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Urban planning for physically disabled people's needs with case studies

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Abstract The aim of this study is to provide urban planning procedures tailored to the needs of disabled people. For this, it analyzes the problems of disabled people, especially physically disabled people, for living in Iran's cities. It also analyses various planning and design characteristics of buildings in Iranian cities. Research methods of this paper are problem-oriented theoretical studies, case studies, a weighted sum method, and a Benchmarking technique. The methods assist to provide relevant standard indicators and a theoretical framework for the comparison of the cities to an optimal alternative. A case study strategy to gather data for certain comparisons and present a disabled-oriented model of urban planning has been performed. The weighted sum method dedicates quantitative scores and performs the comparison and judgment. Finally, this paper concludes that the cities in Iran are not appropriate to the physical and administrative needs of the disabled. This study finds that buildings in Iranian cities often lack the necessary standards for the needs of the disabled. The outcomes of this research concerning urban planning for disabled people will assist better disabled-oriented urban planning, design, and development everywhere in the world.

Keywords Physically disabled people · Problem-oriented method · Weighted sum method · Benchmarking technique · Urban planning · Accessible public spaces

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1 Introduction

Many people with disabilities, particularly physically disabled people are living in this world. On the other hand, cities have been built for people who have a strong and healthy body [1]. Though, all citizens of the cities, including the disabled, have the right to enjoy living and working opportunities in the cities. The importance of equality of citizenship is that persons with disabilities enjoy the facilities available in urban public spaces like other people in society. People with physical disabilities are usually unable to move around in cities due to the physical barriers, unfair land-use policies, non-standard building, and inadequate accessible public spaces [2]. Some advanced countries of the world noticed the needs of persons with disabilities returning from wars since the eighties. The issue became even more important when the social dimension of the problem expanded. The countries implemented applications that guaranteed movement of physically disabled people in the cities without problems. A new responsibility was also created under the title of "Access Officer" who drafted urban development standards based on the recommendations of the disabled society. Monitoring the compatibility of existing buildings with the needs of the physically disabled people and the accessibility of urban spaces in new designs were performed. The establishment of the access officer has been a major shift towards adapting urban spaces for the use of the disabled and securing their rights in the process of urban planning and development [3]. Urban development schemes in the advanced countries are now implementing the requirements of urban space adaptation with the right urban land use planning, building standards, and regulations in place. Salmela i.e. researched about this fact in Malmö [4]. The Scandinavian countries, including Sweden,

have been particularly successful in this regard. All municipalities in the country have set standards for urban planning and design based on the needs of the disabled. The access officer shall agree to start an urban development program. The accessibility of physically disabled people to buildings, urban equipment, transport networks, recreation centers, tourism, and other diverse urban physical structures makes it possible to use the talents and forces of the disabled well. In addition, this measure is also a way of preventing new disabilities. Therefore, it is important to investigate the mismatch of urban public spaces with the needs and wishes of persons with physical disabilities. Right land-use planning to build functional urban spaces and meet the needs of the disabled in the city is the best way to bring physically disabled people out of isolation. This is possible through the creation of convenient and accessible urban spaces. In Iran, although the physically disabled people make up a significant percentage of the population, the problem has not received much attention. These people are lesser in terms of achieving their social rights compared to other people.

There is a need to analyze the present situation of urban public spaces in the cities and find ways to adapt the cities to physically disabled people.

This study aims to analyze the inadequacy of the physical and administrative context of cities for the needs of the physically disabled people.

However, the main target of this article is to provide practical recommendations for the social, spatial, and physical improvement of cities for the benefit of physically disabled people. Therefore, *the main question of this research* is: What is the accessibility rate of public urban spaces for the physically disabled people in Iran's cities? Related to this main question, the following questions must also be answered: What are the characteristics of a suitable city for disabled needs? What types of land-use policies, physical improvement, urban infrastructure, electronic services, urban management, and regulations make the cities suitable for disabled?

Research methods to answer the above questions are both theoretical and field observations. This research is an applied-descriptive-analytic one. The research method is also problem-oriented as well as comparative. All research tools and methods are intended to introduce the standards and compare the buildings to an optimal alternative. Case studies have been carried out in cities that are the center of Iran's provinces.

The outcomes of this research are some practical suggestions to plan and build the cities for the disabled everywhere.

The structure of this article is composed of 6 parts as follows: 1. Introduction, 2. Background of urban planning for disabled, 3. Theories and standards, 4. Methodology and case studies, 5. Results of field studies, and 6. Conclusions.

2 Background of urban planning for disabled

2.1 Global efforts

In the world, the history of this endeavor in European and North American countries is largely due to the results of world wars. After heavy human casualties in the World Wars, disabled people lived in industrialized cities with many problems in buildings and cities [5]. For this reason, the demand for the right urban land-use policies and suitable housing for disabled people had been increased. Further, the optimal construction of future cities based on the needs of the disabled was increased. There were numerous movements expressing the demands of disabled people. Finally, politicians and urban planners concluded that disabled representatives should have a serious role to play in the urban planning process and management. Many theoretical discussions were also undertaken to create a cultural context for the participation of the disabled in the development of the cities. The first international journals published the debate in England and the United States at that time were called Urban Planning. These debates are still ongoing. The fundamental issue in building sustainable, resilient, humane, and disabled-oriented cities is wise urban land-use policies [6, 7]. Based on the land use policy, urban optimal development will be implemented. Then, the discussions on the housing and town buildings are continuing, i.e. Franz in research titled "Housing for people with disability" focused on providing specialized and professional services to people with disabilities across Australia [8].

