

ON INCLUSION, DIVERSITY, EQUITY, AND ACCESSIBILITY IN CIVIL ENGINEERING AND ARCHITECTURAL DESIGN. A REVIEW OF ASSESSMENT TOOLS.

Zallio, Matteo;
Clarkson, P. John

University of Cambridge

ABSTRACT

Since the mid-20th century, assessing the performance of the built environment was recognized as an instrument to improve the efficiency in the design and construction processes. However, it appears difficult to identify assessment tools that currently include a holistic assessment of inclusion, diversity, equity and accessibility criteria for the built environments.

A systematic literature review was performed to define the state of the art of assessment tools in the domain of civil engineering and architectural design, and to identify gaps in the criteria of inclusion, diversity, equity, and accessibility.

The review highlighted three fundamental aspects. First, how the binomial relationship between regulations and assessment tools is not mutually exclusive. Second, how the process of assessing buildings is shifting towards mixed evaluation methods. Third, how assessment tools have been developed with a perceivable evolutionary latency from when standards were released.

With this work, we produced a state-of-the-art overview about inclusion, diversity, equity and accessibility (IDEA) in the built environment, to inform the development of tools that will foster the design of future inclusive environments.

Keywords: Design methodology, Inclusive design, Evaluation tool, Decision making, Built environment

Contact:

Zallio, Matteo
University of Cambridge
Department of Engineering
United Kingdom
mz461@cam.ac.uk

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1 INTRODUCTION

Since the mid-20th century, assessing the performance of the built environment was recognized as an instrument to improve the efficiency in the design and construction processes (Duncan, 1971).

Measuring, assessing, and rating the inner performance of manufacts, considering parameters such as thermal, lighting, air, and water quality, involves gauging the performance against a single criterion or a set of criteria (Francescato, 1991). Civil engineering and architectural design regulations and assessment tools have the power to influence the design process by covering different phases of the building's life cycle, embracing mostly environmental challenges (Haapio and Viitaniemi, 2008).

Advances in people-centred design approaches, more inclined to answer people's needs and priorities (Patnaik and Becker, 2010), brought the emergence of methods and tools to improve the design of accessible and inclusive built environments. Through this paradigm shift in civil engineering and architectural design practice, the design of the built environment started evolving from merely addressing the performance of the built environment towards addressing needs related to accessibility (Zallio and Casiddu, 2016). This evolution slowly embraced a more holistic approach, encompassing a wider concept of accessibility and inclusion (Mosca and Capolongo, 2018) and equity (Smith, 2011), focusing on people of all abilities, age, sex, gender, race, ethnicity, language, cultural background, national origin, ideology, and religion. More recently, with the growth of societal challenges and improved understanding of people's needs and aspirations, it appears fundamental to shift towards assessing additional features related to inclusion, diversity, equity and accessibility in the built environment. Due to these evolving factors, this article aims to review current cutting-edge research on assessment tools that focus on evaluating and measuring incorporated features such as Inclusion, Diversity, Equity and Accessibility (IDEA) in the built environment. The purpose of this study is to challenge the need for more holistic assessment tools as means to improve the civil engineering and architectural design and development process of environments that guarantee inclusion, diversity, equity, and accessible spaces for all human beings. The long-term goal of this study is to positively impact the research and practice of decision-makers, engineers, designers, architects, as well as research practitioners, aiming to foster awareness on IDEA-proof environments and to identify potential challenges to be addressed with further Inclusive Design research.

