤7″(17.8cm) for riser and ≥ 10″(25.4cm) for tread. As shown Table 8, in most cases, stairways complied with basic dimensions of rise and tread height, but handrails of most buildings were rated somewhat poor.

Table 8. UD Application of Stairway Area (%)

Index	Code	Good	Fair	Poor	Total
stair landing area	e-1	12(100)	0(0)	0(0)	12(100)
	e-2	12(100)	0(0)	0(0)	12(100)
stair rise	e-3	12(100)	0(0)	0(0)	12(100)
stair width	e-4	12(100)	0(0)	0(0)	12(100)
	e-5	12(100)	0(0)	0(0)	12(100)
side handrail of stairways	e-6	12(100)	0(0)	0(0)	12(100)
	e-7	12(100)	0(0)	0(0)	12(100)
	e-8	12(100)	0(0)	0(0)	12(100)
	e-9	0(0)	0(0)	4(100)	4(100)
	e-10	0(0)	0(0)	4(100)	4(100)

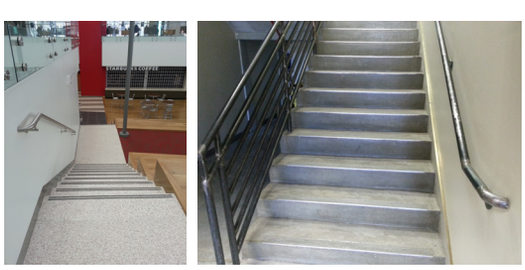


Figure 6. Stairways with handrail(UH), but no braille sign(UTD)

6) Lift

Most student building were equipped with lift which is closely located to main lobby/hall. Furthermore, as shown in Figure 7, most lifts provided convenient location of controller for wheelchair users, but no braille sign. Overall application of UD concept to this design element was evaluated as 72%.

Table 9. UD Application of Lift (%)

Index	Code	Good	Fair	Poor	Total
front area of lift	f-1	12(100)	0(0)	0(0)	12(100)
gap between shaft/frame	f-2	12(100)	0(0)	0(0)	12(100)
inside area	f-3	12(100)	0(0)	0(0)	12(100)
entry width	f-4	12(100)	0(0)	0(0)	12(100)
height of controller	f-5	12(100)	0(0)	0(0)	12(100)
location of controller for wheelchair user	f-6	6(67)	2(22)	1(11)	9(100)
height of controller for wheelchair user	f-7	6(67)	2(22)	1(11)	9(100)
embossed block	f-8	0(0)	0(0)	4(100)	4(100)
front mirror	f-9	0(0)	0(0)	4(100)	4(100)
voice information	f-10	0(0)	0(0)	4(100)	4(100)
handrail	f-11	12(100)	0(0)	0(0)	12(100)
braille sign board	f-12	0(0)	0(0)	4(100)	4(100)

Figure 7. Most lifts provided convenient location of controller for wheelchair users, but no braille sign.(TAMU, UTA)

7) Handicapped rest room

Every public restroom was evaluated as good condition except for lavatory. As shown Figure 8, any users with disabilities can easily access to general toilet facilities, while design of lavatory is not provided. Overall score of UD application was found to be 87%. Most features and public sanitary environment in student hall is seemed to be simple by avoiding complicated pathways. and direct door locking mechanism that can be easily operated.

Table 10. UD Application of handicapped restroom (%)

Index	Code	Good	Fair	Poor	Total
general toilet for handicapped	g-1	12(100)	0(0)	0(0)	12(100)
	g-2	12(100)	0(0)	0(0)	12(100)
	g-3	12(100)	0(0)	0(0)	12(100)
	g-4	12(100)	0(0)	0(0)	12(100)
	g-5	12(100)	0(0)	0(0)	12(100)
valid floor area	g-6	12(100)	0(0)	0(0)	12(100)
front width of toilet	g-7	12(100)	0(0)	0(0)	12(100)
side width of toilet	g-8	12(100)	0(0)	0(0)	12(100)
entry door of toilet	g-9	12(100)	0(0)	0(0)	12(100)
toilet vertical bar	g-10	12(100)	0(0)	0(0)	12(100)
toilet grab bar H	g-11	12(100)	0(0)	0(0)	12(100)
toilet grab bar	g-12	12(100)	0(0)	0(0)	12(100)
toilet height	g-13	12(100)	0(0)	0(0)	12(100)
lavatory horizontal H	g-14	0(0)	0(0)	4(100)	4(100)
lavatory vertical rail	g-15	0(0)	0(0)	4(100)	4(100)
lavatory guide rail	g-16	0(0)	0(0)	4(100)	4(100)
projected width	g-17	0(0)	0(0)	4(100)	4(100)
sink upper height	g-18	12(100)	0(0)	0(0)	12(100)
sink bottom height	g-19	12(100)	0(0)	0(0)	12(100)
bottom space of sink	g-20	12(100)	0(0)	0(0)	12(100)

