Osvaldo Gervasi · Beniamino Murgante · Sanjay Misra · Chiara Garau · Ivan Blečić · David Taniar · Bernady O. Apduhan · Ana Maria A. C. Rocha · Eufemia Tarantino · Carmelo Maria Torre · Yeliz Karaca (Eds.)

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Computational Science and Its Applications – ICCSA 2020

20th International Conference
Cagliari, Italy, July 1–4, 2020
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Preface

These seven volumes (LNCS volumes 12249–12255) consist of the peer-reviewed papers from the International Conference on Computational Science and Its Applications (ICCSA 2020) which took place from July 1–4, 2020. Initially the conference was planned to be held in Cagliari, Italy, in collaboration with the University of Cagliari, but due to the COVID-19 pandemic it was organized as an online event.

ICCSA 2020 was a successful event in the conference series, previously held in Saint Petersburg, Russia (2019), Melbourne, Australia (2018), Trieste, Italy (2017), Beijing, China (2016), Banff, Canada (2015), Guimaraes, Portugal (2014), Ho Chi Minh City, Vietnam (2013), Salvador, Brazil (2012), Santander, Spain (2011), Fukuoka, Japan (2010), Suwon, South Korea (2009), Perugia, Italy (2008), Kuala Lumpur, Malaysia (2007), Glasgow, UK (2006), Singapore (2005), Assisi, Italy (2004), Montreal, Canada (2003), and (as ICCS) Amsterdam, The Netherlands (2002) and San Francisco, USA (2001).

Computational science is the main pillar of most of the present research, industrial and commercial applications, and plays a unique role in exploiting ICT innovative technologies. The ICCSA conference series has provided a venue for researchers and industry practitioners to discuss new ideas, to share complex problems and their solutions, and to shape new trends in computational science.

Apart from the general track, ICCSA 2020 also included 52 workshops in various areas of computational science, ranging from computational science technologies to specific areas of computational science, such as software engineering, security, machine learning and artificial intelligence, blockchain technologies, and of applications in many fields. We accepted 498 papers, distributed among 6 conference main tracks, which included 52 in workshops and 32 short papers. We would like to express our appreciation to the workshops chairs and co-chairs for their hard work and dedication.

The success of the ICCSA conference series in general, and of ICCSA 2020 in particular, vitaly depends on the support from many people: authors, presenters, participants, keynote speakers, workshop chairs, session chairs, Organizing Committee members, student volunteers, Program Committee members, Advisory Committee members, international liaison chairs, reviewers, and others in various roles. We take this opportunity to wholeheartedly thank them all.

We also wish to thank our publisher, Springer, for their acceptance to publish the proceedings, for sponsoring part of the Best Papers Awards, and for their kind assistance and cooperation during the editing process.

We cordially invite you to visit the ICCSA website http://www.iccsa.org where you can find all the relevant information about this interesting and exciting event.

July 2020

Osvaldo Gervasi
Beniamino Murgante
Sanjay Misra

Welcome to the Online Conference

The COVID-19 pandemic disrupted our plans for ICCSA 2020, as was the case for the scientific community around the world. Hence, we had to promptly regroup and rush to set in place the organization and the underlying infrastructure of the online event.

We chose to build the technological infrastructure using only open source software. In particular, we used Jitsi (`jitsi.org`) for the videoconferencing, Riot (`riot.im`) together with Matrix (`matrix.org`) for chat and asynchronous communication, and Jibri (`github.com/jitsi/jibri`) for live streaming sessions on YouTube.

Six Jitsi servers were set up, one for each parallel session. The participants of the sessions were helped and assisted by eight volunteer students (from the Universities of Cagliari, Florence, Perugia, and Bari), who assured technical support and smooth running of the conference proceedings.

The implementation of the software infrastructure and the technical coordination of the volunteers was carried out by Damiano Perri and Marco Simonetti.

Our warmest thanks go to all the volunteering students, to the technical coordinators, and to the development communities of Jitsi, Jibri, Riot, and Matrix, who made their terrific platforms available as open source software.

Our heartfelt thanks go to the keynote speakers: Yaneer Bar-Yam, Cecilia Ceccarelli, and Vincenzo Piuri and to the guests of the closing keynote panel: Mike Batty, Denise Pumain, and Alexis Tsoukiàs.

