



Inclusion, diversity, equity and accessibility in the built environment: A study of architectural design practice

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ABSTRACT

Accessibility is generally recognised as an important element of architectural design practice. However, studies suggest that the adoption of Inclusive Design by the architectural design community is still quite limited. Inclusive Design embraces the principles of accessibility and its extended definition considers key sociological and behavioural aspects such as physical, sensory and cognitive needs.

This paper presents the results of an ethnographic study, conducted amongst 26 professionals from the building industry, on the adoption of Inclusive Design.

This research aims to explore the challenges and limitations that professionals experience in their daily working practice and to identify strategies to expand the use of Inclusive Design and its extended definition.

The findings emphasise how education and awareness are essential factors to encourage an inclusive mindset amongst architectural design professionals and other stakeholders. In particular, holistically mapping the user journey during the design phase and collecting and evaluating post-occupancy user feedback are complementary strategies that can foster a design process based on inclusion, diversity, equity and accessibility principles for the built environment.

1. Introduction

Designing for the whole population with a variety of different needs is challenging and stimulating. Design gives form to people's desires following fit, function, safety, budget, sustainability, regulatory requirements, physio-psychological and social needs as fundamental variables of the architectural design process [1,2].

In a continuous effort to connect all potential user needs and design requirements in a project, sustainability and accessibility, two qualities amongst many, have become more relevant in recent years. Accessibility in the built environment is often defined within a variety of design approaches such as Universal Design (UD) [3], Inclusive Design (ID) [4], and Design for All (DfA) [5].

We can see that a shift towards more physically accessible environments has occurred over the past decades and there is an overall higher level of attention on accessibility.

Notwithstanding the spread of user-centred design approaches, research suggests that overall, rather than designing buildings considering the large variety of user needs, such as those of neurodivergent individuals or underrepresented minorities, there is still a strong focus

on design to address physical accessibility challenges (e.g. wheelchair-accessible entrances, walker-accessible elevators, easy-to-use door handles, etc) [6,7].

ID lags behind physical accessibility, however, research reported that full adoption of ID in architectural design practice has been limited in the last two decades and that ID is generally misunderstood by architectural design professionals [8–10]. Due to this fact, it is often still possible to witness inequalities, exclusion and discrimination at different levels and in different spaces. As a result these challenges can potentially affect people's behaviour and perception of society [11]. Recent social movements, such as the Black Lives Matter movement [12], or the Ni Una Menos [13], clearly demonstrate that the concept of inclusion is concerned with social, cultural and behavioural aspects and the environment in which people live constantly influences these.

That is to say, inclusion is not merely a matter of making a design that works well for people with disabilities, but its extended definition also includes understanding how people behave, how they socialise, how they live and how they access the space. Inclusion is informed by, and helps to create the structures that include large-scale social movements and as a result, is more at the forefront of the minds of designers.

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ID, a design process in which a mainstream product, service or environment is designed to be useable by as many people as reasonably possible [14], is gradually evolving to find a natural extension of its scope to incorporate the principles of social equity and diversity.

Furthermore, it appears that the recent notion of building inclusively is aiming to go beyond the concept of purely addressing physical accessibility, by embracing further key sociological and behavioural aspects of human beings, such as physical, sensory and cognitive needs [15].

With this research, we aim to investigate the broad thinking, challenges and opportunities that ID can bring to the building industry, and the perceptions that architectural design professionals have about ID in their current work practice. An extended definition of the term ID was given by emphasising fundamental aspects that go above and beyond physical accessibility. These include sensory and cognitive inclusion for neurodivergent individuals and an understanding of people's diversity and equality guaranteed by spaces that offer the same opportunities to all individuals. Embracing these aspects in the extended definition led to a summary of the relevant keywords with the acronym of IDEA in the built environment, suggesting four fundamental characteristics: Inclusion, Diversity, Equity and Accessibility, which should constitute a fundamental part of the current and future agenda of architectural design professionals.

Qualitative research was carried out and semi-structured interviews were conducted amongst architectural design professionals, including architects, access consultants and academic experts across several countries. This study reports findings on the current situation and highlights opportunities for the development of strategies to improve the design and development of future-proof inclusive buildings for all.

2. Inclusive design in architectural design practice

ID is an established approach in engineering and product design, in which designers look at functional interactions and strive to optimise the design and development of solutions for individuals with specific needs, also recognised as 'extreme users' [4,16].

ID has only started to be considered in architectural design practice in recent years [8]. With the evolution of design for disability into accessible design and the rise of awareness of ID amongst architects and design professionals, policymakers have recently started to implement standards and regulations to nurture the design of more inclusive environments [11].

However, research highlights that full adoption of ID with an extended concept of inclusion, diversity, equity and accessibility in architectural design is limited so far. This appears to be triggered by several challenges such as a wrong perception of ID, due to the mindset of professionals and unconscious bias, unverified legislative limitations and time-cost-efficiency concerns during the building development process.

In particular, studies suggest that architectural design professionals mainly focus on how they experience a situation and insufficiently empathise with future users [17], leading to a lower understanding of the value of ID as an approach to design for all users. Similarly, the expertise of users is not commonly acknowledged as a valuable resource for architects [9] and they may feel uncertain as to what exactly ID entails, giving precedence to the legislative interpretation [9,18]. For all these reasons many professionals do not give ID high priority in the architectural design agenda. The scope of this challenge can be inferred from the limited number of ID categories for building design awards [19].

Legislative standardisation is perceived as important, although amongst architects scepticism about the growing volume of rules is widespread [20]. As a result, legislative measurements are insufficient to ensure ID uptake [21] and professionals still tend to associate ID with the top-down framework of accessibility legislation, therefore perceiving it as a form of restriction for their creativity [22].

Given that legislative challenges are a relevant problem for the profession, in certain cases the limited application of ID is also due to the lack of economic incentives or funding [23].

Whilst compulsory regulations generally push the boundary towards physical accessibility standards, the challenge is to facilitate and encourage architectural design professionals to go beyond the minimum requirements, targeting a more holistic concept of ID [24].

Notwithstanding past and current research on ID endorsement, limitations and application, there is a strong argument for further investigating the causes of the lack of a widespread adoption of ID and its extended definition amongst building industry professionals.

This paper is presented as an effort to understand why there is a low uptake of ID within the architectural design profession, compared to the product design world [25], and to explore what might be done to overcome this challenge.

It is imperative to investigate how current societal challenges can trigger opportunities to support architectural design professionals to learn more about the extended concept of ID. The same opportunities can be used to promote a culture of diversity and inclusion within teams and amongst stakeholders, and to consciously design future-proof buildings that guarantee inclusion, diversity, equity and accessibility to all their occupants.

3. Materials and methods

This qualitative ethnographic study explores the context of ID and its extended definition of IDEA in the built environment through in-depth, semi-structured interviews with professionals from the building industry. Interviews were developed based on existing knowledge on perceptions, barriers, and motivations for the uptake of ID in architectural design practice [10] the use of experiential user data in the architectural design process [26], and the complex reality of architectural practice [27].

The key goals of the interviews were to identify challenges in the architectural design process and the perception of inclusion, diversity and equity, going beyond physical accessibility, by targeting theoretical saturation of participants' responses. Theoretical saturation occurs after several variations are identified as a pattern from the emerging theory [28]. To recognise when saturation happens, synthesis sessions were conducted after each interview highlighting the diversity of the sample, mapping content and insights and creating codes to account for user sentiments. After insights emerged, a collective sense of the lesson learned and meaningful findings were plotted to inform theoretical saturation. The procedure and the alignment with other research [29, 30], indicates that diversity and appropriate knowledge of participants constitutes a strong starting point from which to conduct thorough analysis. To present the extended concept of ID to individuals from different countries, an informative webpage was created and shared amongst potential participants. Prospective participants had experience in the disciplines of ID, UD, and DfA, architectural design and a broader interest in equity and diversity. Once they had reviewed the webpage information, they were asked to submit their interest to participate in the study. After review of an information sheet and completion of a consent form, participants were involved in a 45-min interview session that started with a further verbal introduction to the IDEA concept, followed by a series of open-ended questions. The questions were framed according to previous literature review findings [11]. Questions were clustered in five areas and focused on understanding the broad thinking and knowledge of IDEA in the practice of planning, designing and assessing buildings tailored for a diverse audience. Questions from cluster (1) focused on working practice attitudes. Cluster (2) focused on knowledge and awareness of accessibility, ID, equity of opportunities and guaranteeing diversity of users. Cluster (3) was focused on the relationship between professionals and their stakeholders and awareness of IDEA. Cluster (4) focused on challenges when designing inclusively. Cluster (5) focused on what strategies could improve a design in

the direction of inclusion, equity, diversity and accessibility of buildings for all.