As another example, Carmona explained in his book that how the UK had been attempting to create dynamic accessibilities for all people through the designing of urban spaces [9]. Other efforts have also been made in Western societies to improve the life of persons with disabilities in other countries of the world. For example, Sanderson and colleagues stated that efforts have been made in Mexico and India [10]. They also explored Canada's efforts to reach people with disabilities in all urban areas. In his dissertation, "Evaluating planning for the access of people with disabilities in Canada's mid-centers," he described the efforts made for people with disabilities. Sanderson defined the planning tools and strategies that have been developed in Canada to improve access for people with disabilities to urban spaces. Schroeder also discussed designs in Japan for disabled access to urban spaces in his article on Living with Disabilities in Japanese Cities. The Japanese intended to

build cities where people with mental and physical disabilities and ordinary people lived next to each other [11].

Hallgrimsdottir introduced a list of the most appropriate cities for disabled lives and social activities. Among them, he listed 22 cities that had implemented the best programs for planning and designing cities based on the needs of people with disabilities. For example, the cities of New York, Winston, Orlando, and Chicago in the United States had the best environment for the disabled. The cities also had modern and convenient transportation systems for all people. Birmingham in England because of the popularity of resources for keeping disabled is on this list. Berlin was on the list because of the comprehensive disability policies in place and the high level of investment in disabled people and all other people. The Nantes Port in France, along the Lorraine River Coast, which had designed the city well for people with disabilities, was also an ideal city for the disabled. It should also be mentioned that Stockholm was a beautiful city in Sweden, 30% of which were located in the water and with a network of bridges and lanes was an ideal city for the disabled [12].

2.2 Iran's efforts

In Iran, the history of the efforts of the Iranian cities mainly goes back to the catastrophic results of the Iran-Iraq war. As a result of that war, a significant number of people with disabilities were left out of their lives and activities. Since then, urban planners, architects, engineers, and decision-makers have talked about better access for the disabled to urban spaces and services.

The Technical Office of the Ministry of the Interior has also presented some works, such as "Analysis of urban development and architecture for disabled" [13]. In 2000, Paragraph C of Article 193 of the third national economic and social development plan act was approved by the parliament. Following the adoption of the plan, the draft of its executive bylaws was drafted in cooperation with the Welfare Organization and the Ministry of housing and town-building, which was approved by the Cabinet on 10/12/1999. Paragraph C of the act promoted public access to services, equal opportunities for persons with disabilities, and their active participation in community outreach. The building and housing research center and the University of Tehran also contributed to the efforts. However, due to the fragility of the efforts and the lack of fair urban land use planning and expert representatives of the disabled community, the measures have not yielded significant results, as many believe [14, 15]. It is why people with disabilities have a hard time when living in Iranian cities.

3 Theories and standards

3.1 Definitions

The Cambridge Dictionary defines the word of disability as follows:

"A person with disabilities does not have one or more of the physical or mental abilities that most people have" (Cambridge Dictionary).

Experts have defined the disability in terms of the extent to which one's involvement in nature or economic affairs. For example, Crane and Warrens have defined the disabled as those who have physical limitations on the activity [16].

The World Health Organization provided an ecological definition of disability and considered a disability in relation to the natural and social environment. As a result, disability is a complex phenomenon that reflects the interaction between the characteristics of a person's body and the characteristics of the community in which he or she lives [17].

Urban land-use planning has been defined as a process of regulating the use of land with the promotion of desirable socioeconomic and spatial distribution to build a sustainable and functional city [18, 19]. *Urban planning* is a multidimensional process that aims at urban land-use, design, and development [20]. *Urban design* deals with the two well-known scopes of the physical form of the private (building) and urban and regional planning that is public [21].

3.2 Theories

From a theoretical point of view, the typology of the disabled and their limitations in relation to urban public spaces can be a guide to making the cities a better place for the disabled. In order to better urban planning for the adaptation of urban spaces (housing, crossing paths, office spaces, sports-recreation, etc.), it is necessary to classify the disabled according to different criteria. The most important of these criteria include the type of disability and functional limitation, the type of means of transportation, the type of housing, and the quality of life. The types of disabilities and functional limitations include visual impairment, hearing impairment, motor disability, and disability in the upper torso [22–24].

Types of housing also include apartments, villas, multi-story homes, and non-class homes. Types of life include solo life, family life, and marriage. According to the type of transport device, disabilities are also divided into the following groups: Wheelchair user, using four wheels, the use of artificial legs, users of crutches, and not using specific tools [25].

From the sociological point of view, the disabled and the community have reciprocal tasks. The task of modern society is to adapt urban spaces to all members of society, including the disabled. As a social being, human beings need to communicate with their environment in order to meet their individual and social needs [26, 27].