A big thank you goes to all the 454 speakers, many of whom showed an enormous collaborative spirit, sometimes participating and presenting in almost prohibitive times of the day, given that the participants of this year's conference come from 52 countries scattered over many time zones of the globe.

Finally, we would like to thank Google for letting us livestream all the events via YouTube. In addition to lightening the load of our Jitsi servers, that will allow us to keep memory and to be able to review the most exciting moments of the conference.

We all hope to meet in our beautiful Cagliari next year, safe from COVID-19, and finally free to meet in person and enjoy the beauty of the ICCSA community in the enchanting Sardinia.

July 2020

Ivan Blečić
Chiara Garau

Organization

ICCSA 2020 was organized by the University of Cagliari (Italy), University of Perugia (Italy), University of Basilicata (Italy), Monash University (Australia), Kyushu Sangyo University (Japan), and University of Minho (Portugal).

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Beyond Architectural Barriers: Building a Bridge Between Disability and Universal Design

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Abstract. The paper is focused on the evolution of the concept of accessibility, by considering data of the World Health Organization (WHO) and of the Istat (Italian statistical institute). From these data it emerges that the population (worldwide and in Italy) dealing with disability represents an important share of the total. These disabilities are linked not only with disease, but also with other situation due to age, size, language, culture, job, etc. For this reason, this paper analyses how the way of seeing and dealing disability is changed over time, starting from the Italian Standard evolution. Then the action of the WHO is analyzed. The two WHO focus points are: i) disability is a health condition in an unfavorable environment; ii) disability is not a problem of a minority group within a community, but an experience that everyone, in their lifetime, can experience. All of these analyses underlined the importance of the environment influence on life of every person. Finally, the concept of Universal design UD is investigated, highlighting the importance of recognizing and understanding that human beings will have different steps in their abilities throughout their life. The originality of this research is the shifting of the attention also to people normally served by poor services, such as people of small stature, the elderly, pregnant women, parents with children in strollers, people who speak different languages and more.

Keywords: Accessibility · Disability · Universal design · World Health Organization · Architectural barriers

Notes: This paper is the result of the joint work of the authors. 'Introduction' 'Evolution of accessibility as a function of disability: the regulatory apparatus in Italy', 'New scenarios after COVID-19' era and 'Discussion and Conclusions' were written jointly by the authors. Francesco Pinna wrote the 'Evolution of accessibility as a function of disability: the universal design with its definition and its principles'. Chiara Garau wrote the 'Evolution of accessibility as a function of disability: the action of the World Health Organization (WHO)'.

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1 Introduction

Accessibility, disability and universal design are now outdated concepts, that over the past few years changed their declination and interrelation, thanks to many international associations, whose work was reworked in its entirety by the World Health Organization (WHO) [1–3].

In particular, this change considered the methodological, technical and cultural approach, in relation to problems concerning accessibility and its relationship with disability [4, 5]. To understand this evolution, the authors begin to analyze the definitions of disability and accessibility, while for that one of universal design UD, see paragraph 4. The disability is defined by WHO as a functional impairment, activity limitation, or participation restriction that reflects the interaction between body and society [6].

Accessibility can instead be related to the concept of individual freedom, because there is a limitation for the human being to freedom of movement, knowledge of things and the usability of services where there is inaccessibility [7]. This condition, may be also influenced by the surrounding context and by the effect that endogenous (e.g. one's own abilities) and exogenous (e.g. interference with traffic) phenomena can have on accessibility [8, 9].

The evaluation of accessibility in urban spaces is often evaluated through the calculation of indices, based on infrastructural aspects subjective perceptions [10–12]. However, the design parameters are based on the "standard user" as an agile person with good vision, hearing, and mobility. These design parameters do not meet the needs of the growing disabled population.

To understand the extension of the problem it is useful to give some numbers. The WHO data indicates that approximately 15% of the global population have a disability [13, 14].

In Italy, according to the latest Istat Report of 2019 [15], people with serious limitations in their usual activities are 3,100,000 (5.2% of the population); between these, about 50% belong to the age group >75 years (about 1 in 5 seniors). Approximately 600,000 citizens are deprived of aid services and only 19.2% say they are satisfied with their lives, against 44.5% of the rest of the population. Taking in account some specific aspects, the data are no less worrying with reference to the opportunities for life and socialization.

