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Workplace Universal Design for the Older Worker: Current Issues and Future Directions

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Objective: The objective of this study is to apply the principals and policies of universal design to offer a safe and efficient workplace for older workers.

Background: The concept of universal design has rapidly developed under the paradigm that tasks should be easy and comfortable for all people with diverse features. The concept is also fitting when designing a workplace.

Method: Legislations, policies and precedents of workplaces with older workers have been studied and analyzed. The compilation has been used to project the present and future of employing universal design at workplace devisal.

Results: Every country has its own legislations/policies regarding universal design, flexible working, and age-friendly workplaces to increase hire of older workers. The basic concept of UD and its application is explained. This study provides guidelines for employing universal design at workplaces and preventing accidents for older workers.

Conclusion: Following the principals of universal design is expected to furnish a comfortable and safe workplace and lengthen the period of workers participating in the labor force in an ageing society.

Application: This study offers the principles for universal design, serving as fundamental research for its application to the workplace.

Keywords: Universal design, Older worker, Age-Friendly workplace

1. Introduction

Life expectancy has increased while birth rate has dropped. The ratio of people aged 65 or more to the total population is increasing every year. According to Statistics Korea, the number has exceeded 6.13 million, over 12.2% of the total population (KOSTAT, 2013). In Japan, the percentage was 25.7% in January of 2014 (Ministry of Internal Affairs and Communications, 2014). U.S. Census Bureau has revealed in 2014 that the proportion of people over 65 exceeded 20% of the population in 2010 for Japan, Germany, Italy, and Monaco. For Korea, the fraction was 11.1%, a little less than America's 13.1%, but was expected to age more rapidly, projecting the rate at 35.9% in 2050 compared with 20.9% for the U.S. (U.S. Census Bureau, 2014).

With the number of people aged over 65 continuously on the rise, the interests in

these people have increased in all aspects of society, including the need for new and diverse welfare measures. The ageing society will also lead to longer service periods, older workers, and a greater need for the workplace to embrace diversity (Saito, 2006). Workers in Korea will be more diversified with older workers, women workers, and temporary workers. Under the paradigm that it should be easy and comfortable for all workers, universal design is of demand. With the increased attention to the wellbeing of senior citizens and the disabled, universal design has flourished in designing public service facilities. Industrial designers, architects, and environmental designers are vitalizing research to suit the needs of diverse people including the elderly, the disabled, and the young. In addition to product and interior design, universal design is also relevant to designing a workplace because it takes diverse people into account. It is especially vital to a worker-oriented workplace as the settings have a large impact on the workers' safety and productivity (Baik *et al.*, 2014).

The purpose of this research is to provide precedents and guidelines on designing workplaces by applying the principles of universal design. It is to allow all workers, including the aged, to do their tasks easily, comfortably, and safely.

2. Workplace Design Paradigm for Older Workers

2.1 Universal design

The term universal design can differ in meaning depending on the researcher or the field of study in use. In one sense, it can be equated with "design for all" and "inclusive design". Alternatively, it may correspond to the term "assisted living". Assisted living products and services are for people who require particular living conditions. They target these consumers' practical use (Frenkler *et al.*, 2006).

Universal design does not design only for the healthy but aims to let the elderly and the disabled to use the products like every other. The word "universal" implies commonality, openness, and personalization. Universal design is the conscientiousness that respects individuality to offer a comfortable environment and product.

The idea of universal design was first introduced in the late 1960s, serving the social needs of the period. In the U.S., injured war veterans had come back from the Vietnam War, and the ageing Northern European society, having to endure harsh weather, suffered labor shortage. The need of barrier free designs for the socially isolated disabled and aged to freely engage in their normal lives without special assistance was the origin of universal design. Mace (1997) was the first person to use the term to describe "a concept of designing all products or environment to be aesthetic and usable to the greatest extent possible by everyone, regardless of their age, ability, or status in life".

2.2 Flexible working

Flexible working is a type of working arrangement that gives the workers some flexibility to their working conditions. It includes working practices such as part-time working, compressed hours, flexitime, and job-sharing (CIPD and TUC, 2011). To maximize the older workforce, the tasks have to be appropriate for the older workers. They should be able to work without physical or mental pressure. Also, their tasks must be something that is doable without prior experience. To identify this type of work, the working environments and the difficulty of tasks must be rated and analyzed. Further measures such an increased opportunity for hire is expected to revitalize the older work force.