3.1. Participant recruitment and procedure

Participant recruitment was carried out after ethical approval by the ethics committee from the University of Cambridge. Participants were selected amongst building industry professionals, made up of architects and designers, access consultants, design managers and academic experts who had been exposed to the field of accessibility, ID, UD, DfA and with an interest in social equity and diversity according to the IDEA concept. Initially, the recruitment started by contacting members of relevant British professional associations (e.g. Royal Institute of British Architects, National Register of Access Consultants, Access Association). Consequentially a snowball sampling approach was used to recruit more participants with similar characteristics in both British and European contexts. Finally, with the support of the business partner IWBI (International WELL Building Institute) further participants were recruited in the North American area. The overall interest rate was satisfactory and amongst 130 connections, a total of 26 experienced participants were recruited and accepted to take part in the study. Before starting the interview, an email was sent with a further description of the study procedure and an informed consent form was collected. The interviewers ran a series of individual 45-min online interviews. In the first part of the interview, the interviewers further explained the meaning of the concept of IDEA and familiarised themselves with the interviewee's background and work process. The interview proper then began. As

Table 1
Participants' information and demographic data.

	Sex	Job title	Region	Age group	Expertise
1	M	Designer/Architect	UK	70+	Accessibility auditing, design practice
2	M	Designer/Architect	North America	60–69	Accessibility auditing, design practice, research/regulations development
3	F		UK		
4	F		UK		
5	M		EU		
6	F	Designer/Architect	UK	50–59	Accessibility auditing, design practice, research/regulations development
7	M	Designer/Architect	North America	40–49	Design practice, design management
8	F		UK		
9	F	Designer/Architect	North America	N/A	Accessibility auditing, design practice, research/regulations development
10	F	Design manager	UK	50–59	Design management, clients' relationships
11	F		UK		
12	F	Design manager	UK	40–49	Design management, clients' relationships, accessibility auditing
13	M		North America		
14	F	Design manager	UK	30–39	Design management, accessibility auditing
15	F	Access consultant	UK	60–69	Accessibility auditing, research/regulations development
16	F	Access consultant	UK	50–59	Design practice, accessibility auditing, research/regulations development
17	F		UK		
18	F		UK		
19	F		UK		
20	F	Access consultant	UK	40–49	Accessibility auditing, research/regulations development, clients' relationships
21	F		UK		
22	F		UK		
23	F		UK		
24	F	Access consultant	UK	N/A	Accessibility auditing, research/regulations development
25	F	Academic expert	North America	40–49	Research/regulations development
26	F		EU		

shown in Table 1, the first group of participants was composed of design professionals who were working in the building design and development process, such as architects, architectural technologists and designers.

A second group was composed of design managers and architectural directors who were involved in management and customer relationships.

A third group consisted of access consultants with experience of working with architectural firms, private or public clients.

A fourth group was represented by academic experts involved in research, as well as in standards and guidelines development.

The sample had a prevalence of female individuals ($n = 21$) and the majority of participants were from the United Kingdom ($n = 19$), with rather a smaller number from North America ($n = 5$) and Europe ($n = 2$).

Interviews were scheduled between November 2020 and January 2021 and carried out in English, according to the ethical procedure.

Data from interviews were analysed through an evidence-based procedure, using the software NVivo, by coding interview notes and recordings. A series of thematic nodes related to the five clusters of questions were created to gather related material and look for emerging patterns and ideas in the research. Macro-thematic node (1) referred to the working practice and design process. Macro-thematic node (2) focused on the knowledge and awareness amongst professionals and stakeholders. Macro-thematic node (3) focused on challenges and future opportunities.

4. Results

The geographical location of participants was an important aspect to consider. Both the European and British settings slightly differ from the North American setting in the use of terminology for the design approach (DfA and ID in Europe and United Kingdom, and UD in North America), in the regulations and standards in place, and in the composition of the society that lead to historical facts that influenced the education and behaviour of professionals. Relevant patterns were found in the answers as it emerged that ID, UD, and DfA were used as synonyms to define projects aiming to satisfy users with different age, abilities, gender, language and culture.

Most of the participants belonged to the age group 40–49 ($n = 10$), less between 50 and 59 ($n = 7$), and 30–39 ($n = 1$), two declined to provide information on age, and a few others were above 60 years old ($n = 6$). The age group spread leads to the assertion that most of the interviewees had a level of seniority, and had gone through several years of experience in the field. This allows us to gain insights from subjects who had extensive experience in the topic of investigation.

Some potential limitations of this study are to be found in the prevalence of British professionals with a high number of female subjects and with a limited age profile, including only six participants aged 60 years old and above.

4.1. Working practice and design process

The vast majority of participants reported that they usually work on a wide variety of projects, covering areas such as health, education, business, sport and leisure facilities. Customers that commissioned ID projects were large private clients, public authorities, or not-for-profit organisations, in other words, large entities. Small private clients more often asked for accessibility audits, which appeared to be a mandatory requirement to guarantee minimum physical accessibility standards, or to benefit from certain public funding.

Several interviewees from the British setting reported that most of the successful projects that heavily encompassed accessibility features were developed in cooperation with public authorities or funded through the so-called 'National Lottery Schemes'. This funding is available for developing adaptations or designs as a support scheme for investors or clients who would not normally be keen to invest in such projects. Public funding was reported to work well in general for large-

size public projects such as the London Olympic Park, or for smaller-size projects such as cultural centres, churches or museum renovations.

There is additional evidence that a shift is slowly occurring in the attention paid to ID in architectural design practice [31]. Interviews confirmed that in North America and more recently in the European setting, large private organisations have a growing interest in providing accessible and inclusive workplaces for their community and workforce.

4: “We are at a different time now than we were even two or three years ago. Now many of our clients, both institutional and governmental, are really looking in and saying, okay, we do need to be much more inclusive in our process.”

In both public and private contexts, cost is an impactful consideration in the design process, particularly when talking about IDEA. While there is a growing availability of public funding, it appears that the value of building inclusively is better understood by large private organisations, as shown by their general willingness to invest in it. However, the value of ID is still not fully perceived by other stakeholders such as developers, construction companies and small private clients. The main reasons appear to be that it might add extra costs to the design process and that people believe designing inclusively is mostly about physical accessibility (e.g. wheelchair access).

15: “Particularly for the development community. If it costs money, they don’t want to do it. Money is often cited, but I actually think that’s not always the case. It’s more attitude than money.”

People who are more aware of the value of ID and understand broadly about IDEA are generally individuals who have experienced some form of exclusion or have a close friend or family member who has experienced it in their life. The understanding gained from several interviews was that many clients still think about ID as an approach to achieve building compliance with the Disability Discrimination Act (UK, 1995) or the Americans with Disabilities Act (US, 1990), rather than a wider concept of inclusion, diversity and equity. Understanding about inclusion and developing empathy for clients seems to be fundamental to initiate a conversation that goes beyond physical accessibility. In several cases, empathy looks more like a design ideology rather than a principle that is applicable under different circumstances [32]. Fig. 1 represents a summarised understanding of the attitudes that different stakeholders have regarding IDEA in the built environment.

