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DEVELOPING A MEASURE OF USER-PERCEIVED UNIVERSAL DESIGN FOR SPORT FACILITIES

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ABSTRACT

Various universal design evaluation tools are in existence, however, very few, and insubstantial guidelines are available specifically for sport facilities. Moreover, most tools developed in previous studies focus on the standard for facility design excluding user perspectives. This study developed and validated a measuring tool to assess user perceptions of universal design in sport facilities. Literature review and expert consultations were conducted to generate items. A questionnaire comprising these items was completed by 197 users. Using exploratory factor analysis and confirmatory factor analysis, a 27-item measure based on the six principles (equitability, usability, convenience, aesthetics, safety and pleasantness) of universal design from user perspectives was formulated.

Keywords: Universal design; Sport facilities; User perspective; Korea.

INTRODUCTION

Developed countries are facing ever increasing medical expenses that can be attributed to the increase in the prevalence of chronic diseases due to aging populations and industrialization and many countries have adopted physical activities as a means to reduce the expenses (Felderer *et al*., 2006). Studies show a verifiable link of physical activities to improved health and disease prevention, thus resulting in reduced medical expenses (Pratt *et al*., 2000).

It was reported in the UK that physical inactivity had incurred both direct and indirect losses of €12 billion (UK Department for Culture, Media and Sport, 2002). In Switzerland, there was a reported reduction of $464 million in medical costs, when the benefit costs from regular physical activities and the loss costs stemming from sports injury were considered (Smala *et al*., 2001). A similar phenomenon was witnessed in Austria with a cost reduction of $339 million (Resch & Lang, 2007).

The 2010 National Survey on Physical Activity Participation in Korea exposed the lack of opportunities for physical activities as the main factor in Koreans' perception of ill health, igniting nation-wide expansion of public sport facilities (Korea Ministry of Culture, Sports and Tourism, 2010:38). Moreover, the recent "Sports Vision 2018" policy promotes public health through sport facility expansion and improvement (Korea Ministry of Culture, Sports and Tourism, 2013). The policy particularly focuses on the underprivileged groups (females, seniors and disabled) to convince them to exercise, thus covering a wider range of social groups. This clearly resonates with the current trend in many countries that promotes equity and the inclusion of social groups previously neglected.

The recent demographic changes in the Korean population – due to low birth rate, aging population, and the increase in the disabled and multicultural families – demand a flexible environment in which diverse user requirements are met. Disability was previously viewed as a weakness, promoting the exclusion of the individual from the "normal" ones. However, it has recently been considered not as a dividing factor, but as one that could apply to all, or as a trait or a circumstance that all may be exposed to (DePoy & Gilson, 2013). An individual without a previous disability has the potential to become disabled (WHO, 2001). This has helped to shed a different light on sport facilities, particularly for the public exercise facilities as various social groups with diverse requirements use them.

Changes in the social environment, such as population demographics and attitude towards disability, require a relevant new approach to sport facilities. The recent social demands of acceptance of diversity align themselves well with the philosophy of Universal Design (Story *et al*., 1998). Universal Design (UD) implies a holistic approach whereby environments and products should be designed to be usable by as many people as possible, if not all, to the greatest extent possible, regardless of ages or abilities (Mace, 1985). It refers to a design for all. Its particular importance arises from the fact that its goals of the creation of environments for the promotion of health, wellness and social participation (Steinfeld & Maisel, 2012) comparable to the essential functions of sport facilities (Heinemann, 2003).

UD was conceived by Mace (1985) and has been steadily embraced by many countries, academic disciplines and international organisations, such as the United Nations and World Trade Organization. Countries, such as Australia, Norway, Germany, Belgium, the U.S. and the Netherlands have used the term UD in their national policy statements (Jones, 2014). Norway announced a national plan, the 'Norway Universally Designed by 2015: The Norwegian government's action plan for universal design and increased accessibility'. Belgium's Tourism Flanders announced an action plan that adopts UD. The key point is transitioning from 'accessible' to 'inclusive' tourism, taking the thinking from disability groups to everyone. The 'Council of Europe Disability Action Plan 2006–2015' published 15 action lines that apply UD to guide member states to develop strategies, to foster participation of people with disabilities in transport, building an environment with attention on people with disabilities, information and communication, public services, education and employment. The cases of such action lines were published in "Achieving full participation through Universal Design" (Ginnerup, 2009).

Various academic research venues have been applying UD as a rehabilitation plan (Gibson, 2014), built environment (Cassim *et al*., 2007), upgrading the education policy (Edyburn, 2010), and initiating the development of assistive technologies (Story, 2006). Most of these studies, however, are centred on discourses on the concept of UD and its philosophies and guidelines for product or facility designers. Although previous studies have contributed to the progress of UD and its application to the built environment, it still remains unanswered as to whether the UD-applied built environment indeed matches with the user requirements (Shea *et al*., 2016). In a nutshell, the rules and guidelines developed for UD are geared towards UD designers and developers, thus lacking specific user evaluation criteria that can be expended by real user environments.