Connecting people to the environment by being present in society is as easy as possible accessing the spaces around and engaging in social activities. In fact, access to urban amenities is a prerequisite for socialization. Urban spaces are spaces where most social activities take place. Urban spaces can be divided into three types: First, public spaces include streets, squares, and parks. Second, there are semi-public spaces such as passages and cultural centers. Third, there are private spaces and personal property in a city. What is important is that people with disabilities should be taken into account as part of the community that uses these spaces. Therefore, from a theoretical point of view, it is imperative that all people, including the disabled, are active in the city. Therefore, access to public spaces requires acceptance of the idea that all people, including people with disabilities, should benefit from all the facilities of the city. Construction regulations must describe how public buildings and places should be designed to be accessible to all. This means that cities shall allocate adequate areas of urban lands to the public spaces and infrastructures [28]. In addition, every city must be designed in such a way that everyone can use it for her/his intended purpose like moving or staying.

Urban planning must be based on a human-centered environment that is built on the commonality of human beings and vehicles. When creating an unobstructed space, the characteristics of people with disabilities, the people who help them, and the wheelchairs used to carry the disabled must be specially considered. Unfortunately, the barriers to the daily life of people with disabilities are overburdened. For example, depending on how much people can withstand the pressure of a wheelchair, not only does the frequent withdrawal of the handicap decrease, but it also reduces the distance traveled [29]. One of the most common definitions of urban design describes: Urban design is concerned with the physical shape of the city. Urban design is an evolutionary and continuous process that must be realized in the context of constant environmental changes [30]. The urban design provides the context and the potential for qualitative change in urban environments to benefit the disabled. In addition, we have to provide the necessary regulations for the professionals involved in building the cities [31]. In terms of content, the main features of urban design are location, density, mixed and consistent uses of urban land, pavement scaling and human culture, natural resources of the area, and the necessities of living and working with the disabled in the city [32]. All physical components of a city, including buildings, squares, passageways, and urban furniture, must be carefully designed with the characteristics of the disabled. For example, in the design of urban furniture, every device or element must be fully integrated with the environment, the urban design community, and the disadvantages of the disabled. The fact is that most of the problems of people with disabilities in urban environments relate to the network of urban passages and furniture. In many countries, some efforts have been made to modify and adapt these cases with a view to achieving their individual independence and social rights.

In many countries, though urban regulation has been mandatory for people with physical disabilities, urban spaces can still not be used without the help of others. Understanding what the limitation of a wheelchair user is important. Limits are i.e. height restriction, wider width, and restricted access.

Such a person needs sufficient space in his or her path. The presence of stairs, roughness, slip surfaces, surface differences, steep slopes, and objects impede his easy and independent movement. The UN has recommendations for the standard of accommodation for disabled people. The convention on the rights of persons with disabilities, comprising 50 articles signed by the member states of the United Nations, is a practical guide to making cities in the world more accessible to people with disabilities. Article 3 of the convention includes principles such as respect for their inherent dignity, freedom of choice and independence, non-discrimination, effective and full participation and inclusion in society, and respect for differences and acceptance of people with disabilities. Article 3 contains also principles in terms of equality of opportunity to access the urban spaces and facilities, a bridge between men and women, and respect for the rights of children with disabilities [33]. In addition, in the local dimension, the social, economic, cultural, and climatic characteristics of every country must be considered for the purpose of the improvement. Therefore, we use successful models, theories, and experiences of the successful cities that made urban spaces suitable for people with disabilities. The results of the review of theories related to the planning and building the cities for the disabled can be summarized in Fig. 1, which is a flowchart diagram. As the flowchart shows, setting standards for cities is a requirement.

3.3 Standards

In addition, UN recommendations, it is necessary to review and develop appropriate disability standards and urban development codes in the advanced countries. The purpose is to identify the best indicators for the proper urbanization