To improve the design process and embrace a more inclusive approach, architects use a variety of different design procedures which are tailored according to personal experience, team composition and client needs. Most of the participants highlighted the importance of using established design procedures [33] such as the RIBA (Royal Institute of British Architects) plan of work, the Integrated Design Process (IDP) or the Building Delivery Process (BDP). The majority of participants noted that in parallel to established design procedures, they prefer to use additional approaches or tailored procedures.

A relevant approach that is often integrated into established procedures is grounded in ethnographic research. Partially defined as ‘infiltrating a user’s life’ [34], ethnographic research entails a person-first approach that targets constant engagement through

observation, interviews, contextual analysis and brainstorming sessions. Some professionals, due to their background and expertise, prefer to include an evidence-based approach in the design stream [35]. This approach is founded on cumulative knowledge, where resources such as literature reviews, research findings and technical standards are used to inform a persuasive dialogue with clients.

13: “The most important thing is understanding who’s going to be using these spaces. What challenges are they facing in the spaces, what conditions people have for these spaces and how the spaces themselves can be future-proofed to better meet the needs of somebody with their condition changes over time.”

There was a strong emphasis amongst the interviewees on understanding a client’s needs, no matter whether they were a public body, a private company or a developer. However, clients were often not representative of the final user or occupant of the building. Some of the replies noted that it was not always possible to interact with end-users fully, particularly because of time constraints, lack of user research at the start of the project or simply the client willingness to “tick a box and say, ‘we’ve met the mandatory regulations’”.

In the product design world there is a strong emphasis on the process of design rather than the output [36]. Several responses from interviewees highlighted the importance of focusing on the process of designing with users, investing time to talk to, observe and study targeted user groups. The main reason cited was that the experience and needs of users constitute the foundation upon which the output (e.g. a building) could be designed. In several interviews it emerged that a tool to support a more inclusive design process can help to gain a better understanding of the user journey and needs with attention to the IDEA precepts. As visualised in Fig. 2, the use of different design procedures allows design professionals to look at the process not only through the lens of functionality and time-cost-efficiency but also through the lens of inclusion.

4.2. Knowledge, awareness and inspiration: designers and stakeholders

Prerequisites for designing inclusively include not only understanding user needs but also education about ID, discovering inspiring design solutions and learning about inclusive terminology. Participants reported they could increase their knowledge of ID through a variety of sources, spending anything from a couple of minutes up to hours per day looking for new information.

Many professionals rely strongly on connecting with other people and networking. A popular way to network is by affiliating with professional associations or organisations such as the RIBA (Royal Institute of British Architects), NRAC (National Register of Access Consultants) and IWBI (International WELL Building Institute), to name a few.

Such an affiliation allows a professional to participate in conferences, events, webinars and CPD (Continuing Professional Development) programmes to keep them up to date on new topics and technical documentation. Classes and events allow professionals to access other sources of information, grounded in technical documentation, scientific



Fig. 1. Overall considerations: stakeholder engagement, design requirements and overall practice.

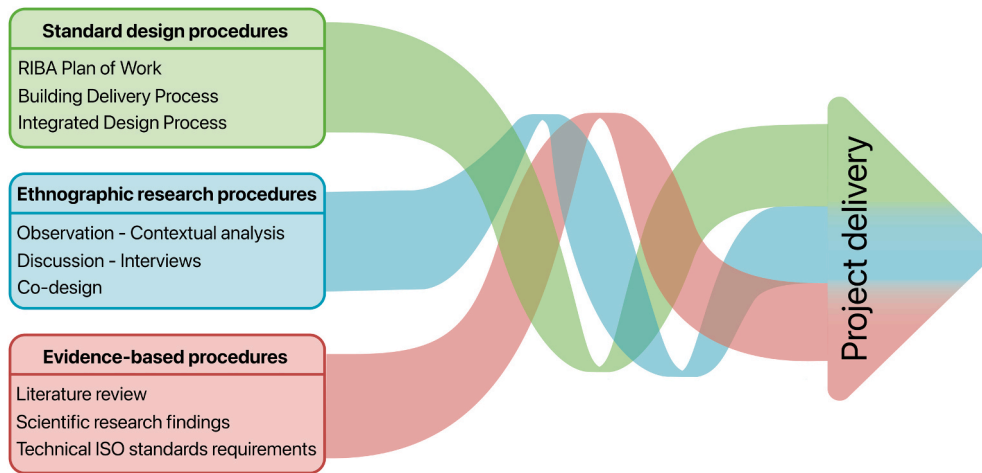


Fig. 2. A conceptual highlight of design procedures and methods used by interview participants.

research and grey literature.

Membership of these associations allows practitioners to be included in mailing lists, newsletters, WhatsApp, Facebook and LinkedIn groups. These opt-in groups offer ways to develop knowledge by interacting with other professionals, asking for advice and sharing mutual interests.

Along with professional organisations, another method that was mentioned as allowing experts to keep up to date with standards and regulations is an involvement with international working groups in policy creation and sitting on standards development committees. These include the British Standards Institute, the International Organization for Standardization, the European Disability Forum and the European Association for the Co-ordination of Consumer Representation in

Standardisation.

An activity that appeared extremely popular in the search for more knowledge and awareness was the exploration on the Internet of magazines, newspapers, podcasts and blogs about stories on inclusion, diversity, equity and accessibility in the built environment. Fig. 3 represents an overview of the source of inspiration divided into two categories, one involving human connections that can happen through meetings, professional associations, policymaker associations and links with other stakeholders, and one involving technical information shared through online media and literature-based information.

Knowledge is fundamental to ID. The interview findings confirmed that an uninformed audience was likely to associate ID with regulations

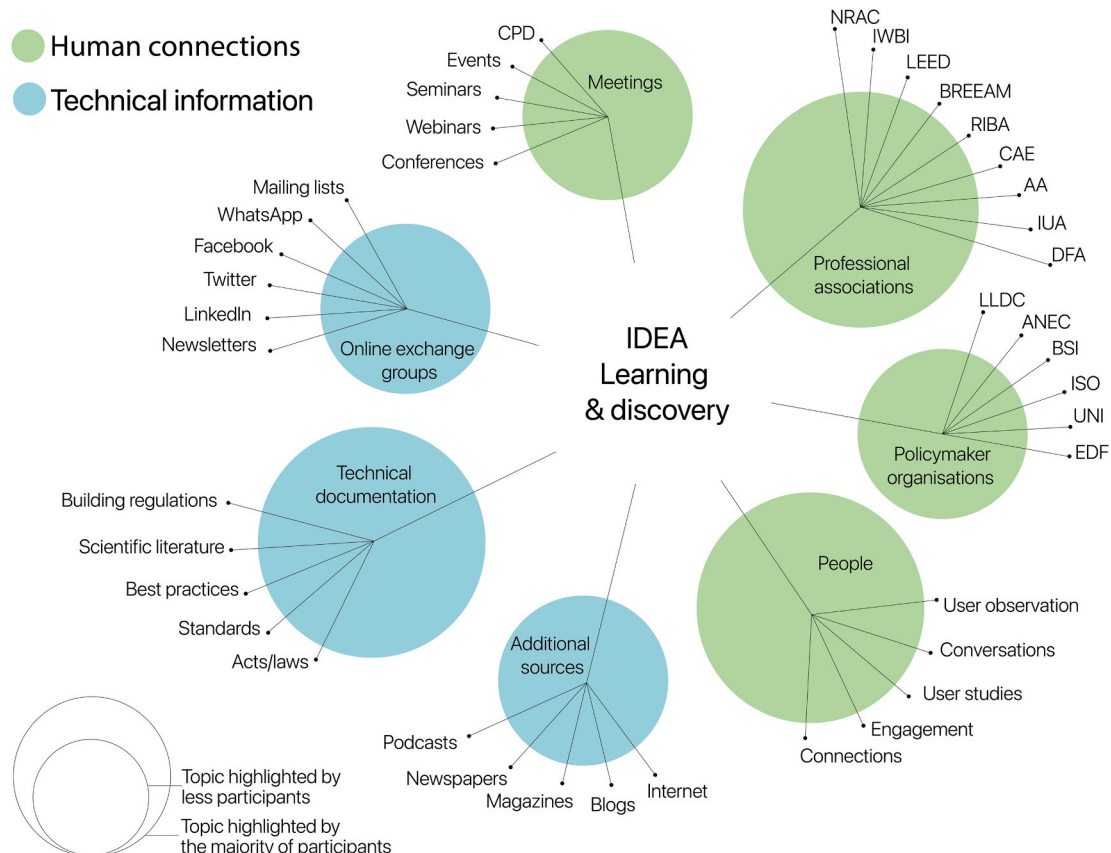


Fig. 3. Representation of the sources of inspiration: human connections and technical information.

on physical accessibility [7]. The perception strongly depends on where the project is located and the cultural background of the clients.