The Korean government conducted a survey for performance evaluation of public facilities, including sport facilities, as part of a larger survey for performance of government agencies. However, the survey for the sport facilities is limited to general user satisfaction of the facilities, with focus on evaluation of service quality. It should also be noted that service quality, a substitute variable for performance evaluation, was developed in the private sector, making it rather unfit to reflect and capture the social and demographic diversities and the public nature of the sport facilities.

PURPOSE OF STUDY

Various universal design evaluation tools are in existence, however, very few and insubstantial guidelines are available specifically for sport facilities. Moreover, most evaluation tools developed in previous studies focus on the standard of facility design, excluding user perspectives. Consequently, it is necessary that evaluation of user-perceived UD elements should be founded upon the core UD concepts and principles engineered to reflect user perspectives in its evaluation method and narratives. Therefore, the purpose of this study is to develop a scale that measures user-perceived UD of sport facilities.

LITERATURE REVIEW

Concept of Universal Design (UD)

Barrier Free Design, a counterpart of UD, has been in use in architecture and public facilities for people with disabilities. However, it tends to divide people with disabilities from the rest, isolating the former from the social areas and activities that the latter enjoy. The dichotomic approach separating people with disabilities from the rest has given way to a more inclusive one, namely UD, which understands and encompasses multifaceted social and demographic variations (Sanford, 2010).

UD is the design of products and environments to be usable by all people, to the greatest extent possible without the need for adaptation or specialised design (Center for Universal Design, 1997). Shea *et al*. (2016) stated that the commonly observed aims of UD research are the creation of a built environment that allows for participation and empowerment for all (Björk, 2014), the development of environments where human performance, health and wellness are facilitated (Steinfeld & Maisel, 2012); and facilities that can be accessed, understood and used regardless of age, shape, size or ability (Centre for Excellence in Universal Design, 2012).

The UN Convention on the Rights of Persons with Disabilities (United Nations, 2008) referred to the definition of UD by the Center for Universal Design and modified it slightly to express it as, “Universal design shall not exclude assistive devices for particular groups of persons with disabilities where this is needed” (Lid, 2013:204), implying that the disability referred to by UD is not limited to a specific but a comprehensive concept of disability. The ICF (International Classification of Functioning, Disability and Health) framework developed by WHO (World Health Organization) defines disability under three headings: impairments in body functions and structures, activity limitations and participation restrictions, implying that anyone can end up suffering from disabilities. An individual without a previous disability has the potential to become disabled (WHO, 2001).

Disability and universality are particularly important concepts in UD. Contrary to the more conventional dichotomous definition of disability with a clear division of the disabled and the rest, UD views any and all handicaps as disability originating from differences, such as in age, gender, body size and individual abilities (Lid, 2013). In short, this perspective views a disability as a condition that may be universally applied to individuals as they live. Lid (2014) claims that disability emerges in the interaction between individuals and the environment, encompassing both social and material factors. The interaction itself is of importance, together with individual and environmental factors, implying that disability results from the interaction between persons with impairments and attitudinal and environmental barriers that hinder their full and effective participation in society on an equal basis with others. Disability in UD has many facets depending on how one approaches it. However, it is deemed to be a universal problem for every individual while acknowledging various groups of users.

The scope of disability in the concept of UD is diverse and comprehensive and can be understood from medical and social model perspectives (Kristiansen *et al*., 2009). The medical model views disability as an individual's medical condition (Scully, 2008), thus focusing on diagnoses, illness, treatment and rehabilitation processes as key concerns. On the other hand, the social model regards disability as oppression in one's environment, arising from the political sphere (Thomas, 2004; Scully, 2008), thus investing its research efforts in environmental factors, such as politics, legislation, discrimination, architecture, and oppression. In conclusion, disability in UD has many facets depending on how one approaches it; however, it is deemed to be a universal problem for every individual while acknowledging various groups of users. This open-minded approach to varied personal requirements has led to the core principle of universality of design (Winance, 2014).

Although UD has been successfully adopted in policies and design practices, one ought to avoid an idealistic take on UD (Steinfeld & Maisel, 2012). The main purpose of UD is to provide equal accessibility to everyone, however, it is not feasible to achieve universal situation (Story *et al*., 1998). Therefore, "the term 'universal' should not be taken to mean 'for all', but 'for as many people as possible' and it must be interpreted as an intended, yet not fully attainable, goal of universal design" (Ketterlin-Geller, 2005:9). This can be considered the value-oriented concept UD pursues. Similarly, Steinfeld and Maisel (2012:29) stated that the term 'universal' should be understood as a communicative vehicle for 'design for inclusion' rather than a 'design for everyone' and provided a modified definition of UD: "universal design is a process that enables and empowers a diverse population by improving human performance, health and wellness, and social participation".