2 FROM DESIGNING FOR THE DISABLED TO DESIGNING INCLUSIVELY

Inclusive Design (ID) strives for optimizing the design and development of solutions for individuals with specific needs, also recognized as “extreme user” focusing on functional interactions (Coleman, 1994, Clarkson et al., 2003). In the civil engineering and architectural design practice, several studies suggest that the adoption of the ID approach is limited so far (Basnak et al., 2015, Heylighen et al., 2017). Some of the reasons are positioned in the awareness on inclusivity and diversity of design practitioners and how holistic tools and metrics can help them to achieve such a level of inclusivity and diversity in their designs (Van der Linden et al., 2016). The emergence of designing products and environments tailored to people's needs became relevant in the international scenario due to one of the first standards aiming to address the needs of people with disabilities: the ANSI 117.1–1961, the first American accessible design standard (ANSI, 1980). Following this path, a growing effort towards a more accessible design practice took place in the decades ahead. In 1988 the Transgenerational Design approach became of public domain (Pirkl and Babic, 1988) and shortly after in 1990, the effort to allow access in the built environment for people of all abilities, culminated with the release of the Americans with Disabilities Act (ADA), the first American law requiring accessibility for governmental buildings (Lebovich, 1993). Shortly after, in the British scenario, the Disability Discrimination Act (DDA) in 1995 guided to avoid discrimination against disabled persons, the provision of goods, facilities, and services (UK, 1995). Both ADA and the DDA created the context for the birth of Universal Design (UD) in 1991 (Mace, 1991, Story, 1998) as well as the development of the European Institute for Design and Disability (EIDD) and the Design for All (Europe) approach (Coleman et al., 2003). The evolution of design for disability into accessibility and consequently design for inclusion emphasized the relevance of the person not only in the product design domain but also in the architectural design domain. With the rise of a wider sensitiveness among engineers, architects, and designers of ID practices, policymakers started implementing standards and regulations to nurture the design of more inclusive environments. Several standards and policies developed at a national and international level, such as the ISO/TR 9527:1994 (Building construction. Needs of

disabled people in buildings. Design guidelines), the ISO 21542:2011 (Building construction. Accessibility and usability of the built environment) (ISO, 2011), the revised code of practice BS 8300-1|2:2018 (Design of an accessible and inclusive built environment) (BSI, 2018), and the EN 17210:2021 (Accessibility and usability of the built environment) (EN, 2021), address issues mainly around physical accessibility, by suggesting technical requirements and recommendations for the design of accessible built environments. They mostly focus on a user journey approach, where accessibility, horizontal and vertical circulation, together with sensory features such as wayfinding, use of materials and colours criteria help architects and designers to create accessible and user-friendly spaces. Therefore their scope is not to provide tools to measure inclusivity and accessibility, i.e. how a building works for a range of users or how people may feel inside a building (Iwarsson and StÅhl, 2003), but to mainly guide the design process. Assessment tools have the potential to rate the built environment and importantly to influence, in the long run, regulations and best practices for an improved design process. Due to these facts, it appears that the evolution of the design practice, regulations, and assessment tools can be expressed with an analogy where regulations and assessment tools should be similar to rails of a railway that run parallel. The advancement of one implies the progress of the other and they constantly inspire their mutual evolution. A systematic literature review was used to clarify the state of the art and to understand gaps in the area of assessment tools on inclusion, diversity, equity and accessibility in the built environment.

3 A SYSTEMATIC LITERATURE REVIEW

A systematic literature review was performed to define the state of the art of assessment tools in civil engineering and architectural design, and to identify gaps in the domain of IDEA. The time frame of the analysis spans from 1994 to 2020 and allows to investigate more than a quarter of a century of advances in the field. The year 1994 was chosen, due to the release of the regulation ISO/TR 9527:1994, a milestone for the concept of disability and inclusion in the built environment. The search was performed in the last quarter of 2020 from Scopus and Science Direct databases that included peer-reviewed scientific journals, books, and conference proceedings, and grey literature.

The literature review search considered only English language articles and was completed by following different steps. The first search phase was articulated with the following terminology: accessibility, diversity, equity, inclusion, Inclusive Design, Universal Design, and Design for All. The first four terms are adjectives used to characterize and gauge the performance of the space and objects concerning human needs and capabilities. The terms ID, UD, and DfA are recognized as major design approaches and practices, interchangeably used by the scientific community in the area of civil engineering and architectural design. The query used was: TITLE-ABS-KEY ("accessibility" OR "diversity" OR "equity" OR "inclusion" OR "universal AND design" OR "inclusive AND Design" OR "Design PRE/2 all").

The second search phase was articulated with the following terminology: assessment and rating as they are within the main scope of this research. The query was: TITLE-ABS-KEY ("Assessment" OR "Rating"). The third search phase focused on the built environment and architecture thematic areas. The query was: TITLE-ABS-KEY ("Built AND Environment*" OR "Architectur*").

A final search was performed by incorporating the three previous search terms.

