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Accessibility of transfer centers with different transportation modes for disabled individuals

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Abstract
Urban mobility of disabled people has crucial importance for integrated society. Disabled people have barriers in built environment. Thus, they cannot access urban spaces easily. Urban spaces are crucial for participation to public life for all. Identifying the barriers of mobility of disabled people and developing suggestions to eliminate deficiencies are necessary. In this study, universal design and accessibility standards have been integrated to show mobility of disabled people in urban spaces. Analysing table has been developed by AHP method to calculate the accessibility of disabled people. In case study, five transfer centers of Istanbul, which are in historical and central business area, have been analyzed and their scores have been calculated. By the analysis, current situation have been showed up and implementations that need to be done have been identified. The findings are going to help to local authority for accessibility implementations.

Keywords
Accessibility, Disability, Disabled people, Universal design, Urban design.

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1. Introduction

Disability is an important phenomenon of the contemporary world. In the process of globalization, urbanization is accompanied by a rapid increase in socio-economic activities and a large increase in population. Medical developments have been effective in prolonging human life, and the disability that comes with age has also increased in parallel with the disabled population.

As stated in the United Nations' and World Health Organization's reports, 15% of the world's population is disabled. According to the results of 2002 Turkey Disability Survey conducted in cooperation with the Office of Disability Administration of Turkey and the State Institute of Statistics, the proportion of disabled population in Turkey is 12.29% (TUIK 2002). In this case, the population of disabled people in Turkey is approximately 9 million, in İstanbul is 460 thousand. In addition to this population, relatives also face difficulties in their daily lives due to barriers, which deprive the disabled people of living an independent life. According to the TUIK datas, for 2013, the household is 3,7 in Turkey. Thus, approximately 33 million people face with difficulties in urban life and they are prevented from connecting with urban life and areas due to the lack of accessibility for all in the country.

As it is stated in the Universal Declaration of Human Rights (United Nations General Assembly, 1948) every human being is equal in their respective rights to lead their lives as they see fit.

Freedom of mobility is every individual's right, regardless of people's social, economic and physical characteristics. Every individual should be able to use services on equal conditions in the city.

Public spaces are the most important elements of the city, where individuals come together to develop urban culture and engage in social interaction (Madanipour 1996). Public spaces that have great importance for integration of the society, public transportation and walking areas must be accessible for all.

In literary studies, the accessibility of urban areas and universal design have been two major topics. Yet, there is no evident study that correlates the two concepts of universal design principles and the accessibility of urban areas for disabled people. In this study, the concept of universal design and the criteria of accessibility have been anticipated to provide an independent life for all.

The aim of this study is to create a new concept on the integration of universal design principles and the criteria of accessibility for disabled people in urban areas. Therewith this new composition would be included to the disability research literature. Furthermore, in this study a new matrix to calculate the accessibility score of transfer centers has been developed.

The transfer centers of Istanbul and their relation to the public transportation have been examined in the direction of universal design principles and accessibility criteria. Assessment of accessibility of 5 transfer centers in Istanbul has been made by scores, which have been given by 10 disabled citizens of Istanbul, 4 of them are wheelchair users and orthopedicly disabled, 5 of them are visually impaired and 1 of them is hearing impaired. The accessibility scores of 5 transfer centers have been compared and their positive and negative qualities for accessibility has been exhibited.

At the end of the study, to ensure full accessibility for all, urban design criteria have been determined. The use of the matrix, which has been prepared in the context of the study in urban design implementations by local governments is thought to be useful for the disabled to be active in urban areas.

The principles of universal design are going to be at the core of the study that revolve-around seven principles, which envisage the importance of accessibility. The selected urban design elements, which have been inquired by 10 disabled citizens using the AHP method and have been calculated accordingly.

2. Literature review

This section includes a literature research of the concept of universal design and accessibility that are the base of the study.

2.1. Accessibility of disabled people in urban areas

In 2005, Independent Living Institute stated that: "Independent living is a philosophy, a way of looking at disability and society, and a worldwide movement of disabled people who work for self-determination, self-respect and equal opportunities". According to the philosophy, the city can be described as a socio-physical space, in which individuals feel themselves as a member of the society they live in, since it is continuously renewed and productive.

In the foreword of Jan Gehl's book "Cities For People" (2010), Richard Rogers describes one's right of accessibility in urban areas as follows: 'Cities can be read as the books. The streets, the squares and the parks are the grammar of the city. These are structures that allow the city to have many activities in the city from quiet activities to loud and crowded activities. Everyone has the right to access open spaces just as they have the right to access clean water' (Gehl 2010). Disabled people have stated that they are facing many architectural barriers. Due to those barriers, the disabled one is hindered from transportation, urban areas and possible employment.(Berube 1981).

The right to the city, which is Lefebvre's concept, indicates that every citizen may assert his/her own rights on the city they live in (Lefebvre, 1968). In this sense, the right of every citizen is to take place in the city and to use the city as an active member. The right to the city is an opportunity to eliminate inequalities in social life and to use the urban areas. In this respect, in the paper, urban design principles, which enable the right to the city, have been predicted that will provide accessibility for all. In this respect, recently, accessibility criteria should be applied in urban design with taking the relation and interaction between citizens and urban areas into consideration.

Accessibility is a way to access housing, shopping, theater, parks and workplaces (CEAPAT 1996). Various projects are being carried out to alter the residential areas, public open spaces, educational areas, hospitals and transportation vehicles to include the disabled (NJSCC 2007; Gilman 2007; Igri, 2004). The way of creating the accessible urban areas is to take all possible users, including children, elderly people, adults and disabled into account. Accessible spaces can be defined as spaces without any architectural barriers. These spaces have the design or building features that provide accessibilty and promote mobility for all (Alonso 2002).