Health, wellness, and social participation are inherent functions of physical activity (Heinemann, 2003) and they are facilitated by sport facilities. Thus, the present study uses the definition of UD offered by Steinfeld and Maisel (2012). In other words, UD applied in sport facilities is defined as a value or process that supports individuals to achieve and promote health, wellness and social participation.

Principles of Universal Design (UD)

The principles of UD offer guidelines for UD developers, applicable for the evaluation of products and environments. The design principles laid out by Mace (1985) and Null (2014) can

be summed up in four points: supportive, adaptable, accessible and safety-oriented. Supportive design places emphasis on design practices that allow increased functional support for individuals. Adaptable design encourages a flexible and malleable design for products and environments, meeting the needs of as many users as possible. Accessible design fosters a design approach that lowers the barriers to accessibility to provide an environment usable by people with varied physical and psychological traits. Safety-oriented design puts emphasis on designs that offer psychological and material safety to users (Steinfeld & Maisel, 2012).

Additional seven principles and related guidelines were put forth by the Center for Universal Design (1997), claiming that the previous one by Mace (1985) was vague and tended towards duplicity. The seven principles of universal design are equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort and size and space for approach and use. Universal design uses the principles to guide designers to inclusive solutions but focuses more on technical fixes, neglecting the root source of exclusion (Preiser & Ostroff, 2001). This could be a downfall of inclusive design in that it seeks where possible to eliminate the barriers to inclusion at the highest level, and at times might force the designer to regress back to a level at which they cannot make any changes. Nonetheless, the seven principles have been beneficial to designers and developers alike in the creation of products and environments.

The Universal Design Guideline published by Gyeonggi province in Korea treats accessibility as the core concept, manifested in its seven principles: aesthetics, convenience, comfortability, eco-friendliness, safety, selectivity, and +α. Aesthetics puts emphasis on aesthetic beauty that resonates with the surroundings; convenience deals with ease of use regardless of knowledge, abilities and circumstances; comfortability refers to physiological pleasantness and psychological steadiness; eco-friendliness refers to no harmful effect on the environment and continuous use; safety emphasises designs that enable security and prevention of accidents; selectivity empowers individual preferences, abilities, physical conditions, age, and ethnicity; and +α refers to a design that caters to local characteristics, while ensuring seamless integration with the cities. These principles view accessibility as an alternative comparable to UD itself, a view different from Ostroff and Weisman (2004).

Kose (2004) suggested that 'durability and economics', 'quality and aesthetics', and 'health and environmental impact' be added to the seven principles of UD, whereas Ormerod and Newton (2005) argued that some of the principles of UD developed in the field of architecture do not translate directly into all educational settings. In all, it is necessary that the principles of UD and their scope of application should closely relate to the problem at hand.

Evaluation of Universal Design

Sanford (2010) proposed the potential and actual demands of the people located in the facilities as UD evaluation measures. With reference to potential demands, designers and evaluators evaluate the UD standards and guidelines applied to the facilities, whereas with respect to actual demands, evaluation is conducted through observation of the behaviours of, or testimony of, the people in a given environment.

Another evaluation method proposed by Shea *et al*. (2016) uses checklist-driven evaluations, holistic evaluations, value-driven evaluations and invisible designer evaluations. Checklist-driven evaluations use a collection of simplified criteria, driven usually from the seven UD principles, with responses in the form of a 'YES' or 'NO'. Holistic evaluation analyses the point of interaction between people and the facilities. Value-driven evaluations consider issues, such as equality, social participation and oppression imposed upon people. Invisible designer evaluations rely on the existing perception or instinct of the designer based on characteristics, such as skill and moral values during the design process. The checklist method is one of the most frequently used method, and the most popular UD checklist consists of 29 detailed evaluation items derived.

The UD guidelines developed by the Gyeonggi province in Korea propose design criteria and principles for public facilities based on the seven principles laid out in the guidelines (Gyeonggi Province, 2011). The guidelines were developed to benefit everyone, regardless of age, gender, physique, disability, abilities, social status or ethnicity, in order to secure equitable use in friendly and safe environments (Gyeonggi Province, 2011:8).

Lee *et al*. (2012) developed age-friendly outdoor sport environmental design guidelines. Sport environments are classified into small, medium, and large sizes, based on which sport equipment, amenities, parking space, drainage/mounding, information signs, and security need to be separately designed. However, this approach is not related to UD per se, rather, it follows traditional service design methods, and it is difficult to ascertain any application of UD principles, which could be due to the spatial divisions applied to multi-purpose sport facilities.