Figure 8. Public restroom for the handicapped (TAMU)

4. Design Implication and Conclusion

University center has always been a focal point for student activities, serving various needs of student customers and the general customers. Previous review of literature in Korea found that minimum legal requirements were enforced to apply universal design details to specific type of public building planning for the disabilities. Kim's study(2012) reported that in overall assessment of UD on student halls in Seoul area, most public rest room lacked some supportive and accessible design consideration, while requiring to provide well-organized and coherent circulation for VIP(visually impaired person).

In the study of student halls in Texas, U.S., based on the checklist developed by Korean conceptual design standard, it appears that pathway/access to the building is the most satisfactory application of UD (98%), while

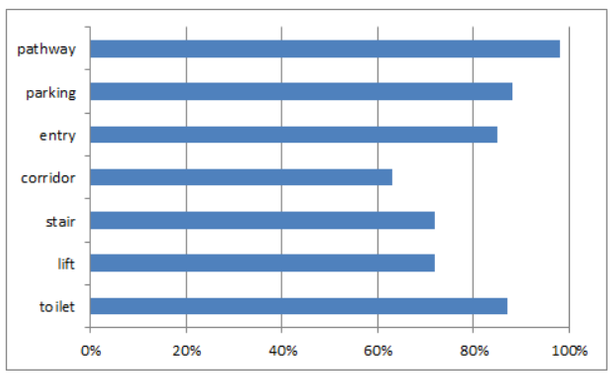


Figure 9. Application level of UD concept on each area

corridor handrails show low adaptation of UD concept (63%) (See Figure 9). Further it also found that four universities selected showed slight differences in the application of UD concept. This might be resulted from their code compliance rather than the negligence of the minimum standard. From the standpoint of their cultural background and professional practice in U.S., most universal design concept are fully applied to the existing facilities because there are spacious planning and room arrangement.

Texas Universities that want their facilities to go beyond the minimum guidelines of the ADA(Americans with Disabilities Act) and other standards have embraced the universal design concept, in which physical environments are designed to be easily usable and approached by the general populace. Through the investigation of student halls in U.S., some useful design guidelines were explored.

Firstly, based upon the cross-cultural background, application of UD concept and code compliance approach might be a little different. For example, design consideration for VIP(visually impaired person) in student buildings or other university facilities at campus environment, can be differently approached; U.S. tends to use portable navigation device while Korea enforces the installation of embossed floor block or braille sign to public facilities. Therefore, with the technology development of navigation and wireless electronic detection devices, it is necessary to review Korean laws and regulations for an efficient application of UD with the assistance of personal electronic devices.

Secondly, the best demonstration of universal design in

student buildings of U.S. can be seen in spacious flat pathway, easy access through ramp and wide entry area, necessary for people in wheel-chairs, but used by all. Further, public space such as lounge and corridor area are large enough to accommodate all volume of traffics and circulations inside. It implies that it is necessary to increase the ratio of public space to overall building area in Korea.

Thirdly, one of the good universal design features in U.S. buildings is an attractive physical environment rather than institutional appearance, in which they ultimately will support and completely adaptable at optimal levels by everyone. Public rest room in U.S. buildings embraces stylish design and attractiveness that can improve overall comfortable atmosphere as well as its accessibility to everyone. Creating the art of aesthetic features that make the place more marketable can be a substantial competitive benefit from UD application.

Fourthly, consistent maintenance and management maximizes the potential of UD principles and minimize physical limitations since UD takes a much more holistic view of life spans and upgrades to be functional at changing society trend.

Since this research takes on four limited cases of university in Texas, there exists limitation to generalize the results. However, it is maintained that implications, generating from cross-cultural concept will complement our local UD standard in a way to promote the wellbeing of all users.

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