9: “Most clients don’t understand it. They think it’s all to do with building ramps and washrooms, but it is a lot more nuanced and complicated than that.”

Previous research [9] as well as interviews with certain project managers and architects within this cohort demonstrate that they sometimes experience difficulties when they have to design in compliance with accessibility standards. Additionally, there is little knowledge about a variety of other aspects of ID, such as cognitive and sensory accessibility, inclusion, equity and diversity amongst many professionals as well as clients.

14: “You can get project teams and architects and project managers that never had an inclusive design consultant working with them. All they’ve done previously is making sure they meet building regulations. On the other hand, there are project teams, architects and project management companies that will always work with an inclusive design consultant off the national register.”

Different types of relationships are established between design professionals and clients [37] and vary according to geographical location. As mentioned before, large organisations and public authorities are becoming more aware of ID and in high-income countries there is greater sensitivity to the topic. This is due to an elevated baseline of knowledge, particularly in larger cities, where there are more chances to engage with spaces designed according to ID principles. While in lower-income countries there is an acute and immediate need; the national standards are not enough to guarantee certain levels of accessibility and inclusion. Some interviewees reported that ID and accessibility are poorly applied in some underdeveloped or rural areas and there is a need to further develop programmes to raise awareness about inclusive environments. This finding is also supported by previous research [38]. Overall, many respondents reported that in the last few years awareness of ID has grown significantly and that more recently people are more aware of racial injustice and social exclusion.

11: “They are starting to understand more. Particularly around the diversity and inclusion agenda. We’re seeing many more inquiries for the business based on diversity and inclusion, being more of a priority of full businesses.”

Interviewees highlighted that a good inclusive project is not just about code compliancy, but about what can be done beyond simply accessibility. It is important to first create awareness, advocate about ID and explain the benefits. Once clients become more familiar with ID and they perceive its long-term benefits, it is easier to embed the concept of inclusion in the project from the start. Fig. 4 shows some of the influencing factors about the perception of ID amongst stakeholders, where the majority constitutes a poorly-informed audience and a minority a

well-informed group.

4.3. Challenges and opportunities

According to the geographical and socio-cultural context, indoor spaces, buildings, cities and the transportation infrastructure do not always provide an inclusive experience to all users. In large cities such as London, recent buildings and newly developed outdoor spaces offer a quite high level of inclusion, particularly for those who have physical disabilities. However, moving towards rural areas and smaller towns the number of challenges increase whilst the level of ID practice diminishes. A possible reason is the large number of heritage and listed buildings which bring more challenges than in the case of newer buildings, but this is not the only factor. The composition of society, with its socio-cultural background and education, brings further challenges. Education and awareness are broadly speaking part of the social context: an underlying asset that allows people to understand differences, empathise with exclusion and accept diversity. Several responses emphasised that education about inclusion should start from pre-school and should then evolve during the educational curriculum, up to college level in all disciplines. Little space is given to ID, UD or DfA education in STEM disciplines and the lack of formal and informal education brings misconceptions of what accessibility, ID, equity and diversity mean.

The use of appropriate terminology is a fundamental aspect of an inclusive educational process that leads professionals to an inclusive style of working practice. Examples of terms used to indicate a master bedroom, instead of principal bedroom, or a male/female toilet, instead of all gender toilet, can lead to exclusion or inequalities.

8: “In a residential setting, the main bedroom has always been called the master bedroom. The term master bedroom was derived from when slavery was in action in the USA. Now, it is more recommended to call it suite or principal bedroom to being the principal space of where you sleep.”

Lack of education and appropriate terminology has led to an overall deficiency in awareness that is now a structural component of modern society. Public discussion about disability and discrimination has only taken place in the last few decades thanks to acts such as the Disability Discrimination Act or the Americans with Disabilities Act. Unfortunately several people still associate ID with the concept of disability. With this misconception clients and certain professionals believe that ID could cost more if implemented in the design process [39]. Additionally, there is a belief that by imposing accessibility regulations the aesthetics of a building may suffer or creativity will be eradicated from its design [22]. To overcome these misconceptions, neurodiversity is a fundamental thematic area of ID, demonstrating that an inclusive building should be designed also according to sensory and cognitive needs, going beyond

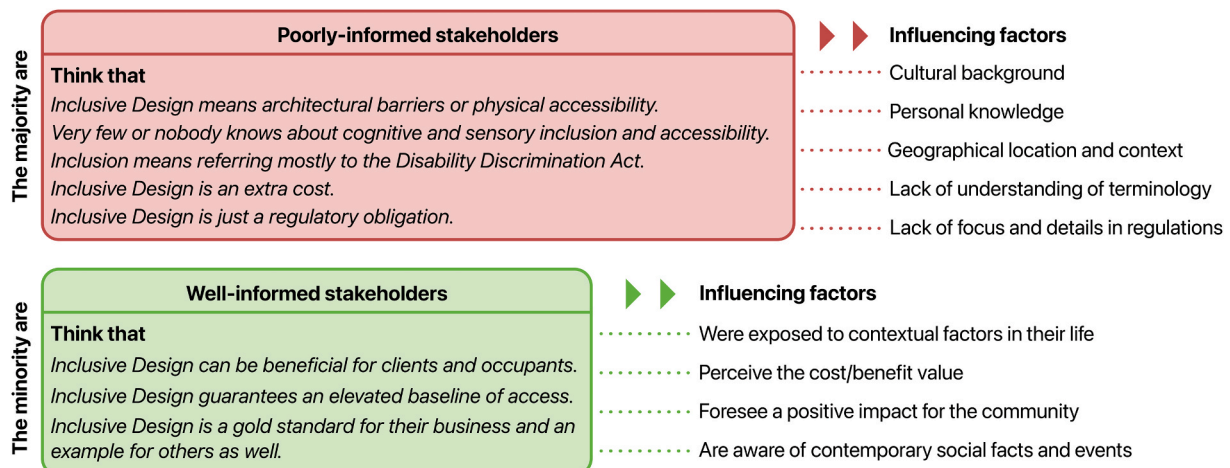


Fig. 4. Awareness amongst stakeholders about IDEA: perception and influencing factors.

the concept of physical accessibility.

Some respondents reported that since the Equality Act was released in the United Kingdom, there has been a shift towards considering disabilities under the same umbrella term of inequalities. As the Equality Act involves nine different protected characteristic groups, and disability is just one of those, a few participants reported that this process brought a ‘cooling off’ of the attention to people with disabilities in favour of a more generalised concept of equality.

22: “What happened in recent times is that disability became absorbed into the general notion of equality. And that meant it had to share space with diversity in terms of race, age, sex and various other vulnerable groups as they’re called in the Equality Act. I’m afraid by absorbing it into the equalities ‘generally disability’ has in a sense gone off the agenda.”