The North Carolina Office on Disability and Health (NCODH) developed a guide "Removing Barriers to Health Clubs and Fitness Facilities" in collaboration with the Center for Universal Design (NCODH, 2008). It is a guide for accommodating all members, including people with disabilities and older adults, based on the Americans with Disability Act (ADA) enacted in 1990. The guidelines consist of three parts: (1) guidelines for creating accessible spaces in fitness facilities (entrance areas, locker and dressing rooms, toilet rooms, showers, family changing room, a universal feature, placement of cardiovascular equipment, placement of strength training equipment, pool and spas); (2) guidelines for selecting equipment (usability of sport equipment, strength training equipment, free weights/stretching areas, cardiovascular equipment); (3) recommendations for assisting people with disabilities (getting started, medical clearance, screening, liability, considerations for different disabilities, such as physical disabilities, learning/cognitive disability, sensory or communication disabilities). NCODH also developed an Abbreviated Accessibility survey, which evaluates facilities in 10 areas: customer service, parking, reception/waiting area, circulation paths and entrances, signage, elevators, locker rooms, exercise equipment, pool areas and emergency procedures.

These evaluation methods are indeed of value, in that they enable designers to apply and evaluate UD values embedded in the facilities being designed and developed. On the other hand, however, it is impossible to evaluate how UD is accepted and appreciated by facility users. Shea *et al*. (2016) pointed out that although UD rules and guidelines reflect user perspectives and cognition, it is not known whether UD-enabled facilities indeed satisfy user requirements, because the subjective experience of users is not formed individually but as a collective

structure, which depends on how the users perceive the facilities in the spaces they reside. Similarly, Passini (1996) stated that while evaluating subjective experience of users in relation to buildings, it is of foremost necessity to understand the user perception of security and communicative role of the buildings. Therefore, this study has endeavoured to develop a tool for evaluating UD as perceived and experienced by users of sport facilities.

METHODOLOGY

Research design

Although a novel study focuses on evaluating user perspectives on sport facilities, it must naturally deal with service physical environments in its formation of user-perceived UD elements. Hence, several previous studies were considered in constructing the UD elements applicable to sport facilities, such as facility-focused UD studies and guidelines (Mace, 1985; Center for Universal Design, 1998; NCODH, 2008; Gyeonggi Province, 2011), and research on service physical environments in sports (Hutton & Richardson, 1995; Wakefield *et al*., 1996; Cavnar *et al*., 2004; Macintosh & Doherty, 2007). Three experts on design, sport facilities and sport management established the content validity of the method and concretised the evaluation items. Initially, equitability, usability, convenience, aesthetics, safety, and pleasantness were developed as major evaluation categories, each of which contains relevant keywords. An evaluation tool was created with a total of 46 detailed survey items under the six categories.

There are many sport facility usage scenarios possible depending on user preferences and choice. In addition, a sport facility is more than simply a collection of sport programmes and equipment. It includes other facilities and services, like parking service and exercise facility layout, auxiliary facilities. Accordingly, it was necessary to classify evaluation targets and limits of the main and auxiliary facilities, based on which the evaluation categories were defined. This study adopted a holistic approach in its scope of sport facilities, in order to evaluate how the UD applied facilities are accepted and appreciated by the users. In other words, the attention was not limited or restricted to specific spaces and scenes of the sport facilities, but rather to the whole user perspectives with regard to the overall sport facilities.

Sample

Data were collected from 197 users at five public sport facilities located in the metropolitan area of Korea. The respondents were divided by gender (male: 101; female: 96), age (20s=56; 30s=32; 40s=48; 50s=42; 60s=19), marital status (married=116; single=81), education (high school graduates=67; junior college graduates=39; university graduates=62; master's degree higher=30). Ethical approval was granted by the Institutional Review Board of Sungkyunkwan University (SKKU 2014–03–031), and written, signed informed consent was obtained from each participant.

RESULTS

An exploratory factor analysis (EFA) with the maximum likelihood estimation method was applied (Table 1). Factor extraction followed the MINEIGEN criterion (all factors with eigenvalues less than 1.0). The Kaiser-Meyer-Olkin measure of sampling adequacy value was 0.97, with a significant Chi Square value for the Bartlett test of sphericity, χ^2=25243.07,

p<0.001, indicating that sufficient correlations exist among the variables (Hair *et al*., 2014). Thus, the EFA was appropriate for the data. Some items had cross-loading issues and failed to exhibit a simple factor structure; therefore, they were removed from the analysis. The final structure of the scale included 27 items, which reflected a six factor solution (equitability, usability, convenience, aesthetics, safety, pleasantness) and accounted for 55.33 percent of the total variance.

