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A study to depict challenges and opportunities building industry professionals face when designing inclusive and accessible buildings

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ABSTRACT

Inclusive Design has been widely promoted in the fields of product, engineering, and user experience design. Despite the educational efforts made by scientists, practitioners, and institutions to raise awareness about accessibility and inclusion, Inclusive Design has not been widely embraced in architectural design practice, where it is often associated with design for disability. This multidisciplinary study, spanning behavioural science, ergonomics, and the social sciences of architecture, explores the challenges architectural design practitioners face when designing inclusively, and identifies opportunities to promote the adoption of Inclusive Design. The results of a questionnaire completed by 114 architectural design practitioners underscore the lack of client awareness of the benefits of inclusive design, highlight the important role practitioners can play in advocating for Inclusive Design, and emphasize the need to develop practices and tools that enhance the design and post-design phases of buildings to ensure inclusion, diversity, equity, and accessibility.

Introduction

Since the mid-twentieth century, society has understood the importance of designing buildings, products and services accessible for, and usable by, people with a variety of abilities and needs (Goldsmith 2000). The concept of designing for people with disabilities evolved strongly after WWII (Gerber 1994).

During the 1960s the American National Standards Institute (American Standards Association 1980) created specifications for making buildings and facilities accessible to, and usable by, the 'physically handicapped' which acknowledged the importance of designing accessible environments for everyone (Goldsmith 1963).

With an enhanced understanding of the concept of disability and its causes, the development of standards and a wider conversation of the topic in the community, an evolution of the design for disability approach and terminology occurred (Lifchez and Winslow 1979).

Along with several design approaches that have burgeoned in the past few decades, including Transgenerational Design (Pirkl and Babic 1988), Universal Design (Mace, Hardie, and Place 1991) and Design for All (EIDD 2020), Inclusive Design became an accepted overarching term amongst the product and engineering design communities. Inclusive Design (ID), initially defined as a design process in which a mainstream product, service or environment is designed to be useable by as many people as reasonably possible (Coleman 1994), evolved towards a design for people of different ages, abilities, genders, faiths, cultures and languages (Clarkson and Coleman 2015), incorporating more recently the principles of social equity and diversity (Zallio and Clarkson 2021a).

In recent years ID has become more widely acknowledged amongst architectural design practitioners, however the widespread use of ID across the building industry community can still be perceived as limited (Basnak, Tauke, and Weidemann 2015; Heylighen, Van der Linden, Dong, and Heylighen 2016; Ryhl 2014). Notwithstanding the educational efforts developed by scholars, practitioners and institutions with the creation of standards (BSI 2005), career professional development courses and books (Bichard and Gheerawo 2013; Coleman 1994; Fernandez et al. 2021; Zallio and Clarkson 2021b) a number of challenges, such as the lack of accessible entrances or the absence of wayfinding for people with cognitive impairments in several buildings across the world, appear to still be present (Zallio and Clarkson 2022a).

This article intends to answer the questions as to what challenges architectural design practitioners face when attempting to designing inclusively and what strategic opportunities allow ID to fully permeate the working routines of architectural design practitioners and bring value to building occupants and other building industry stakeholders?

The primary objective of this article is to identify evidence to better address the key inquiries regarding the challenges faced by architectural design practitioners when striving to incorporate ID principles, as well as to identify strategic opportunities that can facilitate the seamless integration of ID into their working routines.

This study, which spans the disciplines of behavioural science, ergonomics and the social sciences of architecture, validates early-stage results on the challenges that architectural design practitioners face when designing inclusively, including

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the scarcity of adoption of standards and policies, limited willingness to build the business case for inclusion and the insufficiency of incentives to embed ID from the start of the design process.

It additionally looks to pinpoints where interventions and tools could have greatest impact and attempts to depict opportunities to help building industry professionals to improve the design and post-design of buildings that guarantee inclusion, diversity, equity and accessibility (IDEA) for all occupants.

Rationale and study design

Literature review findings highlighted that in recent years regulations and standards about accessibility and ID were more widely used amongst architectural design practitioners, creating opportunities to positively influence the design of buildings but nonetheless limitations (Gray, Gould, and Bickenbach 2003; Van der Linden, Dong, and Heylighen 2016; Zallio and Clarkson 2022b). Amongst several challenges that manifest during the building design phase, facilitating the comprehension of information from technical documentation and deploying it to answer the needs of users has acquired greater importance (Fernandez et al. 2021). In the post-design phase, the necessity to assess buildings through post-occupancy evaluation was more widely acknowledged, however there is a systemic lack of tools to assess inclusion, diversity, equity and accessibility (IDEA) in the built environment (Zallio and Clarkson 2021a). Recent results from ethnographic studies with architectural design practitioners (Zallio and Clarkson 2021b) briefly identified four major themes described below, meriting further investigation. The first theme concerned the working routines of practitioners and their implementation of ID. The second identified the relationship between practitioners and stakeholders. The third focused on present and future challenges when designing inclusively. The fourth described future opportunities to increase the uptake of ID.

Based on the knowledge previously built, this study validates the challenges experienced by architectural design practitioners when implementing ID in the design and post-design phases through an online questionnaire undertaken in the first quarter of 2021.

The early-stage results refer to literature review studies (Zallio and Clarkson 2021a, 2021b) developed 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, and to explore and summarize the requirements that design practitioners need to consider when designing accessible, inclusive, smart, age-friendly environments. Additionally, these early-stage results mention the findings from the qualitative study previously performed (Zallio and Clarkson 2021b) which highlighted how education and awareness are essential factors to encourage an inclusive mindset amongst architectural design professionals and other stakeholders, as well as complementary strategies, such as holistically mapping the user journey during the design phase and collecting and evaluating post-occupancy user feedback, that can foster a design process based on inclusion, diversity, equity and accessibility principles for the built environment.

By studying and analysing these findings, a questionnaire was created with the goal to validate them across a larger population sample of experts. The questionnaire was created by emphasizing the topics identified with previous findings and by developing open ended and close-ended questions focused on work experience, challenges around the design phase and the post-design phase practices.