3.1 Results

Articles were selected by first reviewing titles, keywords, and abstracts and the search produced a total of 1,343 results. A further criterion of exclusion was enforced with limitations to the disciplinary fields of Engineering, Arts and Humanities, Environmental science and Business, Management, and Accounting. This produced 509 results. A remarkable finding brought attention to the evolution of the research on assessment tools for accessibility and inclusivity in the built environment. Within the selected time frame a notable growth of peer-reviewed articles happened to start from the year 2013 with a minor decrease in 2014, then followed by an ever-increasing number of articles published every year from the year 2015. After the first review of titles and keywords, the number of selected items was reduced to 54, with a strong emphasis on works that studied and developed assessment tools on accessibility, inclusivity, diversity and equity in the built environment. Further analysis was performed through a review of the abstracts and the final list of works included 17 items that met the selection criteria. The selected articles went through a full-text examination and ultimately were analysed and

classified according to assessment methodology, challenges addressed, building typology, and application of the assessment tool.

3.2 Findings

The literature review analysis highlighted the gaps and opportunities for future advances in the assessment tools scenario. The search terms were classified according to author, publication year, and applications. Under applications aspects such as the assessment method used in the tool, challenges addressed, building typology, and which phase of the design process the tool could be applied were listed. One of the first insightful findings of this review is the distribution of works across the years. Out of 17 items analysed across 26 years, 11 articles (64.7%) were published in the time frame between 2015 and 2020. That points out the rising awareness in the research setting as well as the growing demand to create more holistic assessment tools for the built environment. According to Preiser, assessment tools should gauge objectively performance criteria across the whole measuring process (Preiser, 2010). Physical accessibility is a criterion mostly measurable through the assessment of numeric and quantitative parameters based on policies and regulations (Ponsard and Snoeck, 2006). However, we can argue that a broader concept of accessibility, which includes sensory and cognitive accessibility, is not uniquely measurable through only quantitative parameters. Table 1 below shows the list of selected items with categorization.

Table 1. Selected items classified according to author, publication year, assessment method (objective (1), subjective (2), mixed method (3)), challenge addressed, building typology (All types of buildings (a), residential (b), educational (c), urban environments (d), rural environments (e)), and application of the tool.

Author	Year	Method	Challenge	Building typology	Tool application
Iwarsson, S.	1999	1	Accessibility	(b)	Research, practice
Wu et al.	2007	1	Accessibility	(a)	Pre & post design
Sawyer et al.	2007	1	Accessibility	(d)	Pre & post design
UK Government	2011	1	Perceived quality	(b)	Pre & post design
Malecki et al.	2014	1	Environmental, physical, social factors	(d)	Pre & post design
Quintas et al.	2014	1	Accessibility and perceived quality	(d)	Pre & post design
Eisenberg et al.	2015	2	Health and inclusion	(d), (e)	Pre & post design
Lau et al.	2016	1	Physical disability, visual impairments	(c)	Post design
Perez-Delhoyo et al.	2017	1	Accessibility	(d)	Pre & post design
Astiaso Garcia et al.	2017	2	Accessibility and perceived quality	(d)	Pre & post design
Kashef, M.	2017	1	Accessibility, sustainability, diversity	(b)	Pre & post design
Gamache et al.	2018	1	Accessibility, inclusion	(d)	Pre & post design
Jeamwathanachai et al.	2019	1	Accessibility, inclusion	(a)	Pre & post design
Isa Mosca et al.	2020	3	Accessibility, sustainability, inclusion	(a)	Pre & post design
Mercader-Moyano et al.	2020	3	Accessibility, sustainability, diversity	(b), (d)	Pre & post design
Rebernik et al.	2020	3	Accessibility, equity, diversity, inclusion	(d)	Pre & post design
Olukoya et al.	2020	3	Accessibility, sustainability, diversity, inclusion	(b)	Pre & post design