An accessible design in urban areas allows disabled people to demonstrate their capabilities to play a vital role in the community. Many wheelchair users, visually impaired and hearing impaired individuals are involved in the public transportation system as key subjects of restricted mobility. Creating accessible urban areas and public transportation is crucial for independent urban mobility of disabled people.

Accessible public transportation plays an enormous role in creating an inclusive society. Accessing the public transportation varies greatly around the world. Western Europe has some good examples of accessible public transportation, but serious issues remain untouched in some regions, particularly in Eastern Europe (International Disability Rights Monitor 2007; Steinfeld and Maisel 2012).

During the past 15 years, researchers have adopted social ecological models to explain physical activity, which emphasize the importance of the built environment (Mcleroy et al. 1988; Sallis et al. 2006; Holle et al. 2014). Walkability reflects the built environments' convenience for primarily transportation walking (Holle et al. 2014). While there is some new evidence that supportive attributes of communities' physical environment can be associated with being more active (Ball et.al. 2001, Frank and Engelke 2001; Leslie et al. 2006). To clarify how built environment factors can infulence participation in physical activity, there is a need to identify and to document objectively, specific attributes of the communities' environment that may be influential (Sallis et al.1998; Sallis and Owen 2002, Leslie et al. 2006).

Increasing accessibility both on public transportation and in walkability is vital to ensure full accessibility for disabled people in urban areas. For this

reason, the matrix that has been prepared, includes the urban design criteria, which are necessary to ensure full accessibility in public transportation and in walkability.

2.2. Universal design in urban areas

The concept of universal design arose from the disability rights movement, which began in the 1960s (Center, 2000). The concept of universal design aims to bring the disabled into the society by ensuring equal opportunity for all and eliminating discrimination based on disability (Steinfeld and Maisel 2012). The concept of universal design aims to create an environment, in which all users may realize all kinds of urban experiences by ensuring that every individual living in the city has access to all the urban areas with equal opportunities. Universal design is the art and practice of design to accommodate the widest variety and number of people throughout their life spans (Salmen 2011). In 1985, Ronald Mace defined universal design as; "The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (Mace, 1985). The principle is to ensure that the environment and products are used without any other customization without regard to age, gender, ability and competence (Mace, 1991).

Universal design increases the potential for developing a better quality of life for a wide range of individuals (Russell 1999; Stineman et al. 2003; Steinfeld and Maisel 2012). It provides benefits not only to people with functional limitations but also to society as a whole (Danford and Maurer 2005; Steinfeld and Maisel 2012). Universal design supports people in being more self-reliant and socially engaged. It helps change social stereotypes of disability and aging. Steinfeld and Maisel define that universal design is a process that enables and empowers a diverse population by improving human performance, health and wellness, and social participation. Universal design makes life easier, healthier, and friendlier. This process involves continuous improvement, based on the resources available, toward the ultimate goal of full inclusion (Steinfeld and Maisel 2012).

Universal design includes principles that prevent the differentiation of disabilities. The concept that the World Health Organization supports and adopts takes every individual into account within the design regardless of its physical, social, economic characteristics. Universal design principles are aesthetic and functional solutions that are made without hinging not only upon the needs of specific individuals ,but as constructions that serve the public as a collective presence.

A similar concept to the universal design is 'design for all'. The term specifically is used in Europe (Steinfeld and Maisel 2012). In 2008, Design for All Foundation defined the term as design for human diversity, social inclusion, and equality (Design for All Europe, 2008). Design for All Foundation defines it as the "intervention on environments, products, and services with the aim that everyone, including future generations, regardless of age, gender, capabilities, or cultural background, can enjoy participating in the construction of our society, with equal opportunities participating in economic, social, cultural, recreational, and entertainment activities while also being able to access, use, and understand whatever part of the environment with as much independence as possible" (Design for All Foundation, 2015). Another similar concept is inclusive design. It is used particularly in the United Kingdom. In 2005, British Standards Institute defined the term as "the design of mainstream products and/or services that is accessible to, and usable by, as many people as reasonably possible . . . without the need for special adaptation or specialized design" (British Standards Institute, 2005).

The Center for Universal Design conducted a research and demonstration project from 1994 to 1997, which was titled Studies to Further the Development of Universal Design, funded by the U.S. Department of Education's National Institute on Disability and Rehabilitation Research (NIDRR). In this project, a set of universal design guidelines were developed.

The main objectives of the universal design concept are to improve the quality of life and to design environmentally and human-made systems to the specifications such as the user's measurements, capabilities and constraints (Kroemer et al. 2001). The user-centered approach focuses on human diversity and is at the center of human factors and ergonomics discipline (Looze and Pikaar 2006).

The principles of universal design aim to ensure that every citizen in the city enjoys equal access to all kinds of urban services. Universal design principles are found in a wide range of product scale to urban scale. Basic universal design principles applied to all design disciplines, including those that focused on built environments, products, and communications (Story et al. 1998; Center for Universal Design 2000a; Mueller 1997; Story 2011).

In this study, the principles of the concept are explained in relation to the urban areas. Within the philosophy of universal design, seven principles have been identified as: equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, size and space for approach and use as seen in Table 1. With these principles, the concept of universal design is more comprehensive than the concept of accessible design and barrier-free design. Universal design practices in urban areas make cities flexible and usable to provide utility for all types of urban users regardless of age, gender, proficiency and status. These solutions are required for the disabled as city users to live without encountering any barriers.