Lack of education and awareness about ID and misuse of terminology were both considered by respondents as relevant factors impacting the implementation and enforcement of standards, laws and local policies for accessibility and inclusion. Often standards or best practices for ID are not fully mandatory and they target minimum accessibility requirements. Additionally, as most standard design procedures used by professionals do not embed ID from the start, a lack of interest tends to appear within the design and construction process.

As a result, the lack of willingness to aim for a high standard is also a matter of assessing the building [11] and measuring the right metrics during and at the end of the design process. Several participants pointed out that particularly in the post-design phase there is a lack of uniform procedures to measure customer satisfaction and criteria such as inclusion, accessibility and equitable use of the space.

20: “Tracking people’s satisfaction, it’s something that I don’t think as an industry, we do have enough actually, but it’s so important. When it comes to product design, it’s just an integral part of what they do, which is part of the process. And I think it needs to be the same for the building industry.”

During the post-design phase, customer satisfaction is a function of staffing and management within the context of the facility, as well as the fabric of the facility itself. Current regulations and best practices focus mostly on recommendations for the design and development phases, with little or no consideration given to management and maintenance. Often spaces that were conceived as inclusive and accessible become inaccessible or lose their features because of inappropriate facility maintenance or management procedures.

17: “Quite often it’s about policies and management of the building. [Where] you have an accessible toilet, you’ll find the cleaners equipment, all sorts of baby highchairs, garbage bins or even bikes. Reception desks or bar counters should have a lower section that’s permanently accessible to wheelchair users, but people often fill it up with things, pamphlets or flowers. So, it’s about valuing the inclusion you have and improving it.”

Ultimately, awareness and understanding of diversity and inclusion strongly impact the composition of the design teams and consequently the outcome of the project. Aiming for diversity in a team, not only in terms of gender but also nationality, skills, knowledge, age and culture, helps to gain a broader understanding of the challenges. This supports ID during all the stages of project implementation.

12: “If you always take engineers, you’ll only come up with an engineering solution, but if you take health professionals, social professionals and digital professionals, they will be able to give customers more comprehensive insights.”

Fig. 5 summarises the three major challenges and connects all the related sub-challenges and causes within several domains.

5. Discussion: exploring IDEA prospects

A previous literature review from the authors [11] highlighted how legislation and best practices in ID are not adequately understood by architectural design professionals, leading them to perceive ID as a

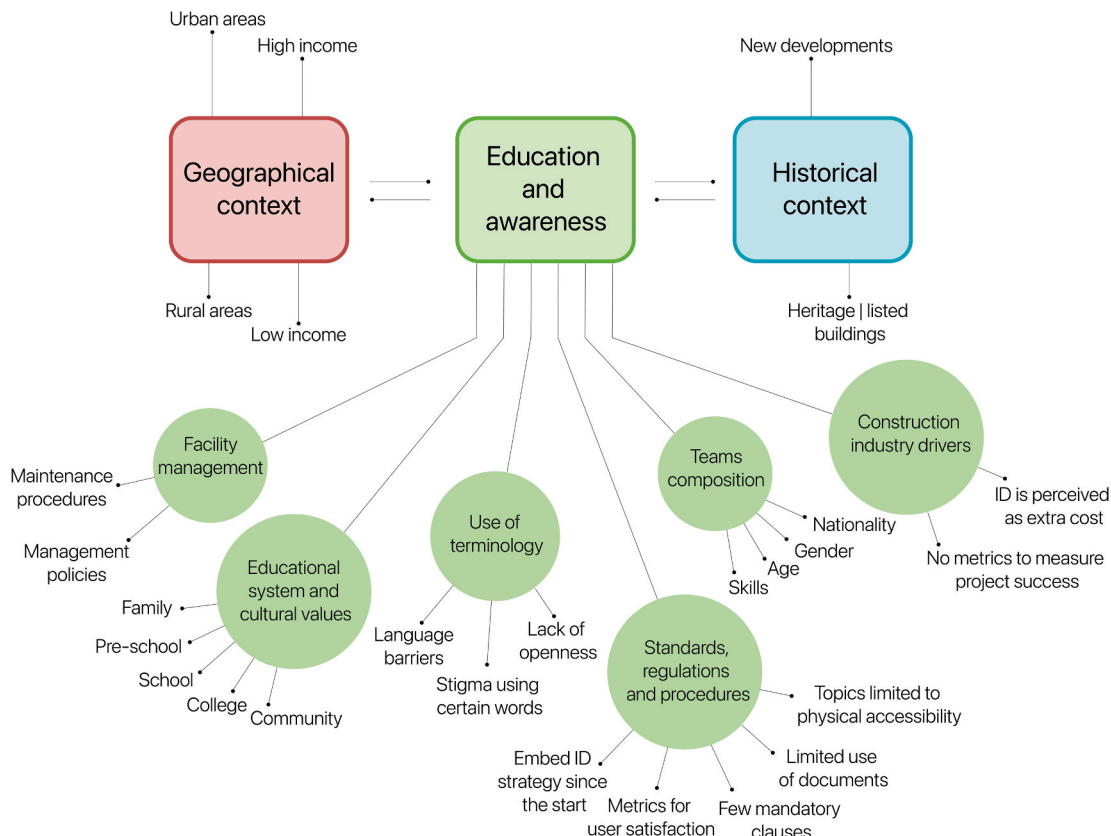


Fig. 5. Challenges identified amongst respondents: perceptions, links and influencing factors.

limitation for the creative design process [22]. The results from the interviews allow better understanding of the challenges to be addressed in all design phases, with the goal of guaranteeing future-proof IDEA buildings.

5.1. Create and raise awareness

Legislation and standards help to increase awareness of ID amongst design professionals. There is a constant need to update and understand the legislation and acquire new knowledge about ID [40], and its broader concepts, to allow and encourage professionals to apply specific legislation according to the design context. Several responses highlighted how important it is to educate professionals on new technical information and design tools to emphasise user needs. Examples here include the use of online media and social network tools to share knowledge, the creation of Continuous Professional Development classes and material and through the use of facilitators such as graphical visualisations [41]. There is a need to educate professionals to think inclusively and implement ID from stage zero of the design process by allowing collaborative teams composed of diverse groups of people to aim for inclusion, diversity and equity, as also indicated by previous research [42]. In raising awareness it is important to understand the use of inclusive terminology across professional and non-professional communities.

What emerged from the interviews was the need to guarantee design inclusivity in both design and post-design phases, throughout the entire life of a building. Research states that the development of facility management policies and practices is still in its infancy and the limited knowledge generated so far relates only to specific purposes such as strategy, performance, operation and innovation [43]. This means that developing facility maintenance policies about inclusion, diversity, equity and accessibility offers an opportunity to maintain buildings in an inclusive fashion over their lifetime.

Therefore, it is important not only to create awareness amongst the design team and the client, but also to develop policies and guidelines that allow building managers and maintenance staff to follow procedures guaranteeing buildings remain IDEA-compliant during their lifetime.

5.2. Inform the design process through an Inclusive Design Canvas

As was emphasised by the interviews, the design of an inclusive building does not happen just by following a check-box exercise or being time-cost-efficient. Rather, it should start from understanding who we are designing for through an experiential user journey. Numerous participants highlighted the importance of learning about the main users of the building and any potential future users. This discovery process is grounded in user research where ‘user experts’ [44] can offer their unique critical insight to highlight pains, problems, desires and aspirations.

Several interviewees pointed out that the user journey should start before approaching the building, particularly from the inner private space, and continue until the user reaches the destination. An experiential user journey, therefore, starts ahead in time and space and can highlight aspects including how a website informs a user to reach a building, the mode of transportation, how to navigate the building and how to reach certain people within the building. Working from the inside out, considering features that influence how brains and bodies interact, in strict connection with the senses and cognitive perception, is key to addressing all the challenges that a set of diverse users may have.