***Table 1*. EXPLORATORY FACTOR ANALYSIS OF UD PERCEPTIONS**

Items	Convenience	Safety	Usability	Pleasantness	Aesthetics	Equitability	*h*
1	0.239	0.127	0.116	0.241	0.216	**0.832**	0.884
2	0.237	0.155	0.052	0.183	0.094	**0.888**	0.913
3	0.216	0.174	0.143	0.198	0.094	**0.952**	0.870
4	0.222	0.312	**0.724**	0.144	0.293	0.065	0.781
5	0.144	0.325	**0.769**	0.177	0.213	0.126	0.810
6	0.247	0.271	**0.745**	0.200	0.130	0.077	0.752
7	0.220	0.174	**0.835**	0.205	0.118	0.078	0.838
8	0.216	0.274	**0.792**	0.182	0.053	0.090	0.793
9	**0.881**	0.187	0.157	0.137	0.107	0.129	0.882
10	**0.864**	0.204	0.185	0.091	0.172	0.185	0.894
11	**0.856**	0.239	0.175	0.126	0.175	0.162	0.894
12	**0.847**	0.210	0.205	0.120	0.120	0.198	0.871
13	**0.880**	0.264	0.182	0.138	0.070	0.106	0.913
14	**0.861**	0.268	0.200	0.086	0.104	0.168	0.900
15	0.112	0.137	0.159	0.094	**0.909**	0.097	0.900
16	0.145	0.151	0.138	0.104	**0.901**	0.125	0.901
17	0.254	0.175	0.237	0.116	**0.798**	0.149	0.824
18	0.217	**0.831**	0.265	0.196	0.137	0.186	0.900
19	0.224	**0.818**	0.289	0.197	0.181	0.103	0.886
20	0.303	**0.770**	0.330	0.245	0.167	0.119	0.896
21	0.299	**0.788**	0.250	0.218	0.111	0.179	0.864
22	0.320	**0.805**	0.251	0.213	0.111	0.107	0.882
23	0.240	**0.853**	0.203	0.221	0.103	0.080	0.891
24	0.126	0.216	0.261	**0.839**	0.162	0.140	0.880
25	0.120	0.337	0.271	**0.803**	0.148	0.125	0.884
26	0.156	0.232	0.140	**0.836**	0.036	0.237	0.855
27	0.148	0.187	0.158	**0.877**	0.066	0.199	0.894
Eigen-value	5.488	5.041	3.951	3.510	2.774	2.689	–
% Var.	20.325	18.670	14.643	13.000	10.274	9.960	–

The measure was confirmed using confirmatory factor analysis (CFA), in particular, by assessing model fit, reliability of the constructs and convergent and discriminant validity of the constructs (Table 2). The examination of the t-value associated with each loading indicated that

the loadings exceeded the critical value of 2.576 (p=0.01) for each item. The fit indices for the total measurement model revealed acceptable values. The χ^2/df ratio (χ^2=649.527; df=309; p<0.001) was greater than the suggested threshold (<3:0). The standard root mean square residual (SRMR=0.044) was lower than the suggested threshold (<0.06). Other indices, such as the comparative fit index (CFI=0.947) and the Tucker-Lewis index (TLI=0.940), were greater than the recommended 0.90 threshold (Hair *et al*., 1998).

Table 2. **CONFIRMATORY FACTOR ANALYSIS OF UD PERCEPTIONS**

Item	λ_x	R^2
Equitability (0.891[a] /0.975[b])		
Facilities support equal use to anyone (senior, children, pregnant women, and disabled)	0.912	0.833
I have felt discrimination when using the facilities	0.936	0.877
I have felt incongruity when using the facilities	0.848	0.773
Usability (0.935[a] /0.973[b])		
Exercise equipment provides efficient functions	0.879	0.740
Exercise equipment is provided to cater to various groups of people	0.882	0.779
Exercise programs are targeted towards various groups of people	0.828	0.685
Efficient functions with no discomfort elements when used	0.859	0.738
Spacious exercise areas are provided	0.838	0.702
Convenience (0.975[a] /0.931[b])		
It is hard to use the facilities	0.918	0.844
It is easy to use the facilities	0.930	0.866
Directions and information on equipment and facilities can be easily understood	0.934	0.872
Entrances to the facilities are not convenient	0.918	0.842
It is easy to move with enough space between areas such as lobby, rest rooms, and locker rooms	0.943	0.890
Facilitated transportation and parking facilities are available	0.940	0.885
Aesthetics (0.927[a] /0.948[b])		
It is aesthetically beautiful	0.915	0.837
It is in harmony with the surroundings	0.935	0.874
It provides an attractive beauty	0.848	0.718
Safety (0.972[a] /0.923[b])		
Safety measures are well implemented	0.934	0.873
There are dangerous elements in place within the facilities	0.932	0.869
Safe access and use is available	0.940	0.884
There is a possibility of accidents	0.910	0.829
Materials used in the facilities are eco-friendly	0.919	0.844
The facilities are eco-friendly concerning energy consumption	0.916	0.839
Pleasantness (0.947[a] /0.881[b])		
The lightings and temperature of the facilities are agreeable	0.933	0.870
Auxiliary facilities such as rest rooms and locker rooms are agreeable	0.937	0.878
The facility foster mental stability	0.856	0.733
The overall colours of the facilities are pleasant	0.889	0.791

[a] Composite reliability/ [b] Cronbach's α

For examining the internal consistency, the composite reliability was assessed where the value exceeded the recommended level of 0.70 (Bagozzi, 1993). The average variance extracted (AVE) estimate was also examined, which assesses the amount of variance captured by a construct's measure relative to the measurement error and the correlation (Φ estimates) among the latent constructs in the model. As shown in Table 3, all the values exceeded the recommended level of 0.50, providing strong evidence of convergent validity. To test discriminant validity, the inter-correlations among the latent constructs was explored. Evidence of discriminant validity comes from the fact that the square of the parameter estimates between two constructs (Φ^2) is less than the AVE estimates of the two constructs (Table 3). This criterion was met across all possible pairs of constructs.