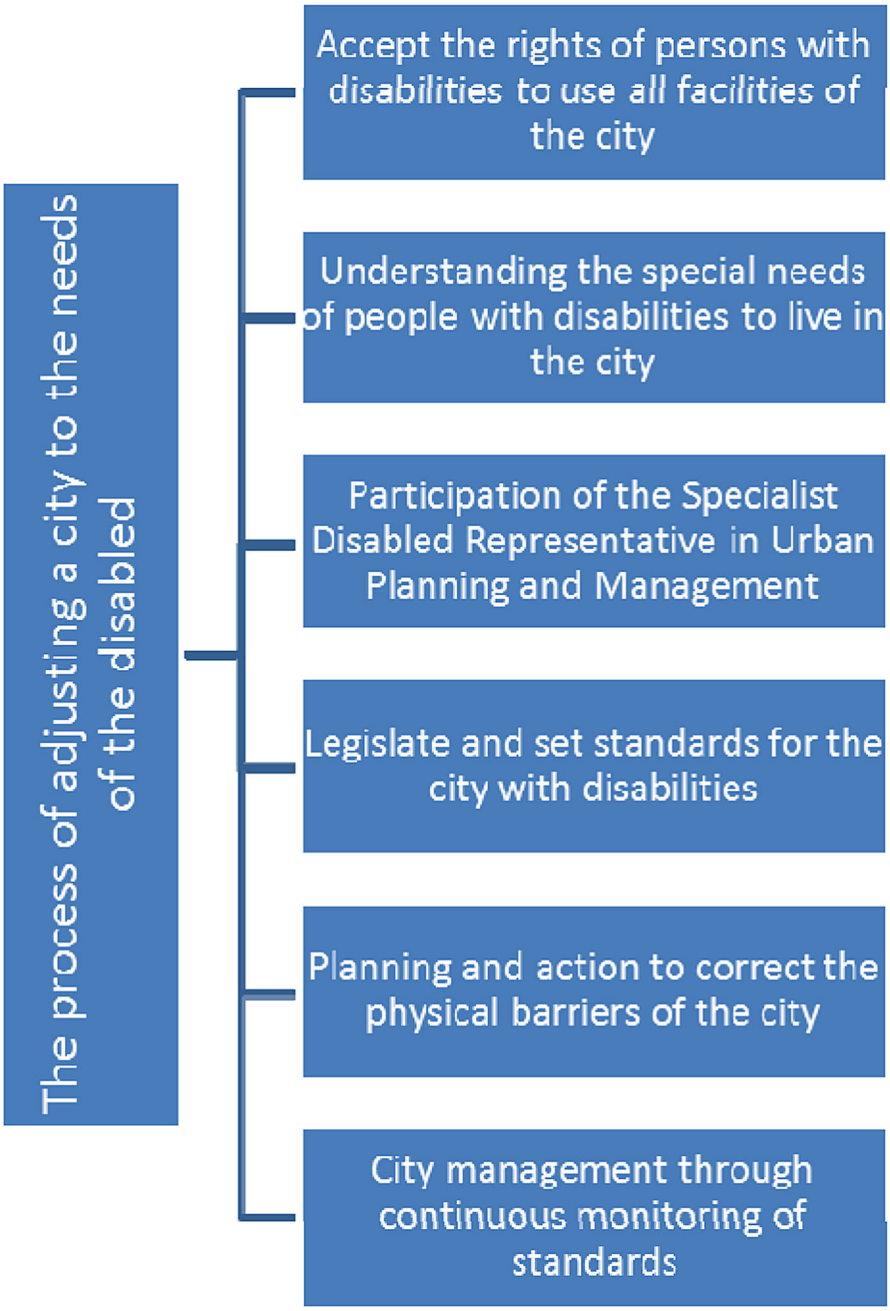

Fig. 1 Chart of the process of adjusting cities with physical disabilities

of the needs of the disabled. Sweden has taken the most prominent steps to adapt its cities to the needs of the disabled and its standards can be a good example. The philosophy of Sweden's urban planners is to provide opportunities for all sections of society, including the disabled, to be able to move around all urban spaces, including streets and squares, in a physically designed environment [34].

Further, the planners have not neglected the beauty of urban spaces for the disabled. To this end, they have examined the types of disabilities and identified their needs. Sweden has published a set of buildings and urban rules and regulations that make the whole physical environment accessible to all. See, for example, publications of Boverket (= National Board of Housing, Building, and Planning) [35]. Sweden is one of the countries where people with disabilities have significant rights to take advantage of city facilities. In Sweden, even people with disabilities benefit from positive discrimination! A specialist representative of the disability community is

involved in housing planning and development. An examination of Sweden's set of codes and standards for urban development shows that it has standards for suitable housing for people with disabilities. There are also standards for urban furniture, sidewalks, streets, squares, pedestrian overpasses, bus stops, pedestrian guides, stairs, ramps, elevators, bridges and passages, sports facilities, and parking spaces for the disabled. The following is an example with some development standards of Helsinki City [36]:

About stairs The exterior stairs of the building have appropriate dimensions and the number of stairs in a residential home should not exceed 8. In addition, the stair width should be at least 1.5 m.

Toilets suitable for use by physically disabled people must meet certain standards Amongst, the dimensions of the toilet compartment shall be at least 2.2 × 2.2 m and there is a space of 90 cm on both sides of the toilet bowl. There shall be at least 1.5 m of space in front of the toilet and a 30 cm space behind the toilet to accommodate the nurse when it is necessary. Other standards have been recommended like an alert system must be in place, the toilet must be at a level of 00, door sill shall be of soft rubber, and a ramp to the entrance must exist. To create the 0 0 levels, there must be a descent from the stairs outside the entrance. In addition, the width of the entrance door shall be at least 0.9 m high.

There are also standards for street furniture according to the needs of people with disabilities i.e. special furniture areas shall be created for everyone, especially for people with a wheelchair. Urban planners shall create extensive walk-in furnishings on the streets in special areas with flower pots and shelves for easy access by all, especially for people with disabilities. The constructor shall consider 1 to 5 square meters of land per person with good walks for people with disabilities. It is important to have a smooth but non-slip surface with minimal slope. Other standards for street furniture are: Dimensions of furniture space is so that two wheelchairs overlap, the width of sidewalks should be at least 2.6 meters plus wheelchair dimensions. Squares and open spaces should be accessible to everyone; surfaces must be smooth and non-slipping and have good and definite symptoms. More standards in street furniture are suitable lighting and adequate space. In large open spaces, such as walkways, urban designers must guide the route. They shall even use natural path markers that are environmentally friendly. The urban designers shall lead the disabled with distinct boundaries between materials and plants, grass, paving, edges, and different types of orientation.

In the case of ramps, standards also make the city fit for the needs of the disabled. As a sample, the Helsingborg city standards recommend that a ramp slope does not exceed 1:20 even preferably less. The idea is that the ramp shall not occupy more than 0.5 meters in height difference. The standards of the city suggest that the ramp shall be divided into multiple landing sections so that each landing is at least 2 m. In addition, the width of ramps should be at least 1.5 m.