Based on previous work by the authors [15,45,46] it emerged that considering user needs when designing inclusively is highly relevant. Additionally, feedback from participants pointed out that it is also beneficial to understand people’s capabilities, including physical, sensory and cognitive skills when mapping the user journey. Having considered the results of the interviews, it appears important to offer

guidance to professionals, particularly at the very early stages of the design process, with a tool that helps to map and analyse the experiential user journey of potential building occupants.

This tool, shaped as a strategic design template [47], has the potential to develop a more inclusive design process, by helping professionals to discover people’s capabilities and better understand the needs and desires of a diversified audience of users. This tool is outlined in Fig. 6 and is envisioned as an Inclusive Design Canvas, offering a summary of complementary aspects to consider during the discovery phase of the design requirements for more inclusive and accessible buildings.

5.2.1. Physical journey

The first impression of a building is extremely important, whether it is online or in person. People have to understand clearly where the building is and how to access it easily. Level access, signage and wayfinding, entrances and doors, entrance hall and all the materials and objects that compose those approaching spaces should be intuitive and welcoming [48].

Once the user has the ability to move horizontally and vertically following the signage, and moving through connecting spaces, the perception of space, the feelings and the experience of the occupants are strongly influenced. In considering how people will access a building it is also important to take into account how they will exit the building in case of emergency and means of escape, fire egress and exit routes are not necessarily accessible for all. Therefore ramps, deaf alerter systems, wayfinding for blind individuals, refuge locations and evacuation chairs are just some of the elements that need to be considered when designing a building. The Inclusive Design Canvas can help to list and emphasise physical journey aspects and support professionals during the design stage with useful information about physical skills and needs.

5.2.2. Sensory journey

Sensory perception is a central part of the user journey within a building. Visual features such as natural light, use of colours and visual contrast, materials and the shapes of objects and spaces can influence the mood, feelings and relationship between space, people and objects.

Auditory stimulus, such as the absence of echo in a meeting room or acoustic transmission in a space, can influence wayfinding for deaf people with different sensory abilities.

The sense of smell also has a role to play. A fragrance diffuser in an entrance hall or how the smell of a cafeteria or a kitchen flows across parts of the building can attract or repel people from reaching that area at certain times of the day. This improves productivity or encourages a user to take a break during the working day.

Touch influences feelings as well as temporary attitudes towards space and other people within the vicinity. The use of metal for handrails or handles, with its associated variation in temperature, may discourage people from touching such fittings and fixtures.

Taste is often misconceived when designing inclusively, however it relates to smell and they often influence each other. For example, the use of paper dishes or cups in a cafeteria that could alter the taste of food and drink may influence people’s perception of the space.

The combination of the senses allows sensory integration to help the brain to sense the space, elaborate feelings and inform decisions. This includes proprioception, where muscles and joints tell the brain where body parts are; vestibular perception, which allows the brain to plan for movements and helps to maintain balance; and interoception, which allows the body to tell the brain what is happening, including when a person is hungry or feels full or the sensation of ‘butterflies in the stomach’ [49].

This complex set of sensory abilities varies widely between individuals and strongly influences aspects of our lives such as emotional wellbeing, perception, cognition and behaviour. The Inclusive Design Canvas would help to support bringing future design requirements to the fore by summarising which details in the sensory journey should be

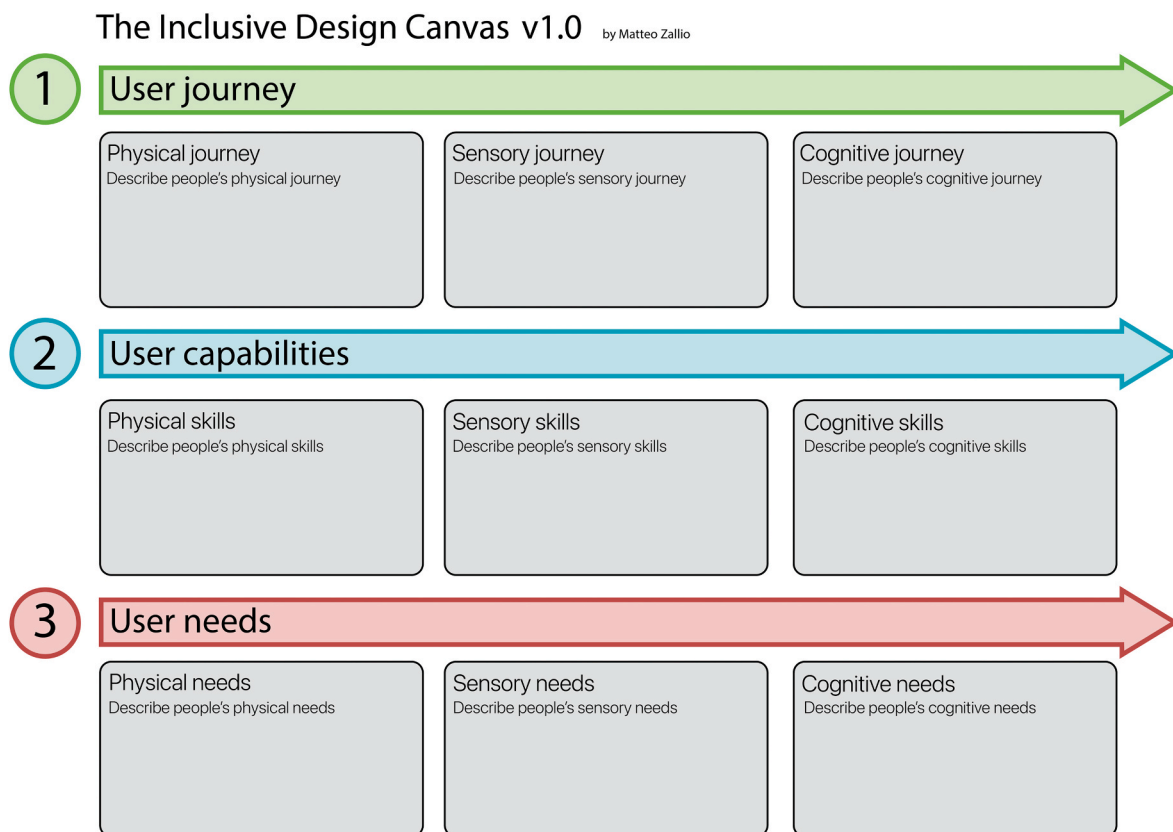


Fig. 6. A diagram illustrating the Inclusive Design Canvas.

prioritised.

5.2.3. Cognitive journey

The cognitive journey is strongly affected by sensory and physical journeys. The brain processes the stimuli received by all parts of the body and creates thoughts and beliefs that influence perception and behaviour [50].

It is important to understand the concept of neurodiversity [51] as well as other cognitive skills including socio-emotional and learning skills, and personality. The combination of these factors impacts the perception of the surrounding environment and relationships amongst people within an environment. A space that is designed to recognise neurodiversity, that allows people to be apart together, to retreat, or to socialise is extremely important in guaranteeing inclusion and equity for a diverse audience.

Interviewees emphasised how designing for cultural differences and people from different nationalities, by being sensitive to people's beliefs, cultural orientation, religion, ideology, ethnicity, gender and age is part of recognising diversity. An accessible changing place, a gender-neutral toilet or an inclusive counter desk are examples of a design that is sensitive to the needs of individuals. Interviewees indicated in their feedback that the Inclusive Design Canvas could facilitate identifying strategic user needs, emphasising the importance of physical, sensory and cognitive journeys for the design of more inclusive and accessible buildings.

5.3. The importance of collecting post-occupancy user feedback

With a focus on the post-design phase, acquiring feedback about the experience of building occupants appears to be a valuable process that is often not implemented by architectural design professionals.

Several respondents reported that in product design it is common to take customer feedback and have an idea of how inclusion impacts the

use of the product. Furthermore, research suggests that tools such as the exclusion calculator [52] can additionally help in this process. However, in the architectural context, participants reported that collecting user feedback is rare. When it is undertaken it is often carried out without following a formal method and is often administered to the building occupants by the design company, with a high risk of unconscious bias. Although there are a variety of post-occupancy surveys available [53] they are not wholly targeted at addressing inclusion, diversity, equity and accessibility in the built environment and thus there is a need to develop scientifically validated, evidence-based mixed methods tools, administered by third-party entities, to gain the feedback of occupants in relation to IDEA.