As this article aims to answer the demandingquestions related to the challenges architectural design practitioners face when attempting to design inclusively and what strategic opportunities can arise to boost the working routines through the implementation of ID practices, the research team deeply analysed the scenario, as well as considered previous findings and collectively chose, through brainstorming sessions, the questionnaire as a tool among quantitative research methods to use to run this research project.

Some of the major reasons behind this choice were given by the opportunity to collect data from a wider number of practitioners, while allowing participants from several countries to anonymously complete the answers in their own time.

Additionally, the ability to collect data from a larger population sample than with qualitative research methods and therefore achieve a greater statistical significance (Ponto 2015) would have provided the opportunity to gather large amounts of information and having the availability of creating more informed validated findings and models (Eaden, Mayberry, and Mayberry 1999).

This method would also offer the opportunity to reduce bias of the results towards influential individuals and allow to reach a statistical consensus in a reasonable timeframe (Barrett and Heale 2020).

Participants, including architects, access consultants and design managers with knowledge and experience of ID and accessibility, were carefully selected with a snowball sampling approach, using mailing lists and second level connections on social media. To overcome instrumental challenges, such as the lack of expert participants, the subsequent high drop-out rates (Winkler and Moser 2016) and travel limitations brought about by the COVID-19 pandemic, panels of experts belonging to professional associations including RIBA, NRAC, AA, IAAP, NCARB, AIA and IWBI, were created after gaining ethical approval from the Ethics Committee at the University of Cambridge.

Participants were allowed to take part to the study after screening questions regarding their work as authors on focused publications, projects they run, or case studies they developed on the topics object of this study, to allow for a potential participant with actual experience in the subject matter to participate to the questionnaire.

A total of 209 subjects were contacted over a four-week timeframe and 114 completed responses were obtained, giving a response rate of 54.5%. The number of completed responses, compared to the number of practitioners belonging to selected geographies, allowed for the consideration of non-probabilistic sampling which enabled ideas to be generated and verified without generalizing the results to the entire population thus leading to high levels of confidence in the validity of the results (Ayhan 2011).

The first version of the questionnaire was piloted amongst eight expert users and feedback was collected to create a revised

version. A second version was implemented with closed-ended questions, made readable by persons with different abilities and allowed for voice control systems to help navigate the questionnaire in about 15–20 min. It was distributed by email and comprised four main sections defined according to previous research findings, including the quality of the working practice and design process, the level of awareness of ID, the challenges experienced and the strategies to build the business case for ID.

The survey questions were aimed at collecting data on (1) demographics (age, gender, geographical location, job title), (2) work experience (type of clients and their enquires, type of project, factors that limit the uptake of ID and source of information to keep up to date), (3) design phase practices (use of design tools to discover people's needs and aspirations), and (4) post-design phase practices (use of tools to collect building occupants' feedback on inclusion and accessibility). Data were analysed through descriptive and inferential statistical methods, further explained in the following section.

Results and discussion

This section reports the results of the questionnaire, managed through Qualtrics XM, by highlighting challenges and opportunities to support building industry professionals with the design and post-design of buildings that guarantee inclusion, diversity, equity and accessibility for all occupants. While this study focuses on data collection, which can be used to inform as an illustrative view of challenges and opportunities, the value of the detailed data allows for a deeper understanding of the concepts described in this article.

Demographics

Among 114 responses, 80.7% ($n = 92$), originated from Europe, whereas participants from the rest of the world totalled 19.3% ($n = 22$), with 13.2% ($n = 15$) from the United States of America, and the remaining from Canada and Asia Pacific. There were 57.8% ($n = 66$) females and 39.5% ($n = 45$) males and three participants preferred not to respond.

The average age of participants fell within the 40–49 years of age group and those whose age was above 30 years, with relatively greater working experience than younger consultants (Smith et al. 1989; Tofan, Galster, and Avgeriou 2013), were 92.1% ($n = 105$).

Among participants, 37.7% ($n = 43$) reported working mainly as access consultants, 34.2% ($n = 39$) as architectural designers/engineers, whereas 28.1% ($n = 32$) self-identified as design

/project managers, surveyors, occupational therapists and housing policy officers.

The population sample and spread across countries shown in Table 1 suggested for a descriptive analytical approach, rather than a purely inferential statistical approach.

Work experience: exploring the scenario and routines

This section looks at practitioners' working practice and knowledge of ID. As shown in Figure 1, approximately 61.4% of participants ($n = 70$) work for public clients, 46.5% ($n = 53$) for large private clients (250 + employees), 35.1% ($n = 40$) for medium private clients (50–249 employees) and 36.0% ($n = 41$) for small private clients (10–49 employees). A significantly high percentage (30.7%) of participants ($n = 35$) work for not-for-profit organizations and 28.9% ($n = 33$) for micro private clients.

Practitioners are involved with a variety of consultations and the results show that 61.4% ($n = 70$) perform access audits, which would appear to be the first step for a client in understanding the importance of accessibility and inclusion in a building (Hashim et al. 2012). Around 60.5% ($n = 69$) of participants were involved with new build projects with greater capacity for implementing regulations addressing accessibility and inclusion (Chrysikou 2018). Approximately 58.8% ($n = 67$) of participants were involved with refurbishment, which allows for space adaptations according to access audits outcomes and regulations (Van der Linden, Dong, and Heylighen 2016). Less than one third of them, 28.1% ($n = 32$), reported 'other' including educational material development and best practice guidance consultancies.

According to the International System of Industrial Classification (United Nations 2008) the building and construction industry is composed of three groups: non-residential, residential and engineering construction, including infrastructures and industrial facilities and this study mainly collected data on the experience of practitioners working in the residential and non-residential groups.