In regular workplaces, older workers would work part-time. Two or more older workers will share the average workload of a young man, reducing the burden of working long hours for the older workers. When practicing part-time employment, each industry will need to conduct research to find the right number of working hours for these workers considering their many traits. Long shifts

of 8 or 12 hours are advised to be practiced in short rotated shifts of 4 or 6 hours. Retired individuals must be individually assessed of their ability to find the best fit.

2.3 Age-friendly workplace

WHO has come up with Age-friendly Environments Program to raise international awareness to creating a social and environmental background to an active and healthy ageing society. In cooperation with this, WHO's Global Age-friendly Cities project focuses on the local communities, making guidelines and publicizing the project, to create physical and social environment that is age-friendly (WHO, 2007). One example of this is the Age-friendly public transport project in Salzburg, Austria. WHO Global Network of Age-friendly Cities and Communities was established in 2012 to exchange knowledge and experience between cities.

Age-friendly Community Links has an Age friendly Workplaces project for the Nonprofit Sector designed to study how to attract older workers to do work for nonprofit sectors. It works to create age-friendly workplaces and increase the sector's capacity to retain older workers (Community Links, 2012).

3. Legislations and Policies on Older Workers in Other Countries

3.1 Laws and guideline

Many European Union Member States have approximately half of their legislation enforced from their European Union membership, which is relevant both nationally and internationally. Key policies include human rights and equality, rights of disabled persons, social inclusion, and sustainable development. The Disability Act also provides a statuary basis for advancing participation of disabled people as it secures accessibility of public sectors. The Equal Status Act states that any selling goods or services must be able to accommodate people with disabilities and The Building Control Act sets the ground for their professional conduct and workmanship.

The Council of Europe Disability Action Plan 2006-2015 suggests the implementation of Universal Design principles into areas such as ICT, transport, the built environment, and product research. The European Union urges to promote the concept of Universal Design to politicians, professional associations, and anyone who strives to establish a livable environment for everyone. The attention is towards suiting the diverse needs of a wide variety of individuals in designing infrastructure, buildings, and consumer products. In countries like Germany, fixed regulations (DIN 18024/18025) apply to these barrier-free buildings and public zones.

American policies are based on The Americans with Disabilities Act (ADA) of 1990, Americans with Disabilities Act Accessibility Guidelines (1991), and Americans with Disabilities Act/Architectural Barriers Act Guidelines (2004). The legislations in Canada such as Employment Equity Act (section 2), Canadian Labour Code (Part II, Occupational Health and Safety, sections 124 and 125), and the Canadian Human Rights Act (Part I, section 3(1)) have addressed employer responsibilities, health and safety at work, and worker discrimination, respectively.

The Law for Building Accessible to and Usable by the Older and Physically Disabled Persons (the Heartful Building Law) has made terms like "barrier-free design/ accessibility" and "universal design" more common people in Japan. Implementing Universal Design in their product design is a recent trend there. Manufacturers and advertising agencies have built a new marketing strategy that even helped businesses recover from their long recession. Recent popularity was key to the amendments being made to the Heartful Building Law (Saito, 2006).

Japanese have also started an organization called JEED, which aims to create a "Society for All". Their main task is to help find work for all people including people with disabilities. Their Occupational Safety and Health Act laid the ground rules in hiring older workers for the following criteria: work management, work environment, workers' health, overall management, and safety education.

Due to the support of the local and state Japanese government, The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) presented guidelines to further improve quality of life using Universal Design to redesign cities in 2007. The guideline is regarded as the "General Principles of Universal Design", and is said to be the composite of the previous "Heartful Building Law" and the "Transportation Equal Access Law".

3.2 Age-friendly universal design approach

Work requirement beyond individuals' capabilities is often a factor in their injuries and poor job performances. This mismatch is more likely happen among older workers. Principles of "universal design" seek a safe, effective product and environment that people with widely ranging differences in age, size and other characteristics can use. Creating an age-friendly workplace is a collaborative work of ergonomics, human factors, and universal design. They together manage the challenges of balance, vision, hearing, strength and endurance faced by aging workers (Silverstein, 2008).

Broadly speaking, Universal Design is applied to three following areas of work: 1) Public design (buildings, interior design, and public spaces), 2) age-friendly products (product design, media design, and service design), 3) workplace design (work rotation, work schedule, workplace improvement). The application to workplace design can again be divided to the following three sectors: 1) work environment including employee workstation and work facility; 2) workplace technologies and tools, including computers, manufacturing tools, controls, machinery, safety equipment, furniture, and communication devices; 3) reconceptualization of work policies, interaction, communication, safety, and, most importantly, the methods used to complete work tasks.