Here, two Swedish standards for lifts are presented First, an elevator must have enough space for a wheelchair with an assistant. Second, the elevator should be equipped so that people can mount the elevator and use the dashboard equipped with the necessary buttons.

Car parking also has special standards to ease physically disabled people's driving. For example, Swedish standards recommend that parking spaces for the disabled shall include health centers, public buildings, shopping malls and pharmacies, parks, recreation areas, campsites, and swimming pools. The standards suggest also that the area of land needed for disabled people should be at least 5% of the total area of parking lots available in a neighborhood. The Swedish standards require that the width of the space shall be suitable for wheelchair access through a ramp or elevator.

Based on the international recommendations and workshop experiences we have extracted certain indicators for the analysis of Iranian cities.

$$[S_i,\ i = (1,\ 2,\ 3,\ 4,\ 5,\ 6)]$$

Table 1 shows six groups of standards and their indicators for investigations. It provides a set of six benchmarks for comparisons. The standards presented in Table 1 have been derived from the international and workshop standards on the adaptation of city buildings to the needs of the disabled. These standards are tools to measure the suitability of public buildings in Iranian cities for field studies in the next section.

4 Methodology and case studies

4.1 Iranian cities and people with disabilities

Iran has 31 provinces. By 2019, Iran's population has reached 83 million [37]. Figure 2 is a map that exhibits Iran and its provinces. Iranian cities are mainly rooted in agricultural production and feudal social relationships. Following the socioeconomic reforms of the Pahlavi dynasty, manifestations of modernism, including the development of some buildings, emerged with the construction of some modern streets. However, the rest of the city remained worn-out and the culture of Feudal relations continued dominance. That is why the inequality of civil rights in urban society, like that of the peasants, has continued to inequality with tyrannical urban administrations

Table 1 Standard groups and indicators to study the cities

Mark	Standard group	Indicators investigated
S_1	Quality of corridors	Corridor width of at least 140 cm
		Undersides of corridors without severe surface differences
S_2	Ramps quality	Ramps
		Ramp width of at least 120 cm
		Fence on both sides of the ramp surface
		Diameter of the fence with a maximum of 3.5 cm
		Fence height from incline between 65 and 80 cm
		No slippery slope, 5% to 8%
		Dimensions of sloping surface at least 150 × 150 cm
S_3	Quality of elevators	General and overall quality of the lift for the disabled
		Minimum useful dimensions of 110 × 140 cm
		Elevator chamber controllers height 100 to 120 cm
S_4	Quality of doors	Width of building doors at least 100 cm
		Door frame without threshold or less than 2 cm
		Handle height from the floor to a maximum of 100 cm
S_5	Quality of services	Minimum width for entry to the bathroom is 91 cm
		No slippery, non-slip flooring
		Suitable for toilet position
		Lever faucets with a maximum distance of 60 cm from the front edge of the toilet
		Standard toilet seat installation (height 45 cm from the floor and 30 cm from the wall
		Auxiliary handle on the sides of the bowl (between 91 and 84 cm from the floor and 20 cm ahead of the front edge of the bowl)
		At least 170 × 150 toilet space with wheelchair rotation
S_6	Quality of the parking	General status of parking for disabled persons
		Special signs for the disabled car park

like the powerful feudal era. Urban land-use policies, urban planning, and development for people with disabilities and poor and suburban neighborhoods were also ignored due to the lawlessness, tyranny, corruption, and lack of competence of city managers. Today, the cities of Iran have numerous management and physical problems in living, commuting, working, studying, and other activities. According to the 2009 census of population and housing, the total number of people with disabilities in the country was 1 million and 17,659.[1] The shares of different disabilities in the community are 9.73% blind, 9.79% deaf, 13.45% speech and voice disorder, 2.52% hand amputation, 12.57% hand defect, 4.65% amputee, 25.86% foot defects. 13.55% had trunk defect and 32.82% had a mental disorder [37].

Fig. 2 Map of the provinces of Iran with the name of their capital. *Source*: [38]

[1] This number is based on government statistics and observations show that the number of people with disabilities is higher.

4.2 Research methods

This research is applied in terms of purpose and employs quantitative and comparative analysis methods. A problem-oriented method (POM) has also been used. This method is helpful in the urban planning studies as many scholars amongst Shahraki had used it earlier [39]. Documentary studies, questionnaires, observations, and workshop experiences were collected. To summarize this article, it has been limited to the analysis of 54 buildings. It is assumed that the results of the study of these buildings can show the situation of other components of urban planning and design in Iran. A questionnaire was developed for exploiting the experiences and ideas of residents with disabilities in the 54 public buildings. Then, the buildings were compared to previously introduced standards. The sample population of this research includes public buildings in all centers of Iranian provinces.