As for health and independence, 61% of people with serious limitations are in bad health, compared to 0.6% of the rest of the population and there are 1,400,000 non-autonomous elderly people with disabilities. As for education, there are 272 thousand pupils with disabilities who study in schools that only in 31.5% of cases are without physical barriers and, indeed, only in 17.5% of cases are without sensory and perceptive barriers. As for employment, only 31.3% of people with serious limitations are employed (57.8% in the rest of the population) and, of these, 65.4% are satisfied with their jobs (75.9% in the rest of the population). Finally, in participating in cultural and sporting activities, only 9.3% attend museums, theaters, etc. and only 9.1% play sports (respectively 30.8% and 36.6% in the rest of the population).

This picture is certainly disconcerting and strengthens the need for modern and, above all, effective interventions to make sure that disadvantaged people can have a life, as far as possible, with the same opportunities and possibilities as those who do not has problems.

Today this idea has difficulty to be applied and often not for the lack of adequate Standards and Acts. In fact, the regulatory apparatus on architectural barriers is often formally applied, without taking into account unwritten but common-sense elementary rules. Even worse, the set of rules is often applied as an obligation, without having a full knowledge of the whole and the complexity of the issues that are being dealt with.

It appears evident the need to clarify what is at the basis of the removal of architectural barriers, specifying how the solution of these are not only technical solutions, but, more importantly, leads to practical, economic and socio-cultural benefits closely linked to the achievement of accessibility. This approach, seen as a process, and not as an outcome, is extremely tied to the concept of healthy city [16–18] which can also benefit from new transport solutions and emerging technologies [19–22].

In fact, both the public space and the spaces inside the buildings must have adequate accessibility, necessary not only for disabled people but also for the entire community, becoming the characteristic sign of the modernity of a society [23]. In this regard, it results fundamental to adopt inclusive approaches by involving key stakeholders and capturing citizens' preferences from a multiple criteria perspective [24–26].

Starting from these assumptions, the paper is organized as follows. Firstly, a background is given to clarify the evolution of the regulatory apparatus in Italy in relation to the main key concepts of accessibility and disability. Then, the authors analyse the action of the World Health Organization (WHO) in order to underline how it is changed the point of view on deficit, disability and handicap. Finally, the UD with its definition and its principles is analysed with also the new scenarios opened after the COVID-19 era. The paper concludes with a discussion on the findings emerged and on possible future developments on the research in this field.

2 Evolution of Accessibility as a Function of Disability: The Regulatory Apparatus in Italy

In Italy, the set of rules relating to the elimination and overcoming of architectural barriers is always characterized by the distinction between: 1) buildings and public-private spaces open to the public; 2) buildings and private spaces.

The first regulatory action was the law 30/03/1971 No. 118 (in Italian called *Conversione in legge del D.L. 30 gennaio 1971 n° 5, e nuove forme dei mutilati ed invalidi civili*). However, it only concerned public offices or offices open to the public and school, pre-school or social interest institutions, all of them newly constructed. In implementation of this law, the D.P.R. No. 384/1978, now repealed by Presidential Decree 503/1996.

Only in 1986 was the problem tackled again, providing for a ban on approving construction and renovation projects in compliance with the technical standards relating to the removal of architectural barriers and establishing that all buildings in contrast with these provisions could not benefit from public contributions or subsidies.

The discipline of architectural barriers in private construction was born, instead, with the Law 09/01/1989 No. 13 (in Italian called *Disposizioni per favorire il superamento e l'eliminazione delle barriere architettoniche negli edifici privati*) and the relative Implementation Regulation adopted with Decree of the Ministry of Public Works 14/06/1989 No. 236. In this law the problem was faced with a different logic since attention is focused on prevention rather than on the amnesty of buildings. That is, compliance with the technical requirements of the Implementing Regulation is imposed on both new and renovated buildings.

What was still partially excluded from the scope of the legislation were the renovations and extraordinary maintenance works, the restoration and conservative restoration.

Law 05/02/1992 No. 104 (in Italian called *Legge quadro per l'assistenza, l'integrazione e i diritti delle persone handicappate*) was issued, in order to deal with every possible aspect of the handicap. The art. 24 of this law recalls all the current legislation on the removal and overcoming of architectural barriers, referring no longer to new or existing buildings but also to the concept of "building works". This law briefly extends the scope of application not only to the renovation of entire buildings, but also to smaller renovations. Furthermore, this law provides for penalties for technicians for works realized in compliance with the regulations.