In the non-residential group, more than half of participants, 51.8% (n = 59), consult for commercial and office spaces, whereas 39.5% ($n = 45$) and 36.8% ($n = 42$), work respectively on educational and entertainment facilities. A significant number of participants, 31.6% (n = 36), reported consulting for healthcare facilities, 29.8% ($n = 34$) for retail, 26.3% ($n = 30$) for hospitality and 22.8% ($n = 26$) for leisure and sport facilities. Almost 25.4% ($n = 29$) of participants reported others, such as public realm improvements, master planning and mixed/playground areas. With regard to residential buildings,

Table 1. Gender and age split across countries.

| Country	Gender			Age		
	Female	Male	Prefer not to respond	Above 30 years old	Below 30 years old	Prefer not to respond
United Kingdom of Great Britain and Northern Ireland	32.2% ($n = 37$)	21.6% ($n = 25$)	1.8% ($n = 2$)	53.6% ($n = 61$)	2.6% ($n = 3$)	–
United States of America	7% ($n = 8$)	5.4% ($n = 6$)	0.9% ($n = 1$)	10.5% ($n = 12$)	1.8% ($n = 2$)	–
Ireland	5.4% ($n = 6$)	1.8% ($n = 2$)	–	7% ($n = 8$)	–	–
Italy	5.4% ($n = 6$)	6.2% ($n = 7$)	–	10.5% ($n = 12$)	0.9% ($n = 1$)	0.9% ($n = 1$)
Other countries	7.8% ($n = 9$)	4.5% ($n = 5$)	–	10.5% ($n = 12$)	1.8% ($n = 2$)	–
TOTAL	57.8% ($n = 66$)	39.5% ($n = 45$)	2.7% ($n = 3$)	92.1% ($n = 105$)	7.1% ($n = 8$)	0.9% ($n = 1$)
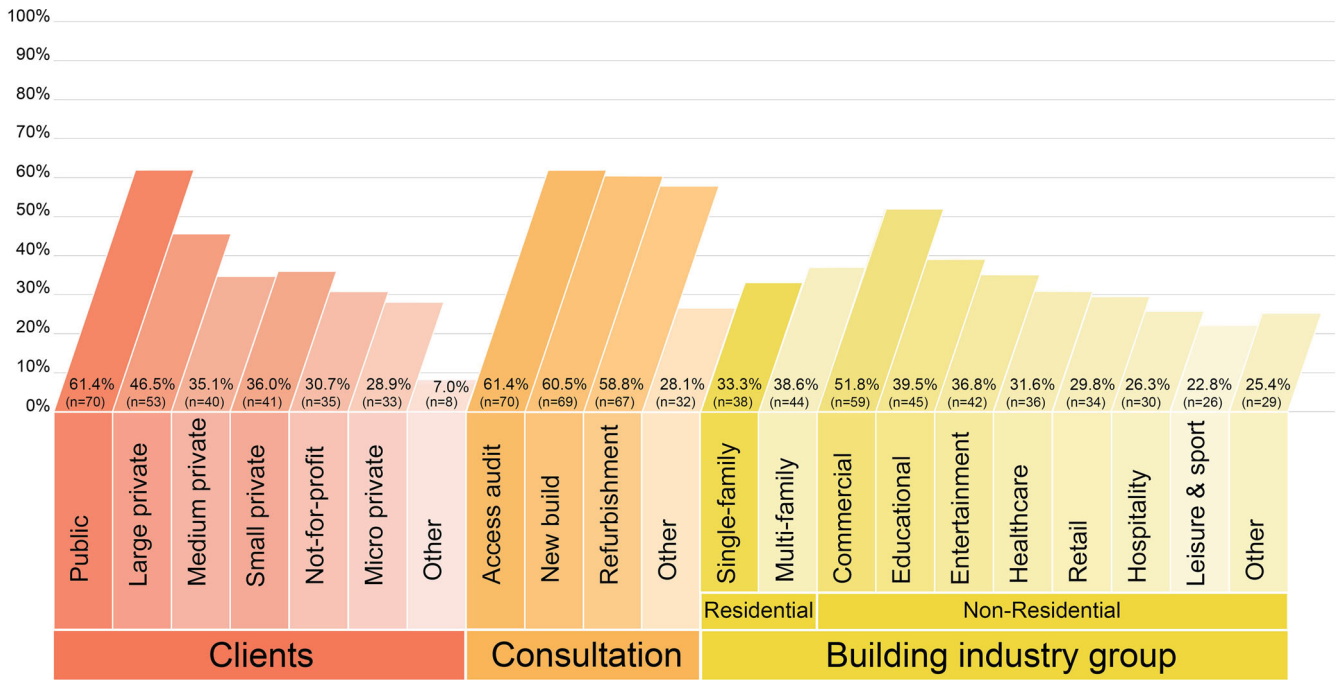
Figure 1. Infographic with details on type of clients, their enquires and the building industry group participants work for.

most enquires are for multi-family residential, 38.6% ($n = 44$), and slightly less for single-family residential, 33.3% ($n = 38$).

To fully comprehend the relationships between clients and building groups inferential statistics techniques were used and Fisher's Exact Test was chosen to evaluate whether variables are statistically related within the current sample size (Kim 2017). A p value less than 0.05 suggests a statistically significant relationship.

As reported in Table 2, there are statistically significant relationships between public bodies and educational ($p = 0.0487$) and entertainment facilities ($p = 0.0468$). Not-for-profit organizations have a correlation with entertainment ($p = 0.00352$) and healthcare facilities ($p = 0.00412$). These relationships suggest that consulting for these clients can lead to greater impact when designing these types of facilities. Working for large private clients appears to be beneficial in delivering impactful designs for commercial/office facilities ($p < 0.00001$), educational ($p = 0.00764$), entertainment ($p = 0.0000131$), retail facilities ($p = 0.0140$), hospitality ($p = 0.0114$) and leisure ($p =$

0.0130). Consulting for medium private clients provides similar opportunities as those afforded by working for large private clients, with the addition of potentially consulting on healthcare facilities ($p = 0.0029$). Small private clients were seen to be involved with similar types of building groups, excluding educational facilities and with the addition of multi-family residential buildings ($p = 0.0166$). Micro private clients have a strong correlation with single-family residential buildings ($p = 0.00084$). These correlations suggest that in order to have greater chances when designing multi-family buildings, it is beneficial to connect with small private clients, whereas when designing or redesigning single-family buildings, micro private clients may offer more opportunities.

Designing buildings for public or large private clients can impact how thousands or even millions of individuals experience their spaces (Kuitert, Volker, and Hermans 2019), whereas working for smaller clients may have an impact at a different scale. Maintaining relationships with different clients allows for the development of different opportunities to design or redesign

Table 2. Relationships between clients and buildings groups according to Fisher's Exact Test data analysis.