***Table 3*. MEANS, STANDARD DEVIATIONS AND INTER-CORRELATIONS**

Item	M±SD	1	2	3	4	5	6
1. Equitability	4.788±1.256		–	–	–	–	–
2. Usability	3.855±1.141	0.380		–	–	–	–
3. Convenience	4.113±1.338	0.502	0.551		–	–	–
4. Aesthetics	5.349±1.008	0.377	0.483	0.397		–	–
5. Safety	4.121±1.369	0.451	0.702	0.613	0.435		–
6. Pleasantness	4.256±1.361	0.499	0.584	0.414	0.366	0.612	1.000
	AVE:	0.727	0.743	0.767	0.809	0.856	0.817

M=Mean SD=Standard deviation AVE=Average Variance

DISCUSSION

A total of 27 evaluation items in 6 categories (equitability, usability, convenience, aesthetics, safety, and pleasantness) were developed to evaluate UD from user perspectives in sport facilities. The description of each category is as follows: *Equitability* implies the level of satisfaction that the user feels, that is, he/she has not been discriminated against when using sport facilities. It expresses the level of individual perception that the facilities can be used by anyone, regardless of physical or psychological difference. This concept closely reflects the core social value of UD, which is unbiased and of equal use and participation. It should be noted, however, that equitability does not necessarily mean equality in an absolute sense; although UD promotes equality, absolute equality is, in practice, unattainable (Steinfeld & Maisel, 2012).

Equalisation accommodates varied requirements, at the same time, it limits flexibility to conflicting requirements, which may explain the recent trend of 'as much as possible and to the greatest extent possible'. Equitability, in this study, is measured in terms of all the users of the facilities, and not by the individual views on equitability. In comparison with the designer-centred principles, equitability has adopted a few ideas from the concept of equitable use put forth by Mace (1985), and reflects the concept of selectivity of the Gyeonggi Province (2011). On the other hand, there appears to be no relation between the seven principles of the Center for Universal Design and equitability in this study, because the Center for Universal Design

has developed unduly designer-focused guidelines, potentially excluding, in effect, equitability for users.

Usability evaluates the functional aspects of sport facilities, more specifically, the functional appropriateness of physical activity programmes, equipment and spaces. Adopting the idea of the supportive design laid out by Mace (1985), the concept of usability in this study represents user-perceived usefulness of sport facilities. Convenience evaluates the ease of using sport facilities, demonstrating the level of facility accessibility perceived by users. This concept resembles accessibility of Mace (1985) and the low physical effort, size, and space for approach and use, the simple and intuitive principles of the Center for Universal Design (1997) and also reflects the concepts of clarity and comfort by Ostroff and Weisman (2004).

Aesthetics denote the beauty perceived by the users of sport facilities, both the interiors and exteriors and is a bridge linking the sensuous experience to the emotional. It complements the concept of aesthetics by the Gyeonggi Province (2011) and Kose (2004), which was not considered by the early UD principles (Mace, 1985). The concept of *safety* evaluates user perception of safety against accidents and risks while using sport facilities. It contains evaluation items of eco-friendliness in Gyeonggi Province (2011), such that user perception on eco-friendliness as part of safety measures could be evaluated. Lastly, the concept of *pleasantness* refers to mental stability experienced by the users. Safety and pleasantness resonate with the safe-oriented principle of Mace (1985), which is expressed in user cognition as two factors, namely mental (safety) and physical (pleasantness).

The above six evaluation categories were developed to evaluate sport facilities, as a whole, without distinguishing spaces and user sequences within the facilities. Hence, if one would like to consider subspaces and individual usage scenes of the facilities, subordinate evaluation items for each category have to be developed further.

CONCLUSIONS

There have been policy initiatives to apply UD to public facilities; however, they could be nascent and insufficient for sport facilities. Although various UD guidelines are in existence, very few and insubstantial guidelines are available specifically for sport facilities. Hence, it is necessary to develop not only UD guidelines for sport facilities, but also various evaluation tools for them.

This study aimed to identify UD principles that could be reflected on sport facilities and to develop UD evaluation measures from user perspectives. A measure that consists of the six attributes (equitability, usability, convenience, aesthetics, safety and pleasantness) was developed to facilitate applicability to sport facilities. This research suggests that the measure developed in this study demonstrates acceptable levels of both reliability and validity.

This study offers both theoretical and practical implications to the reader. With regard to the theoretical contribution, this study developed a measure assessing user perceptions of universal design in sport facilities, which have not been studied before. The UD principles identified in this study are the result of transforming designer-centred UD principles to user-centred. Each

principle effectively reflects the values promoted in UD, however, the content is different from the subordinate content of the designer-centred principles, as well as the different conceptual scopes. This demonstrates that evaluation measure for user-centred UD can be different from those for designer-centred UD.