The statistical population of the research includes the buildings of administrative, medical, religious, recreational, sports, and educational centers. A model called the Weighted Sums Approach has been developed to evaluate the buildings for disability use. The model has been used in a number of multi-criteria measures; look at, for example [40]. This model is well-known for evaluating a number of options with a number of criteria in mind. The model also allows the benchmark technique to compare the buildings to an optimal building. The model is based on the following equation.

$$WS\ of\ B_i = \sum_{j=1}^{n} w_j a_{ij}, \quad i = 1, 2, 2, \ldots, m \tag{1}$$

The WSB is the sum of the weights of a building. Evaluation criteria were measured by observations and experiences of persons with disabilities for each building. To construct a model based on Eq. (1), suppose we want to quantify m number of buildings by measuring n standards and decide whether they meet the needs of the disabled. Assume that any building with the highest weight score is the most appropriate. Also, suppose that W_j represents the standard weight S_j and a_{ij} is an executive coefficient when evaluating and scoring B_j according to the standard of S_j. Therefore, the sum of the weighted significance of B_i, here the total score $B_i(T)$, is determined by the following equation.

$$B_i(T) = \sum_{j=1}^{n} W_j a_{ij} \quad i = 1, 2, 3, \ldots, m \tag{2}$$

To build the model, we introduce 54 buildings as a sample community for measurement. Please see Table 2.

Here, please have a look at the six sets of indicators that were introduced in Part 3 of this article.

$$[S_i,\ i = (1,\ 2,\ 3,\ 4,\ 5,\ 6)]$$

If the total importance of the indicator groups is 100%, the significance of every indicator group is determined on a percentage basis by the experts' ideas, the responses of the disabled, and the field experiences. Please see Table 3.

Table 4 also shows 54 buildings, according to 6 index groups. In this matrix, the weight of every indicator group is determined for each building based on the ideas of the responders. In the right column of Table 4, the total weight of every building is calculated as follows.

$$\begin{aligned} WS\ of\ B_0 &= (16 \times 0.16) + (18 \times 0.18) + (17 \times 0.17) \\ &\quad + (16 \times 0.16) + (18 \times 0.18) + (15 \times 0.15) \\ &= 16.74 \end{aligned} \tag{3}$$

$$\begin{aligned} WS\ of\ B_1 &= (8 \times 0.16) + (9 \times 0.18) + (8 \times 0.17) \\ &\quad + (8 \times 0.16) + (9 \times 0.18) + (7 \times 0.15) \\ &= 8.21 \end{aligned} \tag{4}$$

$$WS\ of\ B_2 = (7 \times 0.16) + (8 \times 0.18) + (7 \times 0.17) + (8 \times 0.16) + (8 \times 0.18) + (8 \times 0.15) = 7.67 \tag{5}$$

$$\ldots$$

$$\begin{aligned} WS\ of\ B_{54} &= (5 \times 0.16) + (4 \times 0.18) + (6 \times 0.17) \\ &\quad + (3 \times 0.16) + (5 \times 0.18) + (4 \times 0.15) \\ &= 4.52 \end{aligned} \tag{6}$$

As you can see from Table 4, however, the total weight of every building is low between approximately 8 and 2. Consider the 16.74 as total weights for an ideal building suitable for the disabled. Figure 3 illustrates this fact graphically. The last dot on the right side of Fig. 3 shows the optimal number curve of 16.74.

The curve in Fig. 3 shows that all buildings are at a lower place than the optimal number. There are many differences between the 54 buildings. Some are far from fit and stand at the minimum point of about 1 weight total. Some show up to about 8, which is 50% of the desired number. Overall the curve shows that the buildings under study do not meet the needs of the disabled.

5 Results of field studies

As the comparisons of buildings with the optimal alternative in the curve show, all the 54 buildings are not suitable for the disabled. However, the buildings have different grades in terms of unsuitability. For the health care buildings, we see the B_2 with a weighted average score of 7.67. This building has major defects in the ramp. Its slope coverage must be improved. Some entrances of the building do not have ramps. The metal benches are exposed to

Table 2 A list over 54 buildings in Iran

Name of the building	Symbol	Name of the building	Symbol
Faculty of Literature, University of Isfahan	B_{28}	Ardabil emergency center	B_1
Azad University of Sanandaj	B_{29}	Bushehr	B_2
Semnan Payamnoor University	B_{30}	Imam hospital of Mashhad	B_3
Zahedan University of Medical Sciences	B_{31}	University hospital of Mashhad	B_4
Kerman University Hall	B_{32}	Central pharmacy of Rasht	B_5
Birjand University Hall	B_{33}	Sanjari pharmacy of Zahedan	B_6
Kosar Mosque in Tehran	B_{34}	Shiraz boarding pharmacy	B_7
Shiraz University Mosque	B_{35}	Central pharmacy of Qazvin	B_8
Tehran Azad University Mosque	B_{36}	Valiasr pharmacy of Tabriz	B_9
Yazd City Mosque	B_{37}	Headquarters of Birjand Martyr Foundation	B_{10}
Hassan bin Ali Mosque in Semnan	B_{38}	Sistan and Baluchistan Governorate	B_{11}
Al Mahdi Mosque in Tehran	B_{39}	Municipality of Bandar Abbas	B_{12}
Noor Mosque of Qom	B_{40}	Municipality of Ahvaz	B_{13}
Hosseinieh Martyrs of Khorramshahr	B_{41}	Municipality of Yasuj	B_{14}
Cemetery of Martyrs of Gorgan	B_{42}	Municipality of Arak	B_{15}
Cemetery of Martyrs of Ilam	B_{43}	Municipality of Ilam	B_{16}
Ekbatan Tehran Sports Complex	B_{44}	Municipality of Kermanshah	B_{17}
Athletic Complex of Beheshti University of Tehran	B_{45}	Kerman Islamic Guidance Office	B_{18}
Zahedan Shahrivar Pool	B_{46}	Education District 1 of Tehran	B_{19}
Sari Sports Complex	B_{47}	Zahedan Shahed Middle School	B_{20}
Yazd Railway Sports Complex	B_{48}	Imam Tehran Secondary School	B_{21}
Hossein Fahmideh gym in Bandar Abbas	B_{49}	Hazrat Mohammad Sari High School	B_{22}
Department of Sport and Youth of Bushehr	B_{50}	Gorgan Road High School	B_{23}
Shiraz Governorate	B_{51}	Bojnurd Management and Planning Organization Library	B_{24}
Qom Document and Property Registration Office	B_{52}	Urmia Customs Administration	B_{25}
Kermanshah Armed Forces Judicial Organization	B_{53}	Zanjan Agriculture Department	B_{26}
Gorgan Department of Natural Resources	B_{54}	Yazd Electricity Department	B_{27}