		Clients					
	p Value	Public	Non-for-profit	Large private	Medium private	Small private	Micro private
Non-Residential	**Commercial** (*p* Value)	1	0.543	< 0.00001	0.000011	0.0110	0.536
	Educational (*p* Value)	0.0487	0.0986	0.00764	0.0013	0.0724	0.679
	Entertainment (*p* Value)	0.0468	0.00352	0.0000131	< 0.00001	0.00223	0.285
	Healthcare (*p* Value)	0.0618	0.00412	0.227	0.0029	0.0385	0.125
	Retail (*p* Value)	0.679	0.827	0.0140	0.000030	0.00548	0.370
	Hospitality (*p* Value)	0.0517	0.107	0.0114	0.00001	0.0272	0.818
	Leisure & sport (*p* Value)	0.0713	0.0884	0.0130	0.000101	0.00451	0.470
Residential	**Single-family** (*p* Value)	1	0.832	0.167	0.407	0.409	0.00084
	Multi-family (*p* Value)	0.554	0.838	0.342	0.164	0.0166	1

Noe: A p value less than 0.05 (in grey) suggests a statistically significant relationship.

more inclusive spaces. Data regarding the involvement of practitioners with different clients and the correlations with building groups creates a baseline of knowledge upon which to develop optimal strategies to promote the future uptake of ID.

The relationship between practitioner and client appears to be essential in order to foster the uptake of ID. Approximately 41.6% of participants ($n = 47$) reported that clients request only legal and regulation compliancy, with the goal being to achieve minimum accessibility standards. Around 36.3% ($n = 42$) reported that clients request best practice compliancy, going beyond minimum accessibility standards and only 10.6% ($n = 12$) reported that clients are well informed about ID and are seeking future-proof inclusive projects targeting sensory and cognitive inclusion over and above just physical accessibility. This data validates early-stage findings from previous ethnographic studies which identified the scarcity of adoption of standards and policies across the industry, unless there is a legal obligation to do so and limited willingness to build the business case for inclusion (Zallio and Clarkson 2021b).

To gain insight into the factors that practitioners perceive to limit the uptake of ID during the design and post-design phases, a five-point Likert scale questionnaire, ranging between one (strongly disagree) and five (strongly agree), was distributed to participants.

Approximately 74.5% of respondents ($n = 85$) agreed that project budgets were a constraining factor (M = 4.02, SD = 1.66) and roughly 73.7% of respondents ($n = 84$) reported clients failing to perceive the value of ID with the view of respondents tending towards somewhat agree (M = 3.90, SD = 1.85).

A limited awareness from clients with regard to ID was reported by 72.8% of respondents ($n = 83$), with responses of somewhat agree (M = 3.90, SD = 2.12).

Other factors such as few requests from clients for ID projects (M = 3.61, SD = 2.32), lack of mandatory laws and regulations (M = 3.61, SD = 2.12) and project time constraints (M = 3.31, SD = 2.33) were also reported as contextual factors preventing practitioners from designing inclusively and these are represented in Figure 2.
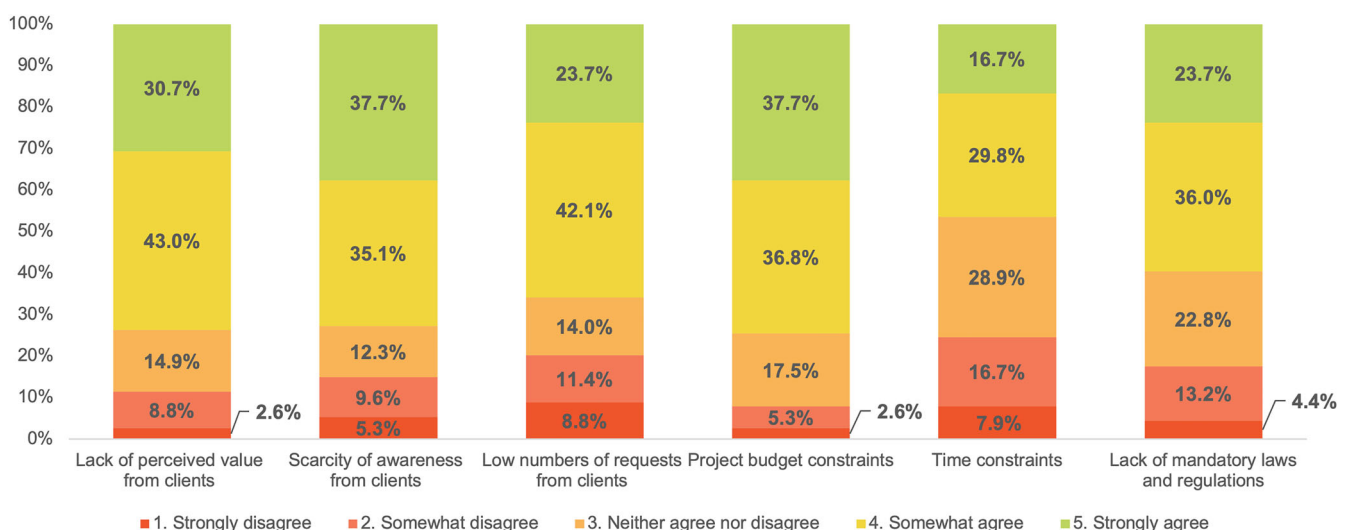
Work experience: investigating the correlations with common practices