One of the principles of universal design is "equitable use" which indicates each individual can use and access the urban areas with equal opportunities. A following principle is "flexibility in use" that is the design of urban areas and the use of transfer centers that are used to access urban areas, which are suitable for every individual with flexible designs. "Simple and intuitive use" is another principle, which means that every individual of the urban area is perceptible with simple stimuli and intuition regardless of their sufficiency status. The following principle is titled "perceptible information". This principle indicates that the stimuli and directions in the urban areas are organized in such a way that each individual can perceive, regardless of their limitations of perception. Another principle that universal design is based upon is named "tolerance for error". It hinges upon the neccessity to take measures to reduce any risk of accidents that can occur in the urban areas. A following principle named "low physical effort" refers to the arrangement to minimize the use of physical force in mobility within the urban area. The last of these principles is named "size and space for approach and use". This principle points out that the urban areas need to be organized in appropriate dimensions to provide an easy use for each individual in the urban areas. The integration of universal design principles and accessibility criteria will make urban mobility possible for every individual.

Designing for the disabled is about making buildings and urban areas accessible and usable by people with disabilities. Universal design is about making urban areas safe and convenient for all their users, including disabled people. Furthermore, it means that the products, where the designs are universaly accommodating, that they cater conveniently for all their users. (Goldsmith 2000). To eliminate the marginalization of disabled people, accessibility criteria and universal design concepts should be used together to create accessible urban areas.

2.3. Integration of accessibility and universal design in urban areas

Planning and constructing accessible urban areas have been the most ignored subjects for centuries. After the World War II, the disabled rights movement turned up claiming right on equal participitation on life all over the globe (Flesicher, 2001). Even though, most of the European countries have released technical accessibility standards and accordingly established anti-discriminination acts. Following these accomplishments, the awareness about accessibility has become an important topic. Unfortunately anthipathy and ignorance of the disabled in the community is still a wide spread attitude (Krpata 2012).

Table 1. *The principles of universal design (Connell et al. 1997).*

Principle 1: Equitable Use The design is useful to people with diverse abilities. Guidelines: • Provide the same means of use for all user: identical whenever possible: equivalent when not • Avoid segregating or stigmatizing any users • Make provisions for privacy, security and safety equally available to all users • Make the design appealing to all users
Principle 2: Flexibility in Use The design accommodates a wide range of individual preferences and abilities. Guidelines: • Provide choice in methods of use • Accommodate right or left handed Access and use • Facilitate the users' accuracy and precision • Privde adaptibility to the users' pace
Principle 3: Simple and Intuitive Use Use of the design is easy to understand, regardless of the users' experience, knowledge, language skills or current concentration level Guidelines: • Eliminate unnecessary complexity • Be consistent with user expectations an intuition • Accommodate a wide range of literacy and klanguage skills • Arrange information consistent with its importance • Provide effective prompting and feedback during and after task completion
Principle 4: Perceptible Information The design communicates necessary information effectively tothe user, regardless of ambient conditions or the users' sensory abilities. Guidelines: • Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information • Maximize legibility of essential information • Differantiate elements in ways that can be described (make it easy to give instructions or directions) • Provide compatibility with a variety of techniques or devices used by people with sensory limitations
Principle 5: Tolerance for Error The design minimizes hazards and the adverse consequences of accidential or unintended actions. Guidelines: • Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated or shielded • Provide warnings of hazards and errors • Provide fail-safe features • Discourage unconscious action in tasks that require vigilance
Principle 6: Low Physical Effort The design can be used efficiently and comfortably and with a minimum of fatigue. Guidelines: • Allow user to maintain a neutral body position • Use reasonable operating forces • Minimize repetitive action • Minimize sustained physical effort
Principle 7: Size and Space for Approach and Use Appropriate size and space is provided for approach, reach, manipulation and use regardless of user's body size, posture or mobility. Guidelines: • Provide a clear line of sight to important elements for any seated or standing user • Make reach to all components comfortable for any seated or standing user • Accommodate variations in hand and grip size • Provide adequate space fort he use of assistive devices or personal assistance

Since the last quarter of the 20th century, a great deal of efforts have been devoted to create accessible built environment (Steinfeld and Maisel 2012). In 1990, The Americans with Disabilities Act (ADA) draw great attention to the concept of accessibility and awareness on disability. Many different studies and legal regulations have been conducted on disability in several countries such as; the United Kingdom, Canada, Australia and New Zealand (Gleeson 1997). Turkey also enacted a law named the Disabilities Act in 2005 and is mandated to provide accessibility in public spaces. Nevertheless, it seems that accessibility is not fully achieved in practice in the country. In all these legal arrangements, accessibility is emphasized, but no emphasis is placed on the concept of universal design.

There is a difference between universal design and accessibility. Accessibility is a function of compliance with regulations or criteria that establish minimum level of a design that is necessary to accommodate the disabled. The concept of universal design has many different dimensions and it emphasizes appropriate design for all people.

Universal design and accessibility must not be considered separately from each other. The universal design and accessibility criteria need to be implemented in order to ensure that urban areas, structures, urban furnishings and all kinds of products needed in the city are used by everyone on equal conditions. The most important urban open space elements that connect the urban areas and provide mobility to the urban user are the streets. The arrangements to be made for this reason must start from the streets. In urban open spaces, signboards, urban furnitures, roads, ramps on the pavements, pedestrian crossings, all kinds of urban users should be considered and the new developments have to meet those users' needs.