Therefore, the discipline of architectural barriers in private construction in the nineties was more up to date and coherent with EU guidelines than that relating to public buildings.

The Presidential Decree 24/07/1996 No. 503 (in Italian called *Regolamento recante norme per l'eliminazione delle barriere architettoniche negli edifici, spazi e servizi pubblici*) intervened to modify this situation. It gave new more specific provisions for public spaces and buildings and, at the same time, extended the requirements of Ministerial Decree 236/1989 to these categories. In particular, the projects of public spaces and urbanization works with prevalently pedestrian use have to include at least an accessible path capable of allowing the use of services, social relations and environmental use also for people with reduced or impeded motor skills or sensory.

Finally, Law No. 67 of 01/03/2006 (in Italian called *Misure per la tutela giudiziaria delle persone con disabilità vittime di discriminazioni*) establishes measures for the judicial protection of people with disabilities who are victims of discrimination. This condition occurs "when an apparently neutral provision, criterion, practice, act, pact or behavior puts a person with a disability at a disadvantage compared to other people".

Italy, with Law No. 18 of 03/03/2009, ratified and enforced the United Nations Convention on the Rights of Persons with Disabilities, adopted by the UN General Assembly on 13 December 2006 and entered into force May 3, 2008 [27].

In all international laws, as well as in Italy, the legislative requirements regarding the removal of architectural barriers do not constitute a constraint but are configured as an added value aimed at a better quality of the work as it is more enjoyable and certainly safer. It is also evident that it is necessary not to design "dedicated" solutions only for disabled people but to have all users as users of these interventions, thus obtaining generalized benefits.

However, this regulatory process has not been able to completely eliminate the discrimination related to the technical solutions identified. A clear example of this is

Law 13/1989 which sets three quality levels that can be reached by design without barriers: accessibility, visitability and adaptability.

Accessibility expresses the highest level as it allows the total use of the structure in the immediate term. The visitability represents a level of accessibility limited to a more or less extended part of the structure which allows, in any case, any type of fundamental relationship also to the person with reduced or impeded motor or sensory capacity. Adaptability represents a reduced level of quality, potentially susceptible to transformation into an accessibility level, thus placing itself as a deferred accessibility.

In practice, adaptability means the possibility of modifying the built space over time at limited costs, in order to make it completely and easily usable even by people with reduced or impeded motor or sensory capacity.

However, these three levels are now outdated, also because they continue to maintain a clear distinction in the use of space between "able-bodied" users and users with reduced or impeded motor or sensory capacity. Beyond accessibility, in fact, visibility does not make the space totally usable, but identifies special solutions for special people, thus maintaining discrimination, even if hidden by the given possibility. Adaptability is, instead, a subtle form of discrimination as it allows to create spaces that are not accessible but that can be transformed at a reduced cost; this discrimination is evident, first of all, because it provides that the achievement of full accessibility is at the expense of disadvantaged people and not, in some way, of the community and, secondly, that this possibility is strictly linked to the economic capacity of those who must intervene: the costs, in fact, become limited if someone can afford them, otherwise they are always and in any case inaccessible.

Finally, going beyond the regulatory process, it is necessary to make a very important consideration on the public space: this often has characteristics not comparable with those of private spaces, especially when the intervention concerns the oldest urban fabric and areas with more altimetric trends handled. In any case, cities are believed to have a good degree of adaptability to removal of architectural barriers.

3 Evolution of Accessibility as a Function of Disability: The Action of the World Health Organization (WHO)

The action of the WHO has developed over time, identifying three fundamental evolutionary phases. The first is responsible for the historical definition of the handicap of 1980, contained within the "International Classification of Impairments, Disabilities, and Handicaps" [28]. It distinguished three levels:

- Impairments (I code), concerned with abnormalities of body structure and appearance and with organ or system function) resulting from any cause; in principle, impairments represent disturbances at the organ level.
- Disabilities (D code), reflecting the consequences of impairment in terms of functional performance and activity by the individual; disabilities thus represent disturbances at the level of the person.

- Handicaps (H code), concerned with the disadvantages experienced by the individual as a result of impairments and disabilities; handicaps thus reflect interaction with and adaptation to the individual's surroundings.