This section looks at practitioners' working practice and investigates the correlations with challenges that limit the uptake of ID.
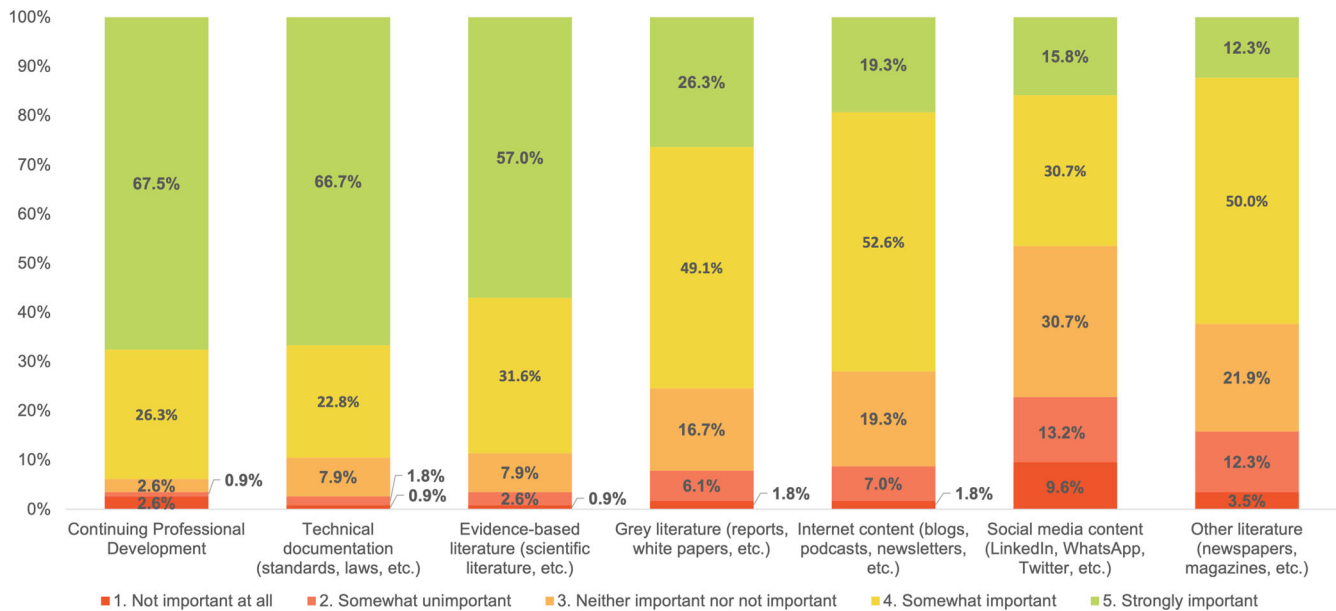
To understand the relationships between paired factors explaining the lack of uptake of ID a correlation test was performed. The Pearson Correlation Coefficient (PCC) was used to measure the correlation between couples of data as no outliers were present in the dataset.

The limited awareness from clients with regard to ID was positively correlated with a lack of perceived value in ID ($p < 0.00001$, Effect Size (Pearson's r) = 0.497). This correlation suggests that limited awareness of ID leads to a reduced perception of value in an inclusively designed building, as identified in a previous ethnographic study (Zallio and Clarkson 2021b). As a result of this biased perception, the proportion of difference between variables, calculated by using the coefficient of R-squared, suggests that limited client awareness was emphasized as the dominant driver for the low numbers of requests from clients for ID projects ($p < 0.00001$, R-squared = 46.5%). A positive correlation was also noted between project budget and time constraints ($p < 0.0000136$, Effect Size (Pearson's r) = 0.395).

It would seem that most of these factors influence the abilities of practitioners to design inclusively and to positively influence the decisions of clients by building the business case for ID. The practitioner would appear to play a key role as advocate for the value of ID at different stages of the design process.

The continuous education of practitioners is fundamental in influencing clients to design inclusively, and a series of instruments to support this process were identified through a five-point Likert scale questionnaire, ranging between one (not important at all) and five (strongly important).

Figure 3 shows that continuing professional development (CPD), identified with formal and informal learning (Daniel, Fleischmann, and Welters 2017), was considered important by 93.8% of participants ($n = 107$), (M = 4.55, SD = 0.82). Technical doc-

Figure 2. Factors that limit the uptake of Inclusive Design among architectural design practitioners.

Figure 3. Importance of instruments to facilitate the development of knowledge of Inclusive Design among architectural design practitioners.

umentation such as standards, regulations and best practices were identified as important by 89.5% of participants ($n = 102$), ($M = 4.53$, $SD = 0.79$), as well as evidence-based literature including scientific literature and market research, by 88.6% ($n = 101$), ($M = 4.41$, $SD = 0.81$).

As reported by 75.4% of participants ($n = 86$), ($M = 3.92$, $SD = 0.91$), three additional instruments of relevance were grey literature (identified with reports), government documents and white papers (Pappas and Williams 2011). Internet content, including blogs, podcasts and newsletters were reported by 71.9% of participants ($n = 82$), ($M = 3.81$, $SD = 0.89$). Other literature, such as newspapers and magazines, were reported by 62.3% of participants ($n = 70$), ($M = 3.55$, $SD = 0.97$), together with social media content and platforms to connect people (e.g. LinkedIn, Twitter, WhatsApp, etc) by 46.5% ($n = 53$), ($M = 3.30$, $SD = 1.7$).

Descriptive statistics data showed that more than half of practitioners (65%) between 50 and 70 + years of age preferred to use more traditional learning tools including CPD, technical documentation and evidence-based literature. More than one third of participants (35%), between 40–49 years of age, strongly believed it was important to use the Internet and social media content for inspiration and to learn more about ID. Overall it appeared that senior practitioners preferred using traditional learning tools, whereas junior practitioners were more willing to engage with contemporary and new methods of learning.

Design phase: understanding the practice

The educational role of practitioners along with their ability to influence the decisions of clients are two important factors in improving the uptake of ID. The design phase represents a fundamental stage in the building development process where practitioners can explore the user journey (Følstad and Kvale 2018) and tailor a design according to the capabilities, needs and desires of the occupants of the building embedding the principles of inclusion, diversity, equity and accessibility (Zallio and Clarkson 2021b).

Most participants 64%, ($n = 73$) reported having no prior knowledge of toolkits or frameworks to help explore the user journey and describe user needs. The remaining 36% ($n = 41$) reported knowledge of Soft Landings from BSRIA, a process to ensure all decisions are based on improving the performance of a building by meeting the expectations of clients (BSRIA 2015); the BUS methodology, a process to capture the complexity of the features of a building, highlighting building performance indicators (Usable Buildings Trust 2021); or customized and not necessarily scientifically validated toolkits. These toolkits appear to be more focused on performance and sustainability, rather than on inclusion and accessibility.