Urban areas influence the individual's participation in urban life. The relationship between the urban environment, the individual and society is a complex and comprehensive relationship. Universal design principles and accessibility criteria are both crucial to ensure the continuity of these relationships. While integration of universal design and accessibility can be defined as communication process on the basis of functionality between user and environment, it can be defined as a means of strengthening the links between the environment, the individual and the community, and the urban physically.

The integration of the concept of accessibility needs to be applied in practice in the seven principles of universal design in order to ensure the mobility of each individual within the city in all urban areas. The citizen whose needs cannot be met, consequently cannot feel him/herself as a part of the particular community, thus the city. Urban areas can be seen as the most important areas that meet the social needs of urban users, are streets, parks, roads, schools, hospitals, shopping centers and entertainment areas. These areas are where the people can be an active member of the city. For this reason, while designing the urban areas one should consider all its users' needs.

With the increase in accessibility and the emphasis on design for all, more and more experimental and observational researches have been conducted. Thus, creating more accessible urban areas for all types of users and practical solutions within the community have been established. Various experts such as; urban planners, architects, sociologists and politicians are involved in this process, while solutions are being sought to ensure that the city is used by all types of urban users. In order to find and implement effective solutions, these actors should have knowledge in theory and practice about the relationship between human and environment. Actors should create a language among themselves when applying solutions they find. Today, unconsciousness, ignorance, inconsistency, lack of communication between actors and contradictions cause the city not to be used equally by citizens.

3. Methodology and research area

In this study, the Analytical Hierarchy Process (AHP) method, which is a multi-criterion decision making method, has been used.

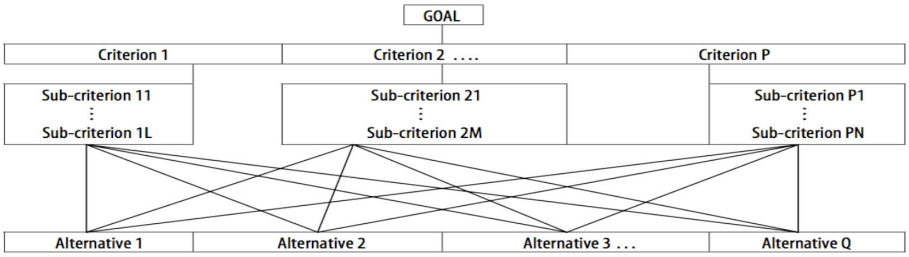

Figure 1. *Generic hierarchic structure (Bhushan and Rai, 2004).*

The AHP method, is developed by Thomas L. Saaty based on the experience gained by him, while directing projects in the US Arms Control and Disarmament Agency. The AHP method was developed as a reaction to enable the taking of complex decisions. The AHP method has been used in social studies as a qualitative analysis technique. The AHP method's universal adoption is a new paradigm for decision-making process with its ease of implementation. In the method, the subjective evaluations are converted into numerical values and processed to rank each alternative on a numerical scale (Bhushan and Rai 2004).

In the study an accessibility matrix has been designed to assess the accessibility of disabled people in transfer centers by AHP method. In the matrix, universal design principles, which are identified in 1997 by the University of North Carolina's Universal Design Center, became the main criteria. These criteria are equitable use, flexibility in use, simple and intiutive use, perceptible information, tolerance for error, low physical effort, size and space for approach and use. The sub-criteria of each main criteria are determined by considering the accessibility criteria of disabled people, that have been found in the literature researches and the needs of the disabled in the urban areas.

4. Determination of the urban design criteria, which are important in accessibility for disabled people, case study: 5 major transfer centers

Istanbul is the largest city in Turkey. Istanbul developed a multi-centric metropolitan or megalopolitan character. Accessibility scores of five major transfer centers of Istanbul have been calculated by the matrix. These centers are Taksim, Kadıköy, Mecidiyeköy, Eminönü and Beşiktaş.

İstanbul was a vigorous core-dominated metropolis until well into the 1950s, with a very limited suburban development in the periphery. In the 1960s, the majority of jobs were in the core of the city. Because of this, in the historic centre Eminönü prouded transportation system initially by boats, cars, metro and buses. In the 1970s, new spatial structure was emerging decentralized in relation to the central business district (CBD). Istanbul is an old city whose long history has produced an interesting spatial development. (Dökmeci & Berköz, 1994).

The reason for the selection of these centers is that they are located in the Central Business District (CBD) of Istanbul and they are transfer centers for public transportation for individuals, who come from every corner of the city. Taksim, Mecidiyeköy and Kadıköy have become new centers in CBD of Istanbul in 1960s. Eminönü is located in historical center and transfer center. Mecidiyeköy and Besiktas are located on the axis of the linear central business area that have gained importance in the 1970s (Dökmeci & Berköz, 1994).

Main criteria and sub-criteria are seen in Figure 1, in which AHP method has been used. The aim of the study is to calculate universal design and accessibility scores of five transfer centers of Istanbul.