The second phase starts in 1999, when WHO published the new International Classification of Functioning and Disability: ICIDH-2 [29], where two of the three main concepts that characterize a morbidity process are redefined:

- its externalization: impairment
- objectification: no more disabilities but personal activities
- the social consequences: no more handicaps or disadvantages but different social participation

More precisely:

- with personal activities we consider the limitations of nature, duration and quality that a person undergoes in his/her activities, at any level of complexity, due to a structural or functional impairment. Based on this definition, each person is disabled.
- with social participation we consider the restrictions of nature, duration and quality that a person suffers in all areas or aspects of his/her life due to the interaction between impairments, activities and contextual factors.

In the new WHO classification, the term "handicap" is definitively shelved because the handicap is a relative and not absolute fact, as opposed to the deficit. For example, blindness cannot be denied and is therefore absolute; the disadvantage (handicap) is related to living and working conditions, therefore to the reality in which the blind person is placed. The handicap is therefore a meeting between the individual and the situation. It is a reducible or (unfortunately) increasing disadvantage.

The third phase was born in 2001, with the International Classification of Functioning, Disability and Health (ICF) [30]. It defines an innovative, multidisciplinary and universal approach classification tool.

The ICF describes the state of health of people in relation to their existential areas (social, family, work) in order to catch the difficulties that in the socio-cultural context can cause disabilities. It therefore describes not people, but their situations of daily life in relation to their environmental context and highlights the individual not only as a person with diseases or disabilities, but, above all, highlighting their uniqueness and globality.

In summary, there are two innovative aspects of the ICF classification. The first is related to the extensive analysis of the health status of individuals and places the correlation between health and the environment, defining disability as a health condition in an unfavorable environment. Previously with the other classifications (ICD and ICIDH), terms such as illness, impairment and handicap were largely used, mainly in the negative sense, with reference to situations of deficit. The new concept of disability is instead based on elements such as universalism, the integrated approach and the multidimensional model of functioning and disability.

The second aspect is based on the concept that disability is not a problem of a minority group within a community, but an experience that everyone, in their lifetime,

can experience. WHO, through the ICF, proposes a model of universal disability, applicable to any person, able-bodied or disabled as each person can be in a precarious environmental context. This can cause disability regardless of whether the cause of the discomfort is physical, psychic or sensory in nature. What matters is to intervene in the social context by building material and immaterial infrastructures that reduce disability.

Disability is therefore not only a deficit, lack, deprivation on an organic or psychic level, but it is a condition that goes beyond limitation, which overcomes mental and architectural barriers [31]. Disability is a universal condition [32] and therefore it is not only applicable to the person who is in a wheelchair, who does not see or hear. Therefore, the evaluation of the influence of the environment on the life of individuals becomes important: society, the family and the working context can influence the state of health, decrease our ability to perform tasks that are required and put us in a difficult situation.

4 Evolution of Accessibility as a Function of Disability: The Universal Design with Its Definition and Its Principles

The definition of Universal Design (UD) is changed over time, just as there are numerous ways to define it (inclusive design [33, 34], design for all, life span design, etc.) [23]. Its first definition focused on usability issues: "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" [36]. Today, the meaning includes broader issues of social inclusion. The new definition states that UD is "a process that enables and empowers a diverse population by improving human performance, health and wellness, and social participation" [37: p. 56]. The general principle is that UD is useful to have a life easier, healthier, and friendlier for all.

UD improves the quality of life for a wide range of individuals and puts people with disabilities on an equal playing field. It does not substitute for assistive technology, but benefits people with functional limitations and society as a whole, supporting people in being more self-reliant and socially engaged. For businesses and government, it reduces the economic burden of special programs and services designed to assist individual citizens, clients, or customers.

From this point of view, UD should be considered a process rather than an end state.

Starting from these assumptions, the UD is the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design [38]. Table 1 shows the principles of UD and their related guidelines.

The principles of UD address only universally usable design, while the practice of design involves more than considerations for usability. Designers must also incorporate other considerations, such as economic, engineering, cultural, gender and environmental concerns, into design processes. These principles offer designers guidance to better integrate features that meet the needs of as many users as possible.