Different thematic areas within ID were briefly explored in previous research (Zallio and Clarkson 2021b) and should be part of the design process. On a five-point Likert scale questionnaire, ranging between one (strongly disagree) and five (strongly agree), 78.9% of participants ($n = 90$) agreed ($M = 4.63$, $SD = 0.90$) that physical accessibility, including dimensions, access, circulation and wayfinding should be strongly considered. Approximately 74.6% of participants ($n = 85$), reported that sensory inclusion ($M = 4.61$, $SD = 0.85$), such as use of light, colours and materials should be strongly considered and that cognitive inclusion ($M = 4.57$, $SD = 0.92$), including perception of space, neurodiversity and psychosocial safety is very important. Data from the three groups of variables was selected and analysed with a Chi-squared test which showed a statistically significant relationship between physical accessibility and cognitive inclusion ($p < 0.00001$, Effect Size = 0.729) and physical accessibility and sensory inclusion ($p < 0.00001$, Effect Size = 0.710). While physical accessibility is perceived as slightly more important than sensory and cognitive inclusion, the significant relationship between the three thematic areas suggests that they all support an ID process.

Exploring opportunities for practitioners: design phase

To understand more about the thematic areas and how ID could be implemented during the design phase, four major components were rated by participants through a five-point Likert scale questionnaire, ranging between one (strongly disagree) and five (strongly agree), and this is illustrated in Figure 4.

Approximately 87.7% of participants ($n = 100$) agreed overall that the use of prompt questions was an effective way for them to better identify physical, sensory and cognitive user needs (M = 4.51, SD = 0.84). Participants reported slightly less agreement, 84.2% ($n = 96$), (M = 4.37, SD = 0.82), when it came to receiving help to identify and organize design requirements. Nearly 82.5% of participants ($n = 94$), (M = 4.2, SD = 0.85), agreed with the use of a framework to organize user needs. Around 81.6% ($n = 93$), (M = 4.32, SD = 0.82), agreed positively with using a framework to recognize and organize key aspects in the user journey.

The positive agreement on different components emphasizes the relevance of receiving a structured, evidence-based foundation of support to help identify user needs, highlight key aspects in the user journey and organize design requirements. In confirmation of this view, participants had a positive perception of the creation of a toolkit that embraces these components. Through a five-point Likert scale questionnaire, ranging between one (extremely unlikely) and five (extremely likely), 79% of participants ($n = 90$), (M = 4.02, SD = 0.91), would be likely to use a toolkit to implement ID in their design process.

This toolkit could prove to be an agent in fostering understanding of ID, using a structured method that listens to different stakeholders in order to tease out meaningful feedback with regard to the design of buildings that guarantee inclusion, diversity, equity and accessibility. Notwithstanding that it is focused primarily on the design phase, practitioners in other fields could benefit from it. Architects and architectural technologists were selected by 91.2% of participants ($n = 104$), design and project managers by 82.5% ($n = 94$), access consultants and interior/product designers by 75.4% ($n = 86$), landscape and urban architects by 74.6% ($n = 85$) and engineers by 61.4% ($n = 70$).

Exploring opportunities for practitioners: post-design phase

The post-design phase constitutes a significant stage where users can fully experience a building or facility (Durosaiye, Hadjri, and Liyanage 2019).

In many cases the design process starts with learning from past experiences through analysis of occupancy data from an existing facility (Hostetler 2010) to further improve a new building. However, studies reported (Zallio and Clarkson 2021a; 2021b) that sometimes practitioners are not keen to explore post-design feedback.