Perceived quality was a key concept that appeared a few times in some of the studies and relates to the overall well-being, physical, and non-physical access to facilities, spaces, and services in a community or building. A further highlight from the recent 5-year time frame reveals that 4 out of 11 tools used keywords and assessment criteria with relationships to equity, diversity, social inclusion, and well-being. These are criteria measurable through a mix of objective and subjective methods of evaluation (Baumgartner and Burns, 2013). In the previous time frame (1994-2015) the vast majority of tools (6 out of 7) emphasized concepts of accessibility and disability assessment, more easily measurable with objective, quantifiable criteria. Tools such as the “Housing Enabler” (Iwarsson, 1999), the “AHP approach” (Wu et al., 2007), the “Measure of Environmental Accessibility - MEA” (Gamache et al., 2018), the “Wisconsin Assessment of the Social and Built Environment - WASABE” (Malecki et al., 2014), the “COURAGE checklist” (Quintas, 2014), the work “Assessing Disability Inclusiveness” (Lau et al., 2016), the “Residential Developments” (Kashef, 2017), the “Methodology for Urban Dynamics Analysis” (Pérez-Delgado et al., 2017), or the “Building Accessibility Measurement” (Jeamwathanachai et al., 2019), are some examples of tools that use objective and quantitative analysis methods, to rate environmental conditions related to disability, inclusion, health and a variety of social aspects. When measuring the sphere of psychosocial and person-related perception of the space, encompassing equity and diversity, a purely and solely objective method doesn't perform well. A hybrid strategy, that uses both objective and subjective methods, with quantitative and qualitative analysis should be preferred (Huxley et al., 2012). Tools such as the “Assessment of Urban Sustainability” (Astiaso Garcia et al., 2017), the “Universal Design-based Framework” (Mosca and Capolongo, 2020), the “MASBE tool” (Mercader-Moyano et al., 2020), the “DIETool” (Rebernik et al., 2020), and the “Social Sustainability Indicators” (Olukoya and Atanda, 2020) are recent examples of tools that use a combination of objective and subjective methods. As a result, several tools dealt with accessibility, however, only a few recent works presented features about inclusion, and more broadly about equity and diversity.

4 TOWARDS HOLISTIC, MIXED-METHOD ASSESSMENT TOOLS

Over the years, assessment tools started shifting their focus from only assessing barrier-free architecture to rating accessibility and lately inclusion. Evaluating accessibility features of buildings should be performed through a reliable and valid professional assessment based on existing norms and guidelines concerning functional capacity in individuals or groups of individuals (Iwarsson and StÅhl, 2003). However, when it comes to understanding aspects of the psychosocial sphere of human beings, encompassing equity, diversity and social inclusion, measuring only physical features of the built environment may constitute a limit. Several factors that relate to neurodiversity come into place. Individual's experience and perspective, people behaviour and abilities, people's attitudes, and subjective perception of the space are some of the most common and are explicitly person-centred and subjective. On the other hand, we can argue that assessing the built environment based only on behavioural and attitudinal characteristics of its occupants, makes appraisal open to interpretations due to lack of objective evidence (Steinfeld and Maisel, 2012). Preiser dealt with the social and psychological factors that constitute criteria for assessing the built environment. The first factor is addressed by basic building regulations (health, safety, security), the second by technological knowledge (functional, efficiency, workflow), and the third encompasses less codifiable social and experiential factors (psychological, social, cultural, aesthetic) (Preiser, 1983).

Therefore, it appears that mixed methods that consider people's needs and experience and physical design characteristics (Iwarsson, 1997) should be preferred.

Mixed methods, composed of qualitative and quantitative user research tools, as well as objective environmental audits, will also help to emphasize the importance of improved design criteria, that go beyond accessibility regulations. Mixed methods have also the potential to recognise the overall level of equity, diversity and social inclusion in the built environment by targeting individual experiences. When it comes to definitions, it is helpful to underline that accessibility is about designing and building a solution usable by as many people as possible. Diversity is about guaranteeing that everybody is recognized as a unique human being: it's about empowering people by respecting and appreciating what makes them different, in terms of age, gender, ethnicity, religion, disability, sexual orientation, education, and national origin. Equality is about ensuring everybody has an equal opportunity and is not treated differently or discriminated against because of their characteristics.

Equity is about ensuring that everyone access to the same opportunities. Inclusion concerns the opportunities that everyone should use the same facilities, take part in the same activities, and enjoy the same experiences, including people who have a disability or other disadvantage (CUP, 2021). All these key components of contemporary society need to be taken into consideration and moderate the people-centrality in different phases of the design and post-design process.

As an outcome, this review highlighted three fundamental aspects. First, how the binomial relationship between regulations and assessment tools is not mutually exclusive. Second, how the process of assessing built environments considering inclusion, diversity, equity and accessibility (IDEA) is shifting towards mixed evaluation methods. Third, how assessment tools are developed with a perceivable evolutionary latency from when regulations and standards (from design for disabled, to design for inclusion) were released.

With the tool “Development of a community health inclusion index” (Eisenberg et al., 2015) published in 2015, there is one of the first attempts to map inclusion as a broader concept, not just limited to accessibility. This example suggests that only recently effort of including aspects of well-being and diversity were embedded within holistic assessment tools. If we consider that a major definition of the term ID dates back to 2003 and the first regulation that explains more into details about ID dates back to 2005 (BS 7000-6:2005), an approximate 10-year evolutionary latency in the knowledge transfer process between, regulations, design practice and assessment tools happen.