Universal Design edited by Christophersen (2002) illustrated cases of universal design applied in 17 different public designs throughout Europe, North American, Asia, and Australia. Universal Design edited by Preiser and Smith (2011) provides systemized standards and guidelines for public spaces, products, and technologies with examples. Martin and Hanington (2012)'s book, Universal Methods of Design, suggests a hundred innovative ideas and effective solutions for universal design. In addition, European publications have discussed cases of older workers and the facilitation of their hire (Walker and Taylor, 1998; Naegele and Walker, 2006).

Government of Western Australia (2010) published a manual on strategies for age-inclusive workplace culture and flexible work practices. Canadian Government of Alberta (2006) made a health and safety guide giving specifics on the mental and physical states of older workers. Moreover, Canada's Human Resources Skills Development (2012) and Community Links (2012) gave example cases where setting age-friendly workplaces played a key role in creating jobs for older workers.

4. Workplace Universal Design and Prevention of Industrial Accidents

4.1 Principle of universal design and workplace universal design

Universal design was initially for product design, architecture and interior design. Thus, the term needs to be redefined for workplace design. Based on the 7 basic principals of universal design (Center for Universal Design, 1997), this study put together the design elements that need to be considered in workplace design. For each element, there exist a list of physical and cognitive features of workers that needs to be taken account. Safety features do not mean that of the workers but is used to indicate

the safeness of each equipment or device which needs to be taken into account (Table 1). Physical features (P) require the measurements of the human body such as static and dynamic measurements and force. Cognitive features (C) include one's mental and emotional state. In occurrence of accidents or machinery or equipment flaws, safety features (S) like failure prevention system and recovery system should exist.

Table 1. Principles of workplace universal design

Design elements		Features	
1. Equitable use	a. Provide the same means of use for all users	P	Measurements of the human body
		C	Display, warning device, operating device
	b. Provisions for privacy, security, and safety should be equally available to all users.	P	Protective Equipment
		C	Consideration of work stress
2. Flexibility in use	a. Provide choice in methods of use.	P	Hand tool, working order, work arrangement, equipment arrangement
		C	Working order, work arrangement, equipment arrangement
	b. Accommodate right- or left-handed access and use	P	Hand tool, work direction, equipment arrangement
	c. Facilitate the user's accuracy and precision	P	Location of display
		C	Direction of operation and measurements for display
	d. Provide adaptability to the user's pace.	P	Process speed, consideration of repetitive operation
		C	Visibility and preciseness of display and operating device
3. Simple and intuitive use	a. Eliminate unnecessary complexity.	P	Working order, verification inspection
		C	Simple display and operating device
	b. Be consistent with user expectations and intuition.	C	Basic model of display and operating device
	c. Accommodate a wide range of literacy and language skills	C	Display, monitoring work, work manual
	d. Arrange information consistent with its importance.	C	Display, monitoring work, component arrangement, operating device arrangement
	e. Provide effective prompting and feedback during and after task completion.	C	Warning device, alarm
4. Perceptible information	a. Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.	C	Display, inspection equipment, safety sign, communication methods
	b. Provide adequate contrast between essential information and its surroundings	C	Color, location, size of display
	c. Provide affordance	C	Shape, icon, operation button, design
	d. Provide compatibility with a variety of techniques or devices used by people with sensory limitations.	C	Warning, sounds alarms, display

Table 1. Principles of workplace universal design (Continued)

Design elements		Features	
5. Tolerance for error	a. Arrange elements to minimize hazards and errors	C	Operating device, operation Information
		S	Prevention of malfunction, tamper proof
	b. Provide warnings of hazards and errors	S	Offer feedback
	c. Provide fail safe features.	S	Fail safe
	d. Discourage unconscious action in tasks that require vigilance.	S	Fool proof
6. Low physical effort	a. Allow user to maintain a neutral body position	P	Work at knuckle height, normal work area
	b. Use reasonable operating forces	P	Force limit for pushing and pulling, recommended weight of carry and lifting
		C	Indicator of heavy weight
	c. Minimize repetitive actions.	P	Hand tool, simple assemble of parts
	d. Minimize sustained physical effort.	P	Protective gear and equipment
		C	Work and posture training
7. Size and space for approach and use	a. Provide a clear line of sight to important elements for any seated or standing user.	C	Component arrangement, height of worktable
	b. Make reach to all components comfortable for any seated or standing user.	P	Component and tool arrangement, width of worktable, width ofcart
	c. Accommodate variations in hand and grip size.	P	Hand tool, operating device
	d. Provide adequate space for the use of assistive devices or personal assistance.	P	Work space, reach distance, clearance