After the determination of the criteria, weights of criteria have been given by 10 disabled people, with whom the interviews have been conducted (Table 2). Weights of criteria indicate the relationships between all the criteria. The hierarchic structure in the pairwise comparison of criteria on a qualitative scale. 1 means equal level between two criteria, 3 means one of criteria is marginally stronger than the other criterion, 5 means one of criteria is stronger than the other criterion, 7 means one

Table 2. *AHP method with weighted percentages of all sub-criteria and main criteria.*

UNIVERSAL DESIGN AND ACCESSIBILITY OF TRANSFER CENTER SCORE ANALYSIS	MAIN CRITERION	SUB CRITERION	WEIGHTS	SCORE	WEIGHTED SCORE	WEIGHTED CORE TOTAL IN SUB CRITERIA	WEIGHTED SCORE TOTAL IN MAIN CRITERION
	EQUITABLE USE %45	Completely double sided pavement	10%				
		Ramps on pedestrian paths	50%				
		Stops do not interfere with the width of the paths	21%				
		Traffic light durations are sufficient for disabled pass-through	11%				
		The height of the railings of stairs and ramps are formed at 2 different levels (60 cm and 90 cm)	4%				
		Well-maintained urban furniture	4%				
	FLEXIBILITY IN USE %3	Foldable seats at the stops	3%				
		Stops are located at the same level with vehicle	45%				
		Public toilets are suitable for disabled people	28%				
		There is urban furniture for protection from climatic conditions	8%				
		Stops' sizes are sufficient for a wheelchair	16%				
	SIMPLE AND INTUITIVE USE %12	Information signs and warnings in different colours and sizes	4%				
		Beginning and ending of pedestrian paths with different textures and colours	16%				
		The warning signs on pedestrian crossings are indicated by light and phosphorous colours	4%				
		Expressing colours and materials are used for pedestrian crossings	4%				
		Staircase and ramp edges are highlighted with contrasting colours	8%				
		Tactile surfaces along the pedestrian axis and at the pedestrian crossing points	16%				
		Continuity of connections between pedestrian paths	48%				
	PERCEPTIBLE INFORMATION %14	Audible warnings on pedestrian crossings	8%				
		Guiding & routing panels, which are prepared with large pinpoint letters and Braille	6%				
		Information and orientation panels which are prepared with Braille	6%				
		Indication of the surroundings of city furniture with remarkable colours and materials	6%				
		Visual and audio information boards in the pauses	8%				
		information and voice information in the directional panels in the square	8%				
		The height of the information and guidance panels is 120 cm for the wheelchair user to see	58%				
	TOLERANCE FOR ERROR %14	Using of non-slip material on the paths, ramps and stairs	32%				
		Appropriateness of laying of surface material	31%				
		Covers on the pedestrian path must be in max.1.25 cm level difference	10%				
		The pedestrian mast is free from obstructing city furniture	15%				
		Sudden constriction or extensions at the cross section of the paths	5%				
		Positioning of city furniture after 2 m height to prevent head injuries	5%				
		Night lighting is sufficient	2%				
	LOW PHYSICAL EFFORT %8	Pavement of material and texture do not force the movement	35%				
		Embossed material is not higher than 5 mm	14%				
		Suitable resting areas in certain periods (60-100m)	2%				
		Corresponding ramps on the opposite sidewalks	13%				
		Strong link between paths and public transit	9%				
		Providing the pedestrian crossings from the shortest spots	14%				
		The pedestrian surface material is well maintained	13%				
	SIZE AND SPACE FOR USE 4%	Paths' and ramps' width is at least 120 cm	30%				
		Maximum height of pavement is 15 cm	30%				
		Ramp gradient is max 5%	13%				
		Traffic signal buttons are positioned 120 cm high	7%				
		The vending machine buttons are positioned at a height of 120 cm	3%				
		Positioning of stimuli / markers at appropriate points to provide guidance	3%				
		Steps on boarding platform are in maximum	14%				
					WEIGHTED TOTAL		

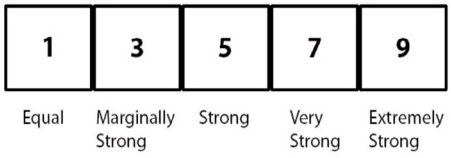

Figure 2. *Format for pairwise comparisons.*

of criteria is very stronger than the other criterion, 9 means one of criteria is extremely stronger than the other criterion (Figure 2).

Universal design principles, which are the main critera of the matrix, have been compared pairwise by the disabled people. For example, "equitable use" criterion outweighs "flexibility in use" criterion and "size and space for approach and use" outweighs "simple an intuitive use" and "perceptible information" and "tolerance for error", outweighs "low physical effort". By taking all the scores of the disabled

people into consideration, the mean of the pairwise compairsons have been calculated (Table 3). For sub-criteria hierarchic comparison has been done by the same way. The comparison has been done for each criterion. The relations between all the criteria have been calculated by this method.

All the hierarchic scores have been converted to percentages (Table 4 and Table 5). The same processes have been done for sub-criteria hierarchy. All the convertion of the AHP hierarchy scores have been applied for all criteria. The accessibility scores of the transfer centers are obtained as seen in Table 6.

The weighting of the main criteria and the sub-criteria are determined by taking the average of the weights, which have been given by the disabled people. All the sub-criteria of the matrix has been scored from 1 to 4 by the disabled people for five major transfer centers in Istanbul.

For the scaling of the sub-criteria the Likert scale has been used in the study. The Likert-type or frequency scales use fixed choice response formats and are designed to measure attitudes or opinions (Bowling, 1997; Burns, & Grove, 1997). The description of scaling in the Likert scale has been given as follows;

1: not absolutely appropriate
2: not appropriate
3: eligible
4: fully appropriate mean scores.

The averages of the given scores by participants for all the main and sub–criteria have been calculated then the final score table for each center has been obtained.

As a result of the tables, universal design and accessibility scores of Istanbul's five major transfer centers, have been calculated and compared with one-another.

In the comparison between the centers, the percentage of the scores obtained from each main criteria for each center have been calculated. Furthermore, the arithmetic averages of these percentages have been taken and the accessibility scores of 5 major transfer centers of Istanbul have been determined.