To better explain the binomial relationship between regulations and assessment tools, and by mentioning the example given in chapter 2, where regulations and assessment tools should be similar to rails of a railway that run parallel, the explanatory infographic below shows the evolutionary latency between the two complementary domains (Image 1).

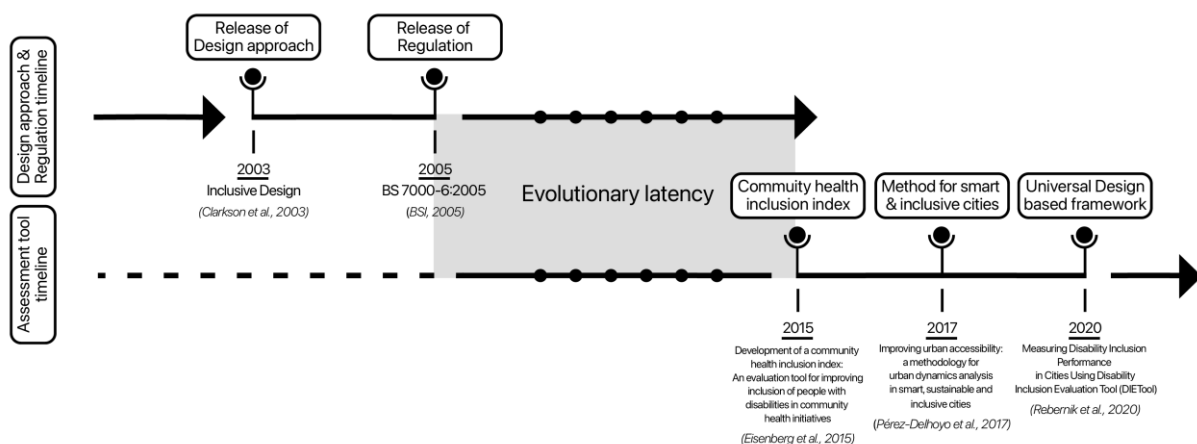


Image 1. A graphical representation of the binomial relationship between regulations and assessment tools and the 10-years evolutionary latency between the two domains.

Due to this parallel evolution between regulations and assessment tools, several aspects should be considered when designing and assessing inclusion, diversity, equity and accessibility in the built environment. As pointed out in the introduction, where the first assessment tools were created to assess the performance of the built environment, nowadays, to guarantee more socially sustainable, accessible, equitable, and inclusive spaces appear indispensable to use holistic assessment tools that use mixed-methods evaluation. As highlighted from this research, the trend is shifting towards mixed-method assessment tools, where a variety of objective methods (i.e., measuring the space, applying coefficients, and visual inspections) should be aligned with subjective methods (i.e., post-occupancy evaluation, satisfaction questionnaires, and user-journey mapping).

5 CONCLUSIONS

While there has been a prominent advancement of regulations and assessment tools for measuring the efficiency, performance, and sustainability of the built environment, just in recent years regulations and holistic tools about accessibility became more common in the civil engineering and architectural design space (Zallio et al., 2016).

With this study, we aimed to highlight the state of the art of assessment tools that consider inclusion, diversity, equity and accessibility (IDEA) with a people-first approach. The review outlined the advances in the domain, as well as the evolutionary latency. Progresses happened on accessibility, however not extensively on inclusion, diversity and equity. Important to highlight that inclusion has the potential to become a form of sustainability as a proclamation about equity and diversity. A design of the built environments that goes beyond accessibility and includes people's feelings, perception, use, relationships among other individuals, and space can positively impact people's lives. Such design can be achieved through forms of awareness-raising mechanism that impact the pre-design and post-design phases. Assessment tools could help to inform decisions for both phases, aiming to push engineers and architects to go beyond the minimum standards requirements. We foresee that holistic, mixed methods approaches to assess the built environment have the potential to guarantee accessible, equitable, diverse and inclusive spaces for everyone. With this work, we aimed to progress critical knowledge fundamental to further develop the IDEA research with the ultimate goal to capture the enormous opportunities of improving people's experience in the built environment.

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Dr. Matteo Zallio wrote the introduction, the state of the art, developed and wrote the research methodology, results and findings, contributed to conclusions and designed the infographic.

Prof. P. John Clarkson wrote the conclusions and supervised the overall research.

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