P=Physical, C=Cognitive, S=Safety

4.2 Design implementation at work

This study suggests designs for workers (19-69 of age) including senior citizens. The measurements required for the designs are from the 2010 6th Size Korea (KATS, 2010), and are sorted by age and gender. The workplaces are divided into places that only have male workers, places that only have female workers, and places that have both male and female workers. The design measurements vary for each of these places. The research is only concerned with providing a maximum permissible area of horizontal handling and recommended range of handling heavy weight.

4.2.1 Maximum permissible range of horizontal handling

To find the maximum permissible area, the measurements for maximum grip reach and forward are used. For the permissible range to be applied to all workers, the area must be set by the shortest standards. Thus, in Table 2, the design measurements are set at 5 percentile of the original measurements of grip reach and forward. For places with only men, the range is 64.5cm, for women-only it was 60cm, and 61cm for workplaces with both men and women.

Table 2. Maximum permissible area of horizontal working - grip reach, forward

Age	Object	Mean	Standard deviation	Design principle	Design measurements (mm)
19~69	Male-only	700	33.2	Minimum measurement of the small person group (5%tile)	645
	Female-only	646	28.9		600
	General use	674	41.3		610

4.2.2 Recommended upper and lower limit of heavy material handling

The recommend handling area for heavy weight items is from "knee-height" to "acromion height." The lower limit is set at 95 percentile of the highest "knee-height" so that worker with big builds would not have to bend as much. The higher end is set at 5 percentile of the lowest "acromion height" so that shorter workers would not have difficulty.

The upper limit of the recommended material handling area from Table 3 is set at 129cm for men usage, 118.3cm for women, and 120.2cm for general usage. The recommended lower limit from Table 4 is set at 48.8cm for men, 44.5 for women, and 47.8cm for general usage.

Table 3. Recommended upper limit of material handling area - acromion height (mm)

Age	Object	Mean	Standard deviation	Design principle	Design Measurements (mm)
19~69	Male usage	1381	56.0	Minimum measurement of small person group (5%tile)	1290
	Female usage	1267	52.2		1183
	General usage	1327	78.6		1202

Table 4. Recommended lower limit of material handling area - knee height (mm)

Age	Object	Mean	Standard deviation	Design principle	Design Measurements (mm)
19~69	Male	442	27.6	Maximum measurement of large person group (95%tile)	488
	Female	406	23.6		445
	General	425	31.2		478

4.3 Accident prevention for older workers

Relevant issues regarding older workers' safety, health, and accident prevention will be summarized. They will be based on Canada (Government of Alberta, 2006) and Australia's (Government of Western Australia, 2010a) Guide to managing an aging workforce, Safety and Health Guidelines for Older Workers (Government of Western Australia, 2010b), Occupational Safety and

Health Act in Japan, Safety Rules for Older Workers by KOSHA (2012).

4.3.1 Consideration of operator management

Older workers have a relatively limited memory span and cognitive abilities. Therefore, it is advisable to assign them planned tasks with specific and detailed instructions rather than tasks that require a quick response. Especially when taking on a new work or operation, they need longer training periods than younger workers. It is important to instruct the work in the exact sequence, complete with an actual supervised trial run.

When older workers are assigned a task that requires collaborative work with the younger workers, it is better to definitively state the nature of the relationship between the workers. Clearly stating the tasks that each worker is expected to complete will also help set an easier work environment.

Work that demands complete focus should not continue over an hour and one should be able to choose their working hours and working practices out of several given choices. Working overtime or alone should be avoided if possible and workers who had night shifts should at least have 2 days of rest before taking on another shift.

4.3.2 Advisable tasks

Older workers are not as agile, so work that requires less than 0.5 second response time is not suitable. Also, their memory and judgment are not as reliable which suggests tasks that involve remembering letters or numbers or making quick judgment are better avoided. They also should have at least 15 minutes of break time for every 2 hours.

Handling heavy materials weakens an older worker's muscular strength. First, it is recommended that these tasks be avoided or reduced. When they do need to lift a heavy object, the proper weight for older workers is under 20kg for men and 15kg for women. If the object is heavier, two or more workers would have to lift it together, or workers should use tools. Safety education for using these tools should be provided beforehand.