In this study we ascertained that most participants, 78.1% ($n = 89$), have limited knowledge of existing post-occupancy evaluation (POE) tools to gauge accessibility and inclusion within buildings. Only 21.9% ($n = 25$) of participants had previous experience with other tools such as the Occupant Survey Toolkit (Graham, Parkinson, and Schiavon 2021), the BUS methodology (Usable Buildings Trust 2017) and Soft Landings (BSRIA 2015). These tools mostly assess sustainability, comfort and efficiency, with little focus on accessibility and inclusion. These findings validate previous research (Zallio and Clarkson 2021b), where it was evidenced that there was a low uptake of post-design feedback and a generalized lack of POE tools targeting inclusion, diversity, equity and accessibility in the built environment.
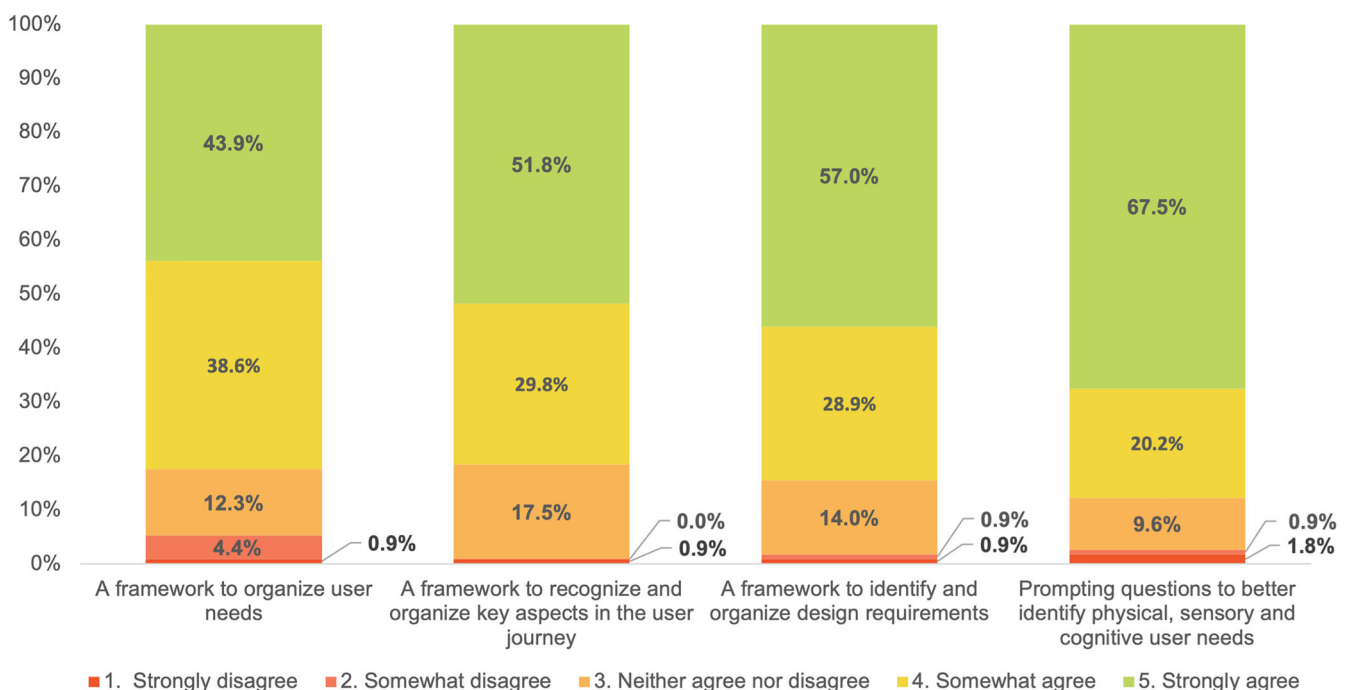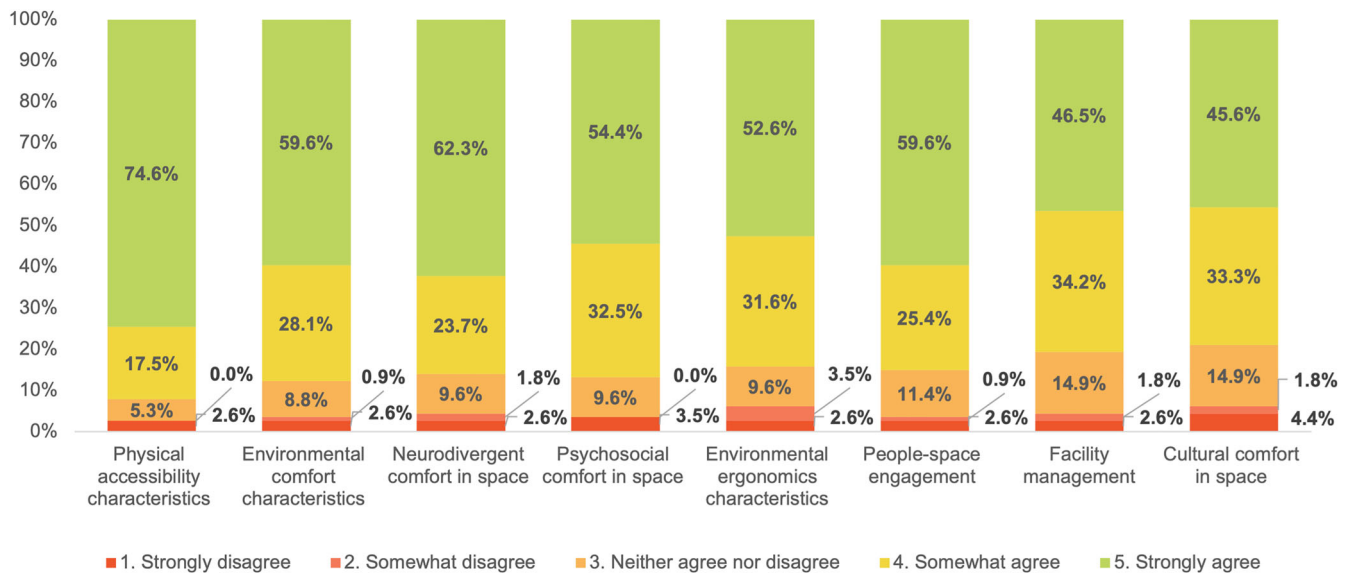

Figure 4. Four major components helpful in improving an Inclusive Design process for practitioners.

Figure 5. Components to consider for a POE tool targeting inclusion, diversity, equity and accessibility.

In similarity to the design phase, eight components that should constitute a POE tool targeting inclusion and accessibility were explored and displayed in Figure 5.

Through a five-point Likert scale questionnaire, ranging between one (strongly disagree) and five (strongly agree), positive agreement was established for physical accessibility characteristics (e.g. access, circulation, wayfinding, interaction, etc) from 92.1% of participants ($n = 105$), (M = 4.61, SD = 0.81). Approximately 87.7% of participants ($n = 100$), (M = 4.41, SD = 0.89), agreed with including environmental comfort characteristics (e.g. air quality, thermal, lighting, sound comfort, etc).

Similarly, 86% of participants (n = 98), (M = 4.41, SD = 0.93), agreed with including neurodivergent comfort within spaces (e.g. behavioural dynamics, neuroinclusion, people diversity, engagement, etc) and psychosocial comfort in space (e.g. gender safety, mental health awareness, anxiety and stress coping, etc), (M = 4.34, SD = 0.92). Roughly 84% of participants ($n = 96$), (M = 4.28, SD = 0.96), agreed with including environmental ergonomics characteristics (e.g. space dimensions, use of materials, use of colours, furniture comfort, space adaptability, etc) and people-space engagement (M = 4.39, SD = 0.91) (e.g. spatial aesthetics, person-space dynamics, space configuration, privacy comfort, etc).

An aspect that is not so often taken into consideration in POE tools is facility management (e.g. maintenance, cleanliness, updating building features, etc) and the importance of this was agreed by 81.2% of participants ($n = 92$), (M = 4.20, SD = 0.94). Finally, cultural comfort in space (e.g. sense of belonging, cultural shift, language and terminology, etc) received a preference from 78.9% participants ($n = 90$), (M = 4.14, SD = 1.02).

The robust agreement expressed for characteristics such as physical accessibility, neurodivergent comfort in space, people-space engagement and environmental comfort suggests these components should be included in a POE tool with an increased weighting to impact the overall rating. However, further investigation with pilots and practical experiences is recommended to appropriately gauge different aspects of inclusion and accessibility.

The development of POE tools with ID as their focus appears to be an emergent priority for more than 83.4% of participants ($n = 95$) and can help a variety of architectural design practitioners to collect feedback from occupants. Architects and architectural technologists constitute major beneficiaries, reported by 58.3% of participants ($n = 91$), followed by access consultants and facility managers, reported by 55.8% ($n = 87$), design and project managers, stated by 53.2% ($n = 83$), and Diversity, Equity and Inclusion human resource managers, indicated by 50.6% ($n = 79$). Building maintenance staff were reported by 35.9% of participants ($n = 56$) and it appears they hold a stronger position when it comes to guaranteeing inclusive and accessible building features.