Table 1. The principles of Universal Design and its Guidelines [39]

Principles	Guidelines
Equitable use	1a. Provide the same means of use for all users: identical whenever possible; equivalent when not 1b. Avoid segregating or stigmatizing any users 1c. Allow provisions for privacy, security and safety that are equally available to all users 1d. Make the design appealing to all users
Flexibility in use	2a. Provide choice in methods of use 2b. Accommodate right or left-handed access and use 2c. Adapt to user's accuracy and precision 2d. Provide adaptability to the user's pace
Simple and intuitive use	3a. Eliminate unnecessary complexity 3b. Be consistent with user expectations and intuition 3c. Accommodate a wide range of literacy and language skills 3d. Arrange information consistent with its importance 3e. Provide effective prompting and feedback during and after task completion
Perceptible information	4a. Use different modes (e.g., pictorial, verbal, tactile) for redundant presentation of essential information 4b. Provide adequate contrast between essential information and its surroundings 4c. Maximize legibility of essential information 4d. Differentiate elements in ways that can be described (in order to make it easy to give instructions or directions) 4e. Provide compatibility with a variety of techniques or devices used by people with sensory limitations
Tolerance for error	5a. Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated or shielded 5b. Provide warnings of hazards and errors 5c. Provide fail-safe features 5d. Discourage unconscious actions in tasks that require vigilance
Low physical effort	6a. Allow users to maintain neutral body position 6b. Use reasonable operating forces 6c. Minimize repetitive actions 6d. Minimize sustained physical effort
Size and space for approach and use	7a. Provide a clear line of sight to important elements for any seated or standing user 7b. Make reach to all components comfortable for any seated or standing user 7c. Accommodate variations in hand and grip size 7d. Provide adequate space for the use of assistive devices or personal assistance

To update these principles, eight goals of UD were developed, specifying the concept of UD, resulting in human performance, health and well-being and social participation, and addressing contextual and cultural issues.

In middle and low-income countries, one barrier to adoption of UD is the fact that it is often perceived as idealistic, expensive, or an imposition of Western values. This fact can be overcame considering that design strategies will differ or be adapted in different places and by different cultures. In fact, it is important that UD strategies also concern cultural values associated with social, economic, and physical context.

Table 2 shows the eight goals [37].

Table 2. The eight goals of Universal Design

	Goals	
1	Body fit	Adapting to a wide range of body sizes and abilities
2	Comfort	Keeping needs within desirable limits of body function
3	Awareness	Ensuring that critical information for use is easily perceived
4	Understanding	Using methods of operation and use intuitive, clear, and unambiguous
5	Wellness	Contributing to health promotion, avoidance of disease, and prevention of injury
6	Social integration	Treating all groups with dignity and respect
7	Personalization	Incorporating opportunities for choice and the expression of individual preferences
8	Cultural appropriateness	Respecting and reinforcing cultural values and the social, economic and environmental context of any design project

The principles of UD bring with them the concept of Universal Abilities. The aim is to recognize and understand that human beings will have different steps in their abilities throughout their life. This takes us to think that there are no distinctions between citizens with or without disabilities, highlighting what is usable and safe for all. This leads to shifting attention also to people normally served by poor services, such as people of small stature, the elderly, pregnant women, parents with children in strollers, people who speak different languages and more.

The comprehension of disability is, from this point of view, very useful: the knowledge of the basic characteristics of different disabilities and the consequent barriers is critical towards understanding individual needs and how to address them when designing the built environment. There are many types of disabilities, that, for ease of reading, can be divided in these classes [40: p. 11]:

Physical Disabilities: involve limited mobility (to walk, move, stand for long periods or to carry objects) or stamina, or restricted skill (to bend, dress, feed oneself, or to use everyday objects).

Visual Disabilities: involve complete blindness, limited or residual sight, but also a loss of visual clarity/acuity or a decrease in the size of the visual field.

Auditory Disabilities: involve people having partial or no hearing (persons who are deaf, deafened or hard of hearing). The difference can be various: for someone, the loudness of the sound will determine whether it is heard, for others, it depends on the type of sound (e.g., consonants versus vowels, or the intonation). In other cases, individuals may also become confused by certain sounds due to excessive background noises.

Situational Disabilities: involve people with difficulties caused by age, size, language or culture. In specific settings involve persons who are situationally disabled. Other types are people with small children, carrying heavy objects, or people with temporary accident injuries.