Postures such as having one's arms higher than one's shoulders should not be held long. Workers should never spend more than 5 minutes bending over or tilting to the side to do work. Standing on one foot should be no longer than 5 seconds. Positions like having their arms over their head, neck bended forward, or knees crouched should happen longer than an hour per day.

4.3.3 Solutions for managing the work environment

There needs to be a resting lounge for older workers. Stairs and wheelchair ramps should be adjusted to proper height and angle to prevent accidents. Slippery floors should be fixed and handrails should be installed for the stairs. Proper lighting must be provided for the workplace and the hallway along with an indicator for whenever the floor is of different heights.

Bad vision is also common for older workers. All signs and notices should be at a size that it is readable for a person with an eyesight of 0.3 and illuminance provided by a light source should be over 600 lux.

4.3.4 Educating workers and managing their health

An understanding of differences in individuals' health is crucial, and opportunities for education should be granted to maintain

a regular lifestyle/exercise routine. Complicated tasks should be taught over time and workers who handle heavy objects should be informed about preventing future back pain.

Older workers need regular medical checkups ensured by law for their health maintenance and disease prevention. Hypertension patients, diabetics, and cardiopulmonary patients must be provided appropriate information for their assistance. Adequate time should be guaranteed when returning to the workforce after a leave of absence to rejuvenate one's strength. Together with flexible working practices, paying attention to one's body conditions, will reduce the risks of disease relapse and chronicity.

5. Conclusion and Discussion

As people age, their physical and mental states change. Biologically, aging refers to a steady decline of the ability to adjust to physical and mental needs of the body. Research on older people focus on their daily activities and instrumental living tasks. Daily activities include eating, preparing food, bathing, clothing which is fundamental to living an independent life. Instrumental daily living tasks are more complicated tasks for the elderly such as managing oneself, shopping for groceries, managing money, dialing the phone, and doing house chores.

It would be a mistake to sum up the aged as one group. There needs to be a divide between the relatively healthy and the relatively weak. Also, within the weak group, aging has a different impact whether the aging is physical or mental. Depending on the state of aging, the main interest in a product or environment design might differ. For instance, the core interests with the relatively weak suffering from both mental and physical aging would be sanatoriums and nursing facilities. Whereas "physically aged" people might be more interested in supplementary equipment for certain body parts. Then, the relatively healthy seniors will seek for reemployment and continuing education. The main issue for them will be job types, working hours and work environments that best suit the elderly (Jeong, 2012).

Older people who are healthy need the public administration's support for better work environment, reemployment, and flexibility at workplaces where they can work safely and easily. South Korea has enforced the Employment Promotion for the Aged Act since 1992 but there is room for improvement in providing practical platforms. Bigger opportunities for employment, and appropriate job training are necessary. In order to efficiently promote the policy platforms for hire of older workers, support from local governments is vital. Most of the older people suffer from chronic diseases and feel tired fairly soon due to the decline of physical and mental abilities. This leads to higher risks of accidents in the workplace (Park and Jeong, 2009). The treatment and prevention methods should be prepared, but this support for the aged is financially burdening. That is why governmental and local governmental support is crucial to maintaining the aged labor forces.

Reemployment or delaying retirement for older workers is a way that companies can escape personnel stagnation without having to spend large money. To promote hiring, the company must allow certain degree of flexibility to job types, tasks, work environments, and working hours. Various forms of jobs must be created and innovative methods for adjusting working hours such as job sharing, part-time work, telecommuting, and multifunctioning should be provided. Training for new technologies must be done through suitable educational methods using appropriate materials. Training should definitely differ from the education that younger workers receive since mental and physical capacities will vastly differ. Thus, it is expected that there will be further study on finding the most effective educational method and material for the elderly.

For the older workers who have been hired, their workplaces should follow and implement universal design principals. Working conditions and environments should take the worker's physical features into account and provide an easier and fault proof task. These efforts will enhance the health and safety of the workers in the workplace and increase their productivity as well.

This study has examined each country's policies for employing older workers and has suggested principals and elements of universal design to help create a more suitable workplace environment for the elderly. The design elements and principals that were proposed based on universal design are expected to help reduce the number of accidents in the workplace and promote productivity by providing older workers with easier, more comfortable, and safer work environment. Further research is much anticipated on the how much influence universal design and taking older workers' physical and cognitive features into account for workplace design have on work productivity and accident prevention.

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