Mixed methods can include ethnographic studies, objective evaluation or the use of smart technology to collect comprehensive information on people's perception of the environment. Such methods should capture how the environment affects daily routines and relationships with other individuals and be designed to guarantee equity and diversity. With the acquired user feedback and unbiased metrics [11] it is possible to better inform architectural design professionals, building managers and occupants about current and future challenges present in selected buildings and this knowledge would facilitate the implementation of future design processes targeting IDEA.

6. Conclusions

Whilst designed spaces can influence a person's behaviour and attitudes, their access and use can also strongly affect the cognitive and emotional world of that individual.

This article delivers insights about challenges and opportunities for the design of buildings that should guarantee inclusion, diversity, equity and accessibility for their occupants.

Some of the major findings that can significantly enhance the design of inclusive buildings are identified - education about ID, the use of

appropriate terminology and the creation of diverse teams of professionals with knowledge of ID.

Education and awareness amongst architectural design professionals, builders and clients, with particular attention to the development of inclusive management and maintenance policies, seem to play a fundamental role in raising the bar to implement and run future-proof IDEA buildings.

The creation of future-proof IDEA buildings is mainly the responsibility of design teams, but maintaining those inclusive features across the entire life of a building is the responsibility of facility managers, maintenance staff and building occupants.

A key finding from this research is that in order to improve the overall design and maintenance of more inclusive buildings, the use of tools in both the design and post-design phases is beneficial.

The Inclusive Design Canvas can enhance an inclusive design process by mapping the user journey and considering people's capabilities and needs.

An evidence-based user feedback collection system can advance understanding of IDEA in post-design amongst stakeholders, including physical, sensory and cognitive needs, the perception of the space and raise the bar for the design and maintenance of future-proof IDEA buildings.

The combination of an Inclusive Design Canvas to map the user journey considering people's needs and capabilities and a post-occupancy evaluation tool targeting IDEA have the potential to support both the design and post-design phases.

Importantly, collecting and evaluating feedback from users during the post-design process, through post-occupancy tools targeting inclusion, diversity, equity and accessibility, could work as a complementary strategy to raise awareness and educate clients, design teams, facility managers and building occupants.

These findings are part of a larger Delphi study, funded under the European Union's Horizon 2020 research and innovation programme, which aims to identify challenges and opportunities to implement ID practice across built environment professionals. The next steps of the project will validate the current data with a large scale survey that will pave the way for the development of toolkits useful for the design and post-design phases.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: There is no financial interest or personal relationship which may be considered as potential competing interest.

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References

- [1] B.C. Brolin, *The Failure of Modern Architecture*, Van Nostrand Reinhold, 1976.
- [2] A. Heylighen, Sustainable and inclusive design: a matter of knowledge? *Local Environ.* 13 (6) (2008) 531–540, <https://doi.org/10.1080/13549830802259938>.
- [3] R.L. Mace, G.J. Hardie, J.P. Place, Accessible environments: toward universal design, in: W. Preiser, J. Vischer, E. White (Eds.), *Design Interventions: toward a More Human Architecture*, Van Nostrand Reinhold, 1991.
- [4] P.J. Clarkson, S. Keates, R. Coleman, C. Lebbon, *Inclusive Design. Design for the Whole Population*, Springer, 2003, <https://doi.org/10.1007/978-1-4471-0001-0>.
- [5] EIDD, *Design for All Europe: Stockholm Declaration*, 2004. Retrieved February 15, 2021, from, <https://dfaeurope.eu/what-is-dfa/dfa-documents/the-eidd-stockholm-declaration-2004/>.
- [6] I. Hacıhasanoglu, O. Hacıhasanoglu, Assessment for accessibility in housing settlements, *Build. Environ.* 36 (5) (2001) 657–666, [https://doi.org/10.1016/S0360-1323\(00\)00041-x](https://doi.org/10.1016/S0360-1323(00)00041-x).
- [7] H. Wauters, P.W. Vermeersch, A. Heylighen, Reality check: notions of accessibility in today's architectural design practice, in: Y.K. Lim, K. Niedderer, J. Redstrom, E. Stolterman, A. Valtonen (Eds.), *Proceedings of DRS 2014: Design's Big Debates*, Design Research Society & Umeå Institute of Design, 2014, pp. 1482–1491.
- [8] M. Basnak, B. Tauke, S. Weidemann, Universal design in architectural education: who is doing it? How is it being done?. *Proceedings of the Future of Architectural Research The Architectural Research Centers Consortium (ARCC)*, Chicago, Illinois, 2015.
- [9] A. Heylighen, V. Van der Linden, I. Van Steenwinkel, Ten questions concerning inclusive design of the built environment, *Build. Environ.* 114 (2017) 507–517, <https://doi.org/10.1016/j.buildenv.2016.12.008>.
- [10] V. Van der Linden, H. Dong, A. Heylighen, From accessibility to experience: opportunities for inclusive design in architectural practice, *Nordic Journal of Architectural Research* 28 (2) (2016) 33–58.
- [11] M. Zallio, P.J. Clarkson, On Inclusion, Diversity, Equity, and Accessibility in civil engineering and architectural design. A review of assessment tools, in: *Proceedings of the International Conference on Engineering Design (ICED21)*, 2021, <https://doi.org/10.1017/pds.2021.491>. Gothenburg, Sweden.
- [12] BLM, Black Lives Matter, 2020. Retrieved February 12, 2021 from, <https://blacklivesmatter.com/>.
- [13] NUM, Ni una menos, 2015. Retrieved February 12, 2021 from, <http://niunamenos.org.ar/>.
- [14] BSI, British Standard - BS 7000-6:2005 Guide to managing inclusive design, 2005. Retrieved September 5, 2021 from, <https://www.bsigroup.com/en-GB/about-bsi/media-centre/press-releases/2005/2/New-British-Standard-addresses-the-need-for-inclusive-design/>.
- [15] C. Fernandez, M. Zallio, D. Berry, J. McGrory, Towards a people-first engineering design approach. A comprehensive ontology for designing inclusive environments, in: *Proceedings of the International Conference on Engineering Design (ICED21)*, 2021, <https://doi.org/10.1017/pds.2021.579>. Gothenburg, Sweden.
- [16] R. Coleman, The case for Inclusive Design - an overview, in: *Proceedings of the 12th Triennial Congress of the International Ergonomics Association*, 1994 (Mississauga, Ontario).
- [17] R. Imrie, Architects' conceptions of the human body, *Environ. Plann. Soc. Space* 21 (1) (2003) 47–65, <https://doi.org/10.1068/d271t>.
- [18] C. Ruhl, The missing link in implementation of universal design: the barrier between legislative framework and architectural practice, in: H.A. Caltenco, A. Larsson, P.-O. Hedvall, K. Rassmus-Gröhn, B. Rydeman (Eds.), *Assistive Technology Research Series*, vol. 35, IOS Press, 2014, pp. 433–434, <https://doi.org/10.3233/978-1-61499-403-9-433>. Universal Design 2014: Three Days of Creativity and Diversity.
- [19] K. Manley, K. Sanders, S. Cardiff, J. Webster, Effective workplace culture: the attributes, enabling factors and consequences of a new concept, *International Practice Development* 1 (2) (2011) 1–29.
- [20] P. De Cauwer, M. Clement, H. Buelens, A. Heylighen, Four Reasons Not to Teach Inclusive Design, *Proceedings of Include 2009*, London, 2009.
- [21] J.M. Franz, G. Bitner, N. Wright, C. Gillett, R. Hannaford, Inclusive universal design practice and activism: a case study, in: M. Narikawa (Ed.), *Proceedings of the 3rd International Conference: Universal Design 2010*, International Association for Universal Design, 2010 (Hamamatsu, Japan).
- [22] D.B. Gray, M. Gould, J.E. Bickenbach, Environmental barriers and disability, *J. Architect. Plann. Res.* 20 (1) (2003) 29–37.
- [23] A. Heylighen, J. Schijlen, V. Van der Linden, D. Meulenijzer, P.W. Vermeersch, Socially innovating architectural design practice by mobilising disability experience. An exploratory study, *Architect. Eng. Des. Manag.* 12 (4) (2016) 253–265, <https://doi.org/10.1080/17452007.2016.1172197>.
- [24] M.G. Ormerod, R.A. Newton, Moving beyond Accessibility: the principles of universal (inclusive) design as a dimension in nD modelling of the built environment, *Architect. Eng. Des. Manag.* 1 (2) (2005) 103–110, <https://doi.org/10.1080/17452007.2005.9684587>.
- [25] J. Goodman-Deane, P. Langdon, J. Clarkson, Key influences on the user-centred design process, *J. Eng. Des.* 21 (2–3) (2010) 345–373, <https://doi.org/10.1080/09544820903364912>.
- [26] M. Annemans, C. Van Audenhove, H. Vermolen, A. Heylighen, How to introduce experiential user data: the use of information in architects' design process, in: Y. K. Lim, K. Niedderer, J. Redstrom, E. Stolterman, A. Valtonen (Eds.), *Proceedings of DRS 2014: Design's Big Debates*, Design Research Society & Umeå Institute of Design, 2014, pp. 1626–1637.
- [27] D. Cuff, *Architecture: the Story of Practice*, MIT Press, 1992.
- [28] G. Guest, A. Bunce, L. Johnson, How many interviews are enough?: an experiment with data saturation and variability, *Field Methods* 18 (1) (2006) 59–82, <https://doi.org/10.1177/1525822x05279903>.
- [29] D. Bertaux, *Biography and Society: the Life History Approach in the Social Sciences*, Sage Publications, 1981.
- [30] S.P. Gaskin, A. Griffin, J.R. Hauser, G.M. Katz, R.L. Klein, *Voice of the Customer*, Wiley International Encyclopedia of Marketing, 2010, <https://doi.org/10.1002/978144316568.wiem05020>.
- [31] V. Fletcher, G. Bonome-Sims, B. Knecht, E. Ostroff, J. Ottingbe, M. Parente, J. Safdie, The challenge of inclusive design in the US context, *Appl. Ergon.* 46 (2015) 267–273, <https://doi.org/10.1016/j.apergo.2013.03.006>.