Table 3 Numerical weight of 54 buildings in percent for each of the 6 index groups

Indicators	S_1 (%)	S_2 (%)	S_3 (%)	S_4 (%)	S_5 (%)	S_6 (%)	WS (%)
Numerical weight of indices in percentage	16	18	17	16	18	15	100

the sun and quickly become hot. They should be changed wooden or laminated benches. In the same building, the elevator door barely opens and needs to be automated. The elevator is more than 10 cm high when stopping at the floor of the hall. This height must be reduced to allow the wheelchair to move inside the hall. It is necessary to have a suitable toilet here.

The Red Crescent B_1 with a score of 8.21, although better than the other buildings, is far from ideal. Pharmacy B_5 with a score of 7.70 lacks ramps and the height of the entrance door is long and inappropriate for disabled. Hospital B_3 with a score of 7.24 has deficiencies that make it difficult for people with disabilities to use it.

In the case of office buildings, the Martyr foundation's general office, B_{10}, although rated at 8.52, is more suitable for use by handicaps, but due to the tight street sidewalks and the crowded surroundings of the building, there are many problems in use. Building B_{11} is better than the rest of the office buildings with a score of 8.52; however, it is about 8 points lower than the optimal case. Customs B_{25} has a score of 7.82. This building lacks elevator, door ramp, toiletries, suitable valves and door thresholds.

Table 4 Matrix 53 Buildings and 6 Standards

Indicator Building	S_1	S_2	S_3	S_4	S_5	S_6	WS
B_1	8	9	8	8	9	7	8.21
B_2	7	8	7	8	8	8	7.67
B_3	8	7	8	7	9	7	7.24
B_4	8	8	7	8	8	6	7.57
B_5	7	8	7	8	8	7	7.70
B_6	7	8	7	8	9	7	7.70
B_7	7	7	7	8	9	6	7.27
B_8	8	8	7	7	8	6	7.27
B_9	8	7	7	8	8	6	7.25
B_{10}	9	9	8	8	9	8	8.52
B_{11}	9	9	8	8	9	8	8.52
B_{12}	8	8	8	8	8	8	7.80
B_{13}	8	8	8	8	8	8	7.80
B_{14}	8	8	8	8	8	7	7.65
B_{15}	7	7	7	7	7	7	7.24
B_{16}	7	7	7	7	7	7	7.24
B_{17}	5	5	5	4	5	5	4.74
B_{18}	8	7	7	8	7	7	7.31
B_{19}	7	7	7	7	7	7	7.24
B_{20}	8	8	7	8	7	8	7.65
B_{21}	7	7	7	7	7	7	7.24
B_{22}	7	7	7	7	7	7	7.24
B_{23}	7	7	7	8	8	7	6.94
B_{24}	8	8	7	7	8	7	7.32
B_{25}	8	8	8	8	7	8	7.82
B_{26}	7	7	8	7	8	7	7.23
B_{27}	7	7	7	7	7	7	7.24
B_{28}	2	3	2	1	2	1	2.07
B_{29}	2	3	3	3	1	2	2.46
B_{30}	3	3	3	4	3	2	3.14
B_{31}	4	4	3	4	3	3	3.33
B_{32}	2	3	2	2	3	2	2.66
B_{33}	3	3	3	3	3	3	3.13
B_{34}	2	1	1	1	2	2	1.49
B_{35}	2	3	2	1	1	2	2.14
B_{36}	2	2	2	2	2	2	2.00
B_{37}	1	2	2	1	1	1	1.37
B_{38}	2	1	1	2	2	2	1.65
B_{39}	2	2	2	2	1	2	1.82
B_{40}	3	2	3	4	3	3	2.81
B_{41}	2	3	3	2	2	2	2.35
B_{42}	2	3	1	3	2	1	1.92
B_{43}	1	3	2	2	1	2	1.84
B_{44}	4	4	5	4	5	4	4.35
B_{45}	3	4	4	3	3	4	3.50
B_{46}	4	4	4	4	3	3	3.67
B_{47}	10	11	10	10	10	10	10.18
B_{48}	7	6	7	6	6	7	6.48
B_{49}	5	5	5	4	4	5	6.15
B_{50}	4	5	4	5	6	6	4.94
B_{51}	6	7	6	8	7	7	6.83
B_{52}	6	6	5	5	6	5	5.52
B_{53}	4	4	3	3	3	3	3.34
B_{54}	5	4	6	3	5	4	4.52
B_0	16	18	17	16	18	15	16.74

Therefore, this building is not suitable for use by persons with disabilities.