Mental Health Disabilities: they are very numerous and different and overlap with other types of disabilities, including emotional disabilities. Some common mental health disabilities include bipolar disorder, psychosis, schizophrenia, anxiety, attention deficit, mood and eating disorders. In addition, mental health is often influenced by external factors, such as where people live, their individual environments, genetics, income and education levels, and people's relationships with friends and family.

Emotional Disabilities: their causes are very varied and common forms are depression, anxiety or stress, that can be hidden or apparent. They may appear as indifference or mood swings.

Intellectual, Developmental and Learning Disabilities: cognitive impairment can vary widely, from severe intellectual disabilities, to the inability to remember, to the absence or impairment of specific cognitive functions (language, autism). A particularly complex disability is autism. Children and adults with autism have difficulties in verbal and nonverbal communication, social interactions, and leisure or play activities.

Therefore, disabilities are many and extremely different and this is certainly a complication for whom are choosing the best solutions. In fact, the removal of architectural barriers is not exclusively a problem for the categories of extreme hardship: the numerical increase of the elderly population (with their numerous degenerative diseases), the number of people affected from injury (forced for a certain period to undergo limitations in their usual mobility), pregnant women, but also parents and grandparents with prams or strollers, workers moving loads or even only people who go to shopping with a trolley makes it clear that remove barriers is a way of generating a city for everyone.

This issue is central to UD, which sets the criteria for a design inclusive and valid for all.

In fact, often, thinking to solve one problem, another determines. This is because a sectoral vision can determine a consequence on someone with problems different from one considered. An example is the substantial difference that the intervention has towards visually impaired people or people in wheelchairs: for the first, a perfectly connected infrastructure, with no elevation continuity, will be an absolute perceptive barrier, for the latter the altitude difference is an absolute physical barrier. But a soil

roughness, not carefully evaluated or not limited in reasonable portions from a functional and dimensional point of view, can also be a barrier.

It must therefore be concluded that the sub-categories of the various disabilities are many as well as the answers to be given to the disabilities present in our society are innumerable. There is never a valid solution in the exact measure for everyone.

However, following COVID-19 pandemic some reflections emerged which will be described in the following paragraph.

5 New Scenarios After COVID-19 Era

The global situation linked to the COVID-19 pandemic highlighted the presence of elements of discrimination that were previously difficult to identify, above all because some behaviours, action methodologies or information and education systems, created to combat the pandemic, could become commonplace. The COVID-19 has emphasized the higher risk for people with disabilities or chronic illnesses, especially in low and middle-income countries. In order to overtake this problem, people with disabilities must be included in all plans to manage the current COVID-19 coronavirus outbreak. This implies that the information provided by governments and institutions both to prevent infection and to know how to act in case of illness must be available in accessible formats, including sign language, video captioning, the use of alternative text in images and graphics displayed digitally, and easy-to-read versions. Secondly, it is necessary to face the problem in accessing health services and hygiene products, as well as to consider reasonable accommodation measures to allow people with disabilities to study or work from home and, if that is not possible, to ensure they receive enough education or a paid leave to guarantee their income. Similarly, the decision of many States to introduce confinement measures to fight the pandemic should be adapted to the needs of specific groups to ensure their well-being. For example, people who need home assistance should keep receiving it and, in the case of people with psychosocial disabilities, they cannot be required to live in total isolation [41].

These goals are achieved, by considering the following points:

- ensuring public health information and communication around COVID-19 is fully accessible.
- any supporting documents on COVID-19 should be fully accessible to people with disabilities. All agencies should publish and share their information on COVID19 in accessible formats, including in which shared materials are accessible online for people using screen reader software, and presentation materials accessible using universal design elemental and additional formats, such as the use of sign languages, Easy Read, plain language, captioned media, Braille, augmentative and alternative communication, and other accessible means.
- the WHO COVID-19 Disability Briefing will became the basis for any indications or advice.
- the collaboration with representative organisations of people with disabilities to distribute fully accessible public health information should be active [42].

From this point of view, the International Disability Alliance (IDA) compiled a list of the main barriers that people with disabilities face in this emergency situation along with some practical solutions and recommendations [43] (Table 3).