- [32] A. Heylighen, A. Dong, To empathise or not to empathise? Empathy and its limits in design, *Des. Stud.* 65 (2019) 107–124, <https://doi.org/10.1016/j.destud.2019.10.007>.
- [33] A. Thompson, *Architectural Design Procedures*, second ed., Routledge, 1999.
- [34] V. Van der Linden, H. Dong, A. Heylighen, Tracing architects' fragile knowing about users in the socio-material environment of design practice, *Des. Stud.* 63 (2019) 65–91, <https://doi.org/10.1016/j.destud.2019.02.004>.
- [35] D.K. Hamilton, D.H. Watkins, *Evidence-Based Design for Multiple Building Types*, John Wiley & Sons, 2008.
- [36] M. Bianchin, A. Heylighen, Just design, *Des. Stud.* 54 (2018) 1–22, <https://doi.org/10.1016/j.destud.2017.10.001>.
- [37] M. Bruce, C. Docherty, It's all in a relationship: a comparative study of client-design consultant relationships, *Des. Stud.* 14 (4) (1993) 402–422, [https://doi.org/10.1016/0142-694x\(93\)80015-5](https://doi.org/10.1016/0142-694x(93)80015-5).
- [38] M.P. Amado, I. Ramalheite, A.R. Amado, J.C. Freitas, Inclusive housing program: the case of Oé-Cusse region in East Timor, *Frontiers of Architectural Research* 6 (1) (2017) 74–88, <https://doi.org/10.1016/j.foar.2016.12.001>.
- [39] H. Dong, P.J. Clarkson, S. Ahmed, S. Keates, Investigating perceptions of manufacturers and retailers to inclusive design, *Des. J.* 7 (3) (2004) 3–15, <https://doi.org/10.2752/146069204789338398>.
- [40] N. Wilson, A. Thomson, A. Thomson, A.F. Holliman, Understanding inclusive design education, *Proceedings of the Design Society: International Conference on Engineering Design* 1 (1) (2019) 619–628, <https://doi.org/10.1017/dsi.2019.66>.
- [41] M. Zallio, Democratizing information visualization. A study to map the value of graphic design, in: M.M. Soares, E. Rosenzweig, A. Marcus (Eds.), *Design, User Experience, and Usability: UX Research and Design. HCII 2021. Lecture Notes in Computer Science*, vol. 12779, Springer, 2021, https://doi.org/10.1007/978-3-030-78221-4_33.
- [42] J.S. Hui, S.D. Farnham, Designing for Inclusion. Supporting gender diversity in independent innovation teams, in: *Proceedings of the 19th International Conference on Supporting Group Work*, ACM, 2016, pp. 71–85, <https://doi.org/10.1145/2957276.2957290>.
- [43] M. Mari, P. Poggesi, *Facility management: current trends and future perspectives*, *Int. J. Glob. Small Bus.* 6 (3/4) (2014) 177–192.
- [44] E. Ostroff, Mining our natural resources: the user as expert, *Innovation* 16 (1) (1997) 33–35.
- [45] M. Zallio, D. Berry, N. Casiddu, Adaptive homes for enabling senior citizens: a holistic assessment tool for housing design and IoT-based technologies, in: *Proceedings of the IEEE 3rd World Forum of Internet of Things (Wf-IoT)*, 2016 (Reston, Vancouver).
- [46] M. Zallio, N. Casiddu, Lifelong housing design: user feedback evaluation of smart objects and accessible houses for healthy ageing, in: *Proceedings of the 9th ACM International Conference on Pervasive Technologies Related to Assistive Environments (PETRA)*, 2016 (Corfu, Greece).
- [47] U. Persad, P. Langdon, J. Clarkson, Characterising user capabilities to support inclusive design evaluation, *Univers. Access Inf. Soc.* 6 (2) (2007) 119–135, <https://doi.org/10.1007/s10209-007-0083-y>.
- [48] C. Chivaran, M. Zallio, S. Waller, P.J. Clarkson, Visual accessibility and inclusion. An exploratory study to understand visual accessibility in the built environment, in: *Proceedings of Smart Accessibility 2021: the Sixth International Conference on Universal Accessibility in the Internet of Things and Smart Environments*, 2021 (Nice, France).
- [49] E. Ceunen, J.W.S. Vlaeyen, I. Van Diest, On the origin of interoception, *Front. Psychol.* 7 (2016), <https://doi.org/10.3389/fpsyg.2016.00743>.
- [50] L.E. Humes, L.A. Young, Sensory-cognitive interactions in older adults, *Ear Hear.* 37 (1) (2016) 52S–61S, <https://doi.org/10.1097/aud.0000000000000303>.
- [51] L. Benton, A. Vasalou, R. Khaled, H. Johnson, D. Gooch, Diversity for design: a framework for involving neurodiverse children in the technology design process, in: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '14)*, 2014, pp. 3747–3756, <https://doi.org/10.1145/2556288.2557244>. Association for Computing Machinery.
- [52] S. Keates, P.J. Clarkson, *Countering Design Exclusion: an Introduction to Inclusive Design*, Springer, 2003.
- [53] R. Hay, F. Samuel, K.J. Watson, S. Bradbury, Post-occupancy evaluation in architecture: experiences and perspectives from UK practice, *Build. Res. Inf.* 46 (6) (2018) 698–710, <https://doi.org/10.1080/09613218.2017.1314692>.