The B_{52} with a score of 5.52 has a very bad situation. District education building, B_{19}, with a total weight score of 7.24, found defects in the flooring of the main entrance, lack of toilets and inadequate faucets for use by persons with disabilities. Central municipality B_{12} and municipality B_{15} scored 7.80 and 7.24, respectively, due to non-compliance with pedestrian slope standards, bridge height, ramp and toilets for use by persons with disabilities.

Religious buildings for the use of persons with disabilities are generally more inappropriate than office spaces. For example, Tehran Azad University mosque, B_{36}, with a score of 2.00 and mosque B_{35} with a score of 2.14 have physical problems and lack standards. Therefore, those do not fit the religious activities of the disabled. The mosque B_{39} and mosque B_{38} with scores of 1.65 and 1.37 are still the most inappropriate for disabled use.

If we look at sport buildings, the analyses showed that for example pool B_{46} had a score of 3.67 which, due to non-compliance with slope ramps, the height of door threshold and sharp stairs has got such a low score. Thus, the pool is inappropriate for disabled use. Other sport buildings are unacceptable either. Sporting B_{45} with a score of 3.50 is also in poor condition.

Educational buildings are also inappropriate for the disabled. For example, the University of Beheshti, Free University and Hedayat High School have been found unsuitable. The University Hall, B_{32}, with a low score of 2.66, requires elevators, ramps, automatic doors and proper toilets. It should be said that the university has no facilities for the disabled on campus. Ramps must be fitted in all sections. The elevator should be built in all colleges. The barriers along the way shall be removed. The routes are not suitable for wheelchair travel. There must be at least one route for the disabled wheelchair traveler. Parking for the disabled must be provided. Toilets need equipment. The thresholds of the doors in buildings are high and need to be

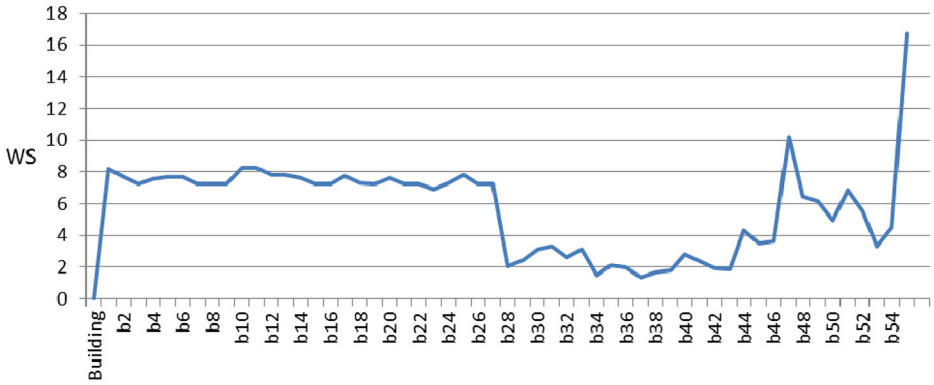

Fig. 3 Displays 54 inappropriate buildings for people with disabilities compared to the optimal number

shorter. The central library likewise requires ramps and the removal of the high thresholds. It needs a special parking for the disabled.

Azad University B_{29} with a score of 2.66 which is a low score is not suitable for people with disabilities and needs some measures to improve its buildings. The high school B_{23} has a score of 6.94 which indicates that the high school is far from the desired score.

6 Conclusion

This study explained the need for urban planning, design, and development for physically disabled people. It reviewed the post-World War II efforts of Western societies to rebuild the cities for the sake of persons with disabilities. This paper also examined physical and legal barriers to living and the active participation of people with disabilities in Iran's cities.

The research hypothesis was that existing public buildings and urban infrastructures in the cities are not suitable for living, working, and commuting in Iran. The problem was investigated with the help of field observation. Some standards under the umbrella of the six indexes have been introduced to evaluate 54 public buildings in Iran's cities. Those indicators would lead us towards the disabled-oriented rebuilding of the cities. The benchmarking method and the weighted sum method have shown that buildings are not suitable for the physically disabled people in Iran's cities. Therefore, the studies proved the validity of the theory of this research.

The novelty of this research is its advice to join the strategic master planning of cities and the needs of the physically disabled people in the early phase of planning. Of course, the representative of the disabled community shall participate in the process of urban spatial planning.

As a result, this research presented a well-designed and practical model for the improvement of the cities. The model is paying particular attention to the problems of urban spatial planning, design, development, and management respecting the requirements of the disabled community. The model of the measurement, comparisons, and urban spatial planning can lead all efforts to build the cities for people with disabilities.

The outcome of this research could help planners, architects, civil engineers, decision-makers, and entrepreneurs that plan urban spatial development programs to improve the cities for the disabled everywhere in the world.

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Compliance with ethical standards

Conflict of interest The author declares that he has no conflict with interest.

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