The results of this study also offer managerial implications. In a situation where few measures and guidelines are available specifically for sport facilities, improper guidelines may lead to the kind of UD that might not be suitable for a group with diverse user requirements of sport facilities. Therefore, the UD measure developed in this study can be used to evaluate the effectiveness of sport facilities. In addition, the measure can be a potential aid in strategic decision support for managers, as it can reveal UD principles imperceptible to the users.

Although this research provides evidence supporting the validity of the new instrument, there are some limitations that warrant mention. This study has not addressed other types of sport facilities other than the public facilities. Furthermore, it has focused on the UD perception of users, on the whole, of the facilities, rather than considering the facilities in their subordinate space and usage, which may require more detailed and diverse guidelines enabling the efficient application of UD. A future study that identifies potential differences in user perception of UD according to varying user groups, such as pregnant women, seniors, multi-ethnic families and the disabled is also envisioned.

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REFERENCES

BAGOZZI, R.P. (1993). An examination of the psychometric properties of measures of negative affect in the PANAS-X Scales. *Journal of Personality and Social Psychology*, 65(4): 836-851.

BJÖRK, E. (2014). A Nordic charter for universal design. *Scandinavian Journal of Public Health*, 42(1): 1-6.

CASSIM, J.; COLEMAN, R.; CLARKSON, P.J. & DONG, H. (2007). Why inclusive design? In R. Coleman, J. Clarkson, H. Dong & J. Cassim (Eds.), *Design for inclusivity*. Aldershot, UK: Gower Publishing.

CAVNAR, M.M.; KIRTLAND, K.A.; EVANS, M.H.; WILSON, D.K.; WILLIAMS, J.E.; MIXON, G.M. & HENDERSON, K.A. (2004). Evaluating the quality of recreation facilities: Development of an assessment tool. *Journal of Park and Recreation Administration*, 22(1): 96-114.

CENTER FOR UNIVERSAL DESIGN (1997). *The principles of universal design, Version 2.0*. Raleigh, NC: North Carolina State University.

CENTRE FOR EXCELLENCE IN UNIVERSAL DESIGN (2012). *Building for everyone*. Dublin, Ireland: National Disability Authority.

DEPOY, E. & GILSON, S. (2013). Disability design and branding: Rethinking disability for the 21st century. In L. Davis (Eds.), *The disability studies reader* (pp. 477-488). New York, NY: Routledge.

EDYBURN, D.L. (2010). Would you recognize universal design for learning if you saw it? Ten propositions for new directions for the second decade of UDL. *Learning Disability Quarterly*, 33(1): 33-41.

FELDERER, B.; HELMENSTEIN, C.; KLEISSNER, A.; MOSER, B.; SCHINDLER, J. & TREILER, R. (2006). *Sport und Ökonomie in Europa: Ein Tour d'Horizon*. (*trans*.: Sport and economy in Europe: A tour of the horizon). Vienna, Austria: SportsEconAustria.

GIBSON, B.E. (2014). Parallels and problems of normalization in rehabilitation and universal design: Enabling connectivities. *Disability and Rehabilitation*, 36(16): 1328-1333.

GINNERUP, S. (2009). *Achieving full participation through universal design*. Strasbourg, France: Council of Europe Publishing.

GYEONGGI PROVINCE (2011). *Gyeonggi-do universal design guideline*. Gyeonggi Province: Republic of Korea.

HAIR, J.F.; BLACK, W.C.; BABIN, B.J. & ANDERSON, R.E. (2014). *Multivariate data analysis* (7th ed.). Harlow, Essex, UK: Pearson Education Limited.

HEINEMANN, K. (2003). *Sport and welfare policies: Six European case studies*. Schorndorf, Germany: Verlag Karl Hofmann GmbH & Co.

HUTTON, J. & RICHARDSON, L. (1995). Healthscapes: The roles of the facility and physical environment on consumer attitudes, satisfaction, quality assessments, and behaviors. *Health Care Management Review*, 20(2): 48-61.

JONES, P. (2014). Situation universal design architecture: designing with whom. *Disability & Rehabilitation*, 36(16): 1369-1374.

KETTERLIN-GELLER, L.R. (2005). Knowing what all students know: Procedures for developing universal design for assessment. Journal of Technology. *Learning, and Assessment*, 4(2): 1-23.

KOSE, S. (2004). Principles of Universal Design revisited. Pre-conference event at "Designing for the 21st Century III", Rio de Janeiro, Brazil. December 8.

KOREA MINISTRY OF CULTURE, SPORTS AND TOURISM (2010). *2009 Sport White Paper*. Seoul, Korea: Ministry of Culture, Sports and Tourism.

KOREA MINISTRY OF CULTURE, SPORTS AND TOURISM (2013). *2012 Sport White Paper*. Seoul, Korea: Ministry of Culture, Sports and Tourism.