5. Findings

In the analysis, if all the criteria are met, a transfer center would score as 4. While, in a case where the transfer center would not meet any of the criteria it would score as 1. Depending on this resolution, Taksim has scored

Table 3. *Hierarchic comparison of main criteria.*

	EQUITAIBLE USE	FLEXIBLITY IN USE	SIMPLE AND INTUITIVE USE	PERCEPTIBLE INFORMATION	TOLERANCE FOR ERROR	LOW PHYSICAL EFFORT	SIZE AND SPACE FOR USE
EQUITABLE USE	1	9	5	5	5	7	9
FLEXIBLITY IN USE	1/9	1	1/5	1/5	1/5	1/3	1
SIMPLE AND INTUITIVE USE	1/5	5	1	1	1	3	1
PERCEPTIBLE INFORMATION	1/5	5	1	1	1	3	5
TOLERANCE FOR ERROR	1/5	5	1	1	1	3	5
LOW PHYSICAL EFFORT	1/7	3	1/3	1/3	1/3	1	7
SIZE AND SPACE FOR USE	1/9	1	1	1/5	1/5	1/7	1
Total	2	29	9,53	8,73	8,73	17,47	29

Table 4. *Convertion to percentage of hierarchic comparison of main criterion.*

	EQUITABLEUSE	%	FLEXIBLITY IN USE	%	SIMPLE AND INTUITIVE USE	%	PERCEPTIBLE INFORMATION	%	TOLERANCE FOR ERROR	%	LOW PHYSICAL EFFORT	%	SIZE AND SPACE FOR USE	%	Total	Mean
EQUITABLE USE	1	0,50	9	0,31	5	0,52	5	0,57	5	0,57	7	0,40	9	0,31	3,19	0,45
FLEXIBLITY IN USE	1/9	0,05	1	0,03	1/5	0,02	1/5	0,02	1/5	0,02	1/3	0,01	1	0,03	0,21	0,03
SIMPLE AND INTUITIVE USE	1/5	0,10	5	0,17	1	0,10	1	0,11	1	0,11	3	0,17	1	0,03	0,81	0,11
PERCEPTIBLE INFORMATION	1/5	0,10	5	0,17	1	0,10	1	0,11	1	0,11	3	0,17	5	0,17	0,95	0,13
TOLERANCE FOR ERROR	1/5	0,10	5	0,17	1	0,10	1	0,11	1	0,11	3	0,17	5	0,17	0,95	0,13
LOW PHYSICAL EFFORT	1/7	0,07	3	0,10	1/3	0,03	1/3	0,03	1/3	0,03	1	0,05	7	0,24	0,58	0,08
SIZE AND SPACE FOR USE	1/9	0,05	1	0,03	1	0,10	1/5	0,02	1/5	0,02	1/7	0,008	1	0,03	0,28	0,04
Total	2	1	29	1	9,53	1	8,73	1	8,73	1	17,47	1	29	1	7	1

Table 5. *Hierarchy of main criteria.*

EQUITABLE USE	45%
FLEXIBLITY IN USE	3%
SIMPLE AND INTUITIVE USE	12%
PERCEPTIBLE INFORMATION	14%
TOLERANCE FOR ERROR	14%
LOW PHYSICAL EFFORT	8%
SIZE AND SPACE FOR USE	4%
Total	100%

Table 6. *Five transfer centers' universal design score results.*

TRANSFER CENTER	UNIVERSAL DESING AND ACCESSIBILITY SCORES
TAKSİM	2,79
KADIKÖY	2,74
MECİDİYEKÖY	1,86
EMİNÖNÜ	1,81
BEŞİKTAŞ	1,28

Table 7. *Transfer center-based covarage ratios of universal design main criteria.*

UNIVERSAL DESIGN PRINCIPLE PERCENTAGES OF THE TRANSFER CENTERS	TAKSİM	KADIKÖY	BEŞİKTAŞ	EMİNÖNÜ	MECİDİYEKÖY	Average
EQUITABLE USE	87%	80%	58%	51%	50%	**65,20%**
FLEXIBILITY IN USE	41%	58%	45%	39%	29%	**42,40%**
SIMPLE AND INTUITIVE USE	49%	25%	38%	42%	39%	**38,60%**
PERCEPTIBLE INFORMATION	41%	45%	32%	29%	43%	**38,00%**
TOLERANCE FOR ERROR	52%	85%	48%	44%	53%	**56,40%**
LOW PHYSICAL EFFORT	58%	63%	43%	46%	50%	**52,00%**
SIZE AND SPACE FOR APPROACH AND USE	75%	69%	41%	41%	51%	**55,40%**

Table 8. *Distribution of 7 main criteria for all transfer centers.*

UNIVERSAL DESIGN PRINCIPLE PERCENTAGES OF THE TRANSFER CENTERS	TAKSİM	KADIKÖY	BEŞİKTAŞ	EMİNÖNÜ	MECİDİYEKÖY
EQUITABLE USE	53%	62%	43%	51%	48%
FLEXIBILITY IN USE	3%	2%	5%	3%	3%
SIMPLE AND INTUITIVE USE	4%	8%	9%	11%	13%
PERCEPTIBLE INFORMATION	11%	8%	11%	9%	12%
TOLERANCE FOR ERROR	17%	9%	19%	14%	13%
LOW PHYSICAL EFFORT	8%	7%	6%	8%	7%
SIZE AND SPACE FOR APPROACH AND USE	4%	4%	7%	4%	4%
TOTAL	100%	100%	100%	100%	100%

the highest accessibility score, which is 2.79, and Beşiktaş has scored the lowest accessibility score, which is 1.28. As a result, none of the five transfer centers are fully accessible for disabled people.