Table 3. International disability alliance key recommendations

	Key Recommendations
1	People with disabilities must receive information about infection mitigating tips, public restriction plans, and the services offered, in a diversity of accessible formats with use of accessible technologies
2	Additional protective measures must be taken for people with certain types of impairment
3	All preparedness and response plans must be inclusive of and accessible to women with disabilities
4	No disability-based institutionalization and abandonment is acceptable
5	During quarantine, support services, personal assistance, physical and communication accessibility must be ensured
6	Measures of public restrictions must consider persons with disabilities on an equal basis with others
7	Persons with disabilities in need of health services due to COVID19 cannot be deprioritized on the ground of their disability
8	Organizations of Persons with Disabilities can and should play a key role in raising awareness of persons with disabilities and their families
9	Organizations of Persons with Disabilities can and should play a key role in advocating for disability-inclusive response to the COVID19 crisis

6 Discussion and Conclusions

In this paper the authors have analyzed the national and international evolution of the issues concerning what, in an elementary way, has always been called removal of the architectural barriers. Analyzes have shown the overcoming of this concept, which has always been linked, above all, to physical disability.

UD, on the other hand, has shown that the handicap is not linked, as traditionally thought, to the deficit, but that it depends strictly on the environment in which the human being is forced to live. This implies that it is necessary to extend the concept of disability to all citizens because each of them will happen to be in conditions of disability, temporarily (due to fractures, surgical operations, etc.) or definitively, by age, by social status, etc.

In this regard and in accordance with WBDG Accessible Committee [35], the analysis of the principles and goals of UD highlights some issues (such as aging in place, sustainability, workplace design, public spaces, and social justice). The following considerations can be made on these issues.

Aging in Place: many people want to age where they currently live. A research [44] on adults over the age of 65 showed that almost 90% want to remain in their own home for as long as they are able and 80% plans to live permanently in their current residence. Aging in place offers numerous social and financial benefits and promotes keys to successful aging such as life satisfaction, health, and self-esteem. Another research [45] describes factors that often prevent older adults from aging in place (such as land organization for car use, lack of access to transportation, etc.). Others who remain in their homes with barriers that endanger their safety and limit their ability to participate in the community due to the costs of the necessary renovations.

To remain in their own homes while aging, people need housing designs that can be adapted to wider range of health conditions than usual. So, it is necessary to adopt UD features for aging in place. This includes a no-step entry, bathrooms on an accessible floor level, a sleeping space on an accessible level, good lighting, efficient space planning, and other features that reduce effort and accommodate short-term and chronic disabilities.

Sustainability: Sustainable products used in buildings need to be designed not only for people with limited function in order to comply with accessibility laws, but also for the broader population or they will not be effective in practice. Due to their novelty, they often present usability issues to end users. Acceptance of innovative sustainable products can be enhanced through UD.

Workplace: UD is a basic consideration when designing workplace environments for several reasons: 21.3 million (nearly 65%) of American adults with disabilities in working-age (16–64 years old) live with a chronic condition that inhibits their capacity to maintain employment [46]. Good design of the workplace can help increase participation of people with disabilities in the workforce and can help to ensure that fewer accommodations will be needed if an employee has a disability. Additionally, achieving the highest level of usability in the workplace environment increases overall task efficiency, productivity, employee morale, and general safety.

Public Spaces: they include facilities open to the public such as stores, restaurants, amusement parks, parks and other recreation facilities, street rights-of-way, and transportation systems. Public arrangements are a critical domain for UD because they are characterized by participation activities, such as civic affairs, employment, recreation, education, and community mobility.

Social Justice: although initially focused on disability rights, UD can focus on any civil rights issue because design for diversity is concerned with social justice for all. Thus, UD should give attention to supporting access to housing, education, healthcare, transportation, and other resources in society for all those groups that have been excluded from full participation. UD is particularly appropriate in the context of design for low-income minority groups, which often have higher rates of disability than the general population.

These issues represent only some aspects on which great attention has never been paid and on which the authors intend to focus their research in the future.

In addition, the analysis led the authors to reflect on the concept of accessibility in cases where problems related to disability are being treated. In fact, this concept is widely used in its meaning of possibility of accessing a place, a service, a good, etc.

A classic example of this is accessibility linked to transport infrastructure problems, material and immaterial links between areas, or more generally, to problems related to ease of movement rather than full usability.

With this work, the authors argue that for problems related to disability it is preferable to use the term "usability" instead of accessibility, which makes more evident the character of a device, a service, a resource or an environment to be easily usable by any type of user.

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