KRISTIANSEN, K.; VEHMAS, S. & SHAKESPEARE, T. (2009). *Arguing about disability: Philosophical perspectives*. London, UK: Routledge.

LEE, Y.; AHN, C. & LEE, D. (2012). Aging-friendly outdoor exercise environmental design guideline with universal design. *Journal of the Korea Institute of Ecological Architecture and Environment*, 12(4): 47-57.

LID, I.M. (2013). Developing the theoretical content in universal design. *Scandinavian Journal of Disability Research*, 15(3): 203-215.

LID, I.M. (2014). Universal design and disability: An interdisciplinary perspective. *Disability and Rehabilitation*, 36(16): 1344-1349.

MACE, R.L. (1985). Universal design, barrier free environments for everyone. *Designers West*, 33(1): 147-152.

MACINTOSH, E. & DOHERTY, A. (2007). Reframing the service environment in the fitness industry. *Managing Leisure*, 12(4): 273-289.

NCODH (North Carolina Office on Disability and Health) (2008). *Removing barriers to health clubs and fitness facilities*. Chapel Hill, NC: FPG Child Development Institute.

NULL, R. (2014). *Universal design: Principles and models*. Boca Raton, FL: CRC Press.

ORMEROD, M.G. & NEWTON, R.A. (2005). Moving beyond accessibility: The principles of Universal (inclusive) Design as a dimension in nD modelling of the built environment, *Architectural Engineering and Design Management*, 1(2): 103-110.

OSTROFF, E. & WEISMAN, L. K. (2004). Universal Design principles revisited. A preconference workshop at "Designing for the 21st Century III", Institute for Human Centered Design. Rio de Janeiro, Brazil, December 7-12.

PASSINI, R. (1996). Way finding design: Logic, application and some thoughts on universality. *Design Studies*, 17(3): 319-331.

PRATT, M.; MACERA, C.A. & WANG, G. (2000). Higher direct medical costs associated with physical inactivity. *The Physician and Sportsmedicine,* 28(10): 63-70.

PREISER, W.F.E. & OSTROFF, E. (2001). *Universal design handbook*. New York, NY: McGraw-Hill.

RESCH, K. & LANG, G. (2007). *Overview on health promotion for older people in Austria*. Vienna, Austria: Research Institute of the Viennese Red Cross.

SANFORD, J.A. (2010). Assessing universal design in the physical environment. In T. Oakland & E. Mpofu (Eds.), *Rehabilitation and health assessment*, (pp. 255-278). New York, NY: Springer.

SCULLY, J.L. (2008). *Disability bioethics: Moral bodies, moral difference*. Landham, MD: Rowman & Littlefield.

SHEA, E.C.O.; PAVIA, S.; DYER, M.; CRADDOCK, G. & MURPHY, N. (2016). Measuring the design of empathetic buildings: A review of universal design evaluation methods. *Disability and Rehabilitation, Assistive Technology,* 11(1): 13-21.

SMALA, A.; BEELER, I. & SZUCS, T.D. (2001). "Die Kosten der körperlichen Inaktivität in der Schweiz" (*trans*.: Costs of physical inactivity in Switzerland). Hyperlink: [https://www.zora.uzh.ch/ 33375/1/Smala_et_al_Bericht_Volkswirtschaft.pdf]. Retrieved on 20 September 2016.

STEINFELD, E. & MAISEL, J. (2012). *Universal Design: Creating inclusive environments*. Hoboken, NJ: John Wiley & Sons.

STORY, M.F. (2006). Applying the principles of universal design to medical devices. In J.M. Winter & M.F. Story (Eds.), *Medical instrumentation: Accessibility and usability consideration* (pp. 83-92). Boca Raton, FL: CRC Press.

STORY, M.F.; MUELLER, J.L. & MACE, R.L. (1998). *The universal design file: designing for people of all ages and abilities*. Raleigh, NC: The Center for Universal Design North Carolina State University.

THOMAS, C. (2004). Rescuing a social relational understanding of disability. *Scandinavian Journal of Disability Research,* 6(1): 22-36.

UK DEPARTMENT FOR CULTURE, MEDIA AND SPORT (2002). "Game plan: A strategy for delivering the government's sport and physical activity objectives". Hyperlink: [http://www.games monitor.org.uk/ files/game_plan_report.pdf]. Retrieved on 5 September 2016.

UNITED NATIONS (2008). *Convention on the rights of persons with disabilities*. New York, NY: United Nations.

WAKEFIELD, K.L.; BLODGETT, J.G. & SLOAN, H.J. (1996). Measurement and management of Sportscape. *Journal of Sport Management,* 10(1): 15-31.

WHO (World Health Organization) (2001). *ICF: International classification of functioning, disability and health.* Geneva, Switzerland: WHO Library Cataloguing-in-Publication Data.

WINANCE, M. (2014). Universal design and the challenge of diversity: Reflections on the principles of UD, based on empirical research of people's mobility. *Disability and Rehabilitation*, 36(16): 1334-1343.

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