Renovation works that have been carried out in Mecidiyeköy and Eminönü. They have low accessibility scores because accessibility design criteria have not been provided yet. The reason why the accessibility score in Taksim is higher than other centers is that the renovation work has been completed at this transfer center. In Taksim; it is expected that the accessibility score will be higher than 2.79 despite the fact that the regulation work has already been completed. This score reveals the incompleteness of the implementation in this transfer center.

There has not been any renovatory or regulatory work done in Besiktas. The reason that this centre has ranked the lowest score can be illustrated by its lack of a strong connection of its different modes of transportation and the spatial distance between the aforementioned modes of transportation.

As a result of the analysis; the principle of "equitable use" has given a result of 87% in Taksim, 80% in Kadıköy, 58% in Beşiktaş and 50% in Eminönü. When the average of these five centers have been realized considering the equitable use principle, the value would equate to 65.2%. The principle of "equitable use" has the greatest proportional value among the other principles in terms of fulfilling the criteria (Table 7 and Table 8).

"Tolerance for error", "low physical effort" and "size and space for approach and use" main criteria have similar average values equate to a range of 50%.

'Flexibility in use' main criterion has scored 42.4% average value.

'Perceptible information' main criterion has scored 38%, 'simple and intuitive use' main criterion has scored 38.6%; which is the lowest score. These two main criteria include particularly the urban design criteria, which meet the needs of people with sensory disabilities. This low scoring is the result of taking only the orthopedicly disabled citizens into consideration while conducting the matrix.

When the criteria of the transfer centers with the highest and lowest rates are considered; When in Taksim, the subcriteria of "equitable use" provides %87, while the sub-criteria of "flexibility in use" and "perceptible information" provide a scoring of 41%.

According to this matrix's results, Taksim has scored a high score considering the main criteria of 'equitable use' and 'size and space for approach and use', yet has scored a low score in 'flexibility in use' and 'simple and intuitive use' and "perceptible information" main criteria, despite the renovation efforts in the transfer center.

In Kadıköy, the sub-criteria of 'tolerance for error' main criterion has provided 85% while sub-criteria of "simple and intuitive use" main criterion have provided 25%.

According to Table 6; Beşiktaş, has the lowest accessibility score (1,28) in five transfer centers, according to Table 8; 58% of the sub-criteria of the 'eq-

uitable use' main criterion have been provided, while 32% of the sub-criteria of the "perceptible information" main criterion have been provided.

In Eminönü, 51% of the sub-criteria of the 'equitable use' main criterion have provided, while 29% of the sub-criteria of the 'perceptible information' main criterion have been provided 29%.

In Mecidiyeköy, 53% of the subcriteria of the 'tolerance for error' main criterion have been provided, while 29% of the sub criteria of 'flexibility in use' main criterion have been provided.

The 5 transfer centers of Istanbul are crucial for the mobility of the urban citizens. If an accessible transfer center project is to be designed in Istanbul, it is crucial to use such a matrix as the integration of universal design and accessibility criteria.

The current situation of the centers shows that Taksim largely contributes to urban mobility of disabled people with 'equitable use', 'simple and intuitive use' and 'size and space for approach and use' criteria; Kadıköy largely contributes to urban mobility of disabled people with 'flexibility in use', 'perceptible information', 'tolerance for error' and 'low physical effort' criteria (Table 9).

In Figure 3, the circle diameters are determined by the universal design and accessibility scores of the centers. As seen above, Taksim, Kadıköy, Beşiktaş, Eminönü and Mecidiyeköy rank from the highest to the lowest. In Figure 4, there are images from the 5 transfer centers.

In the analysis, ongoing renewal works in Eminönü and the ongoing metro construction in Mecidiyeköy cause the lowest accessibility scores for these transfer centers. Renewal works that have not been completed yet affect accessibility negatively.

The findings of the study, which assess the situation of urban design elements by AHP method, that are important in the accessibility for disabled people in the central areas in Istanbul, suggest that urban design elements are inadequate in transfer centers and that quality is far lower than the required standard.

Taksim has the highest accessibility score, all the sub-criteria of 'equitable use' have been implemented but "the height of railings of stairs and ramps formed at two different levels as 60 cm and 90 cm" criterion has been ranked inefficient.

All the sub-criteria of 'flexibility in use' have been implemented but "fold-

Table 9. *Center-based proportion of universal design main criteria.*

UNIVERSAL DESIGN PRINCIPLE PERCENTAGES OF THE TRANSFER CENTERS	TAKSİM	KADIKÖY	BEŞİKTAŞ	EMİNÖNÜ	MECİDİYEKÖY	TOTAL
EQUITABLE USE	26,7%	24,5%	17,8%	15,6%	15,3%	100%
FLEXIBILITY IN USE	19,3%	27,4%	21,2%	18,4%	13,7%	100%
SIMPLE AND INTUITIVE USE	25,4%	13,0%	19,7%	21,8%	20,2%	100%
PERCEPTIBLE INFORMATION	21,6%	23,7%	16,8%	15,3%	22,6%	100%
TOLERANCE FOR ERROR	18,4%	30,1%	17,0%	15,6%	18,8%	100%
LOW PHYSICAL EFFORT	22,3%	24,2%	16,5%	17,7%	19,2%	100%
SIZE AND SPACE FOR APPROACH AND USE	27,1%	24,9%	14,8%	14,8%	18,4%	100%

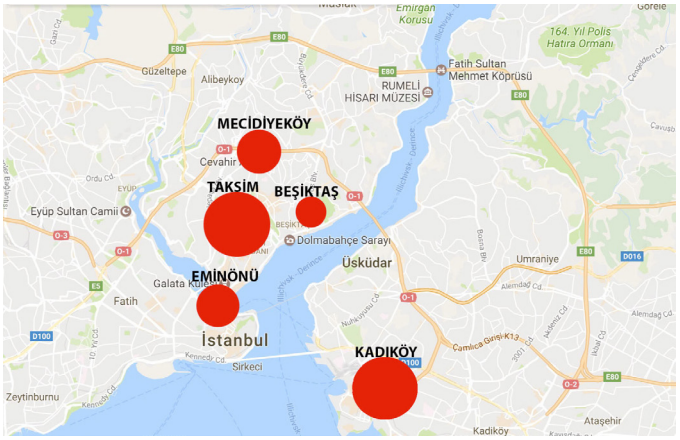

Figure 3. *Five transfer centers of Istanbul.*

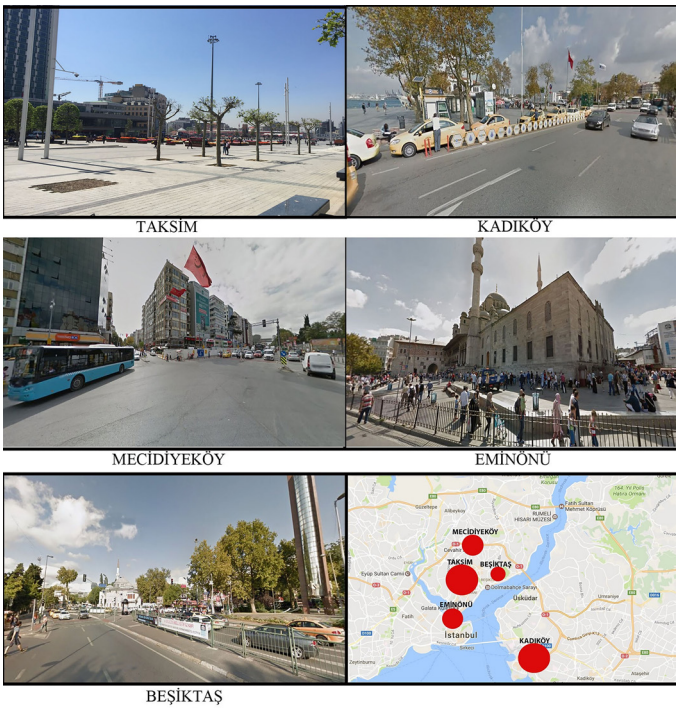

Figure 4. *Five transfer centers of Istanbul.*

able seats are at the stops", "stops located at the same level with vehicle", "public toilets are suitable for disabled people" and "stops' sizes are sufficient for a wheelchair user" criteria have been ranked inefficient.

All the sub-criteria of 'simple and intuitive use' have been implemented but 'the warning signs on pedestrian crossings are indicated by light and phosphorus colours", "staircase and ramp edges are highlighted with contrasting colours" criteria have been ranked as low quality.

Two of subcriteria of 'perceptible information' main criterion have not been implemented, which are "guiding & routing panels prepared with large pinpoint letters & Braille" and "information & orientation panels prepared with Braille". Three sub-criteria have been ranked as low quality, which are "indication of the surroundings of urban furniture with remarkable coluors & materials", "information & voice information in the directional panels", "the height of the information and guidance panels is 120 cm to be seen by wheelchair users".

All the sub-criteria of 'tolerance for error' have been implemented but "the floor of the covers on the paths must be maximum in 1,25 cm level difference", "sudden constrictions or extensions at the cross section of the paths" and "positioning of urban furnitures (required a minimum of 2 m height to prevent head injures)" have been ranked as low quality.

All the sub-criteria of 'low physical effort' have been implemented but "embossed material, not higher than 5 mm on the surface of paths", "suitable resting areas in certain periods (60-100m)" and "corresponding ramps on the opposite sidewalks" have been ranked in low quality.

All the sub-criteria of 'size and space for approach and use' main criterion have been implemented but "paths' and ramps' width must be at least 90 cm", "maximum height of pavement must be max.15 cm", "ramp gradient must be max. 5%", "positioning of stimuli/markers at appropriate points to provide guidance" and "steps on boarding platform are in same level" have been ranked as low quality.

As a result, 'simple and intuitive use' and 'perceptible information' criteria, which have scored the lowest in all the transfer centers, primarily have to be improved. Furthermore, the other main criteria should be raised up to the top level as %100.

6. Conclusions

In this study, the quality of urban design elements and the conformity of the accessibility criteria of five major transfer centers of İstanbul, that have connections between the different modes of transportation in the central business area of Istanbul, have been assessed. The state of the urban design elements, which are important in the accessibility for all. Therefore those have been determined in the framework of the seven principles of universal design, have been evaluated by 10 disabled individuals. The results have been calculated by the AHP method.

Urban design should create democratic and equal habitats for all people. To achieve accessibility, universal design concept and its principles must be adopted in urban areas. Accessible urban areas provide equal protection, equal opportunities for all and create social justice and human-centered urban environments. To increase independence of mobility of disabled people in urban areas, all urban design implementations should be based on accessibility criteria.

The design of transfer centers, with the adoption of universal design principles, is very important for the independent mobility of disabled people. Sub-criteria, which have been considered for planning and design studies should be provided according to the universal design principles. All kinds of design implementations are important to ensure accessibility and mobility in urban areas. All the urban areas should be designed in accordance with the needs of disabled people to create fully accessible urban areas.

Accessibility score calculation matrix, which has been prepared in the study, will be available to local governments to calculate the accessibility of transfer centers' designs. Full accessibility will be ensured when all of the design criteria can be applied to the implementations.

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