As reported in this section, there is an overall understanding of the scarcity of perceived value of ID from different stakeholders and a continuous effort from some practitioners to stay informed about new tools, practices and regulations on ID. As broadly identified by previous research (Basnak, Tauke, and Weidemann 2015; Heylighen, Van der Linden, and Van Steenwinkel 2017; Ryhl 2014; Zallio and Clarkson 2021b) there is an overarching understanding of the influence that new practices and tools, particularly for the design and post-design phases, can make to embed ID at different stages of the building design process. In the following sections a deeper understanding of these findings is depicted.

Depicting opportunities

The age spread across participants may suggest that practitioners who have an understanding and knowledge of ID have received previous training and been practicing ID for a considerable number of years. However, several practitioners reported having limited knowledge of frameworks or toolkits for the implementation of ID when designing or redesigning a building. Toolkits afford the opportunity to create value by helping their users in the design and development process (Franke and Piller 2004), and could specifically support practitioners through an ID process.

Additionally, practitioners highlighted that some clients scarcely acknowledge the added value of an inclusive project and this is mainly due to lack of awareness. This systematic challenge is one of the major drivers for the low numbers of requests from clients for ID projects across different building groups.

It emerged that practitioners play a fundamental role in influencing clients and building the business case for ID.

Considering the educational role of practitioners, the projects they engage with, the variety of their clients and the challenges experienced, there is at present a willingness to acquire new knowledge of inclusive and accessible design through different learning tools and processes, develop the evidences to build the business case for ID, advance a data-informed design process and better understand the journey and perception different building occupants have of inclusion, diversity, equity and accessibility.

Discovering the journey of users (Følstad and Kvale 2018) and their needs and desires in relation to product and experiential design (Persad et al. 2007) is a fundamental part of anticipating their experiences (Hamilton and Price 2019).

Similarly in architectural design, discovering the user journey and understanding physical, sensory and cognitive needs with an inclusive approach is essential to guarantee the design of buildings that foster inclusion and accessibility for all (Zallio and Clarkson 2021b).

In different fields, such as engineering, product design and business development there are tools and strategic design templates to help professionals to map out needs and aspirations of the customers. By leveraging on the data from this research and taking inspiration from established practices in ID (Persad et al. 2007) and business and management (Osterwalder and Pigneur 2010), there is an opportunity to help practitioners to increase knowledge of ID while better understanding user journeys, aspirations and needs with a tool that offers new avenues to increase the uptake of ID since a very early stage of the building design process, as well as to raise the bar of awareness of ID across practitioners and different stakeholders.

A prototype tool, deployed as an Inclusive Design Canvas, as shown in Figure 6, has the potential to become a strategic design template supporting practitioners to develop more inclusive design processes by considering physical, sensory and cognitive needs through specific questions and identify and organize bespoke design requirements by highlighting key aspects in the user journey. Such a tool can boost the ability to build the business case for ID to different clients and to advance a data-informed design process.

To guarantee the success of such a tool, there is a need to have it seamlessly integrated within existing design practices, such as the RIBA plan of work and be compatible with other design processes that are more focused on building performance and sustainability and aligned with regulations and standards (Imrie and Hall 2001; Schelings and Elsen 2017; Zallio and Clarkson 2021b).

Such a tool that has the potential to allow practitioners to explore areas of exclusion for building occupants, but without becoming a tick box exercise or unscrupulous practice that may allow individuals to amplify their success without any consideration as to what best guarantees the satisfaction of occupants.

Regarding the post-design phase, it is of great importance to guarantee a continuous positive experience to all building
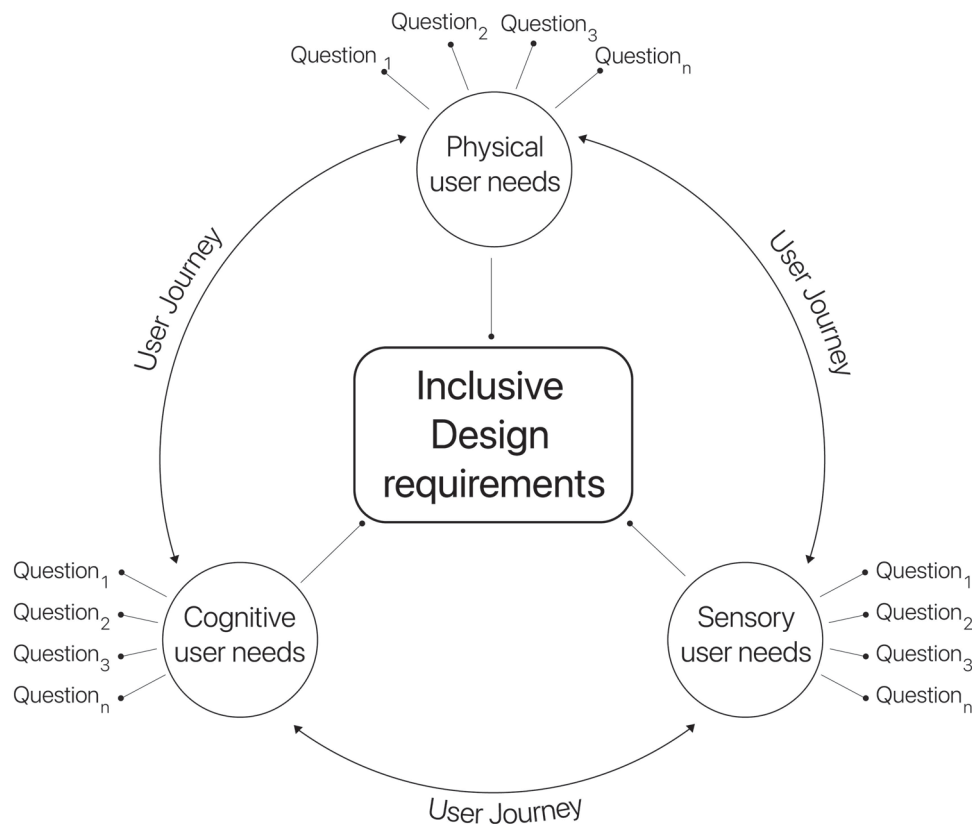
Figure 6. The components of the Inclusive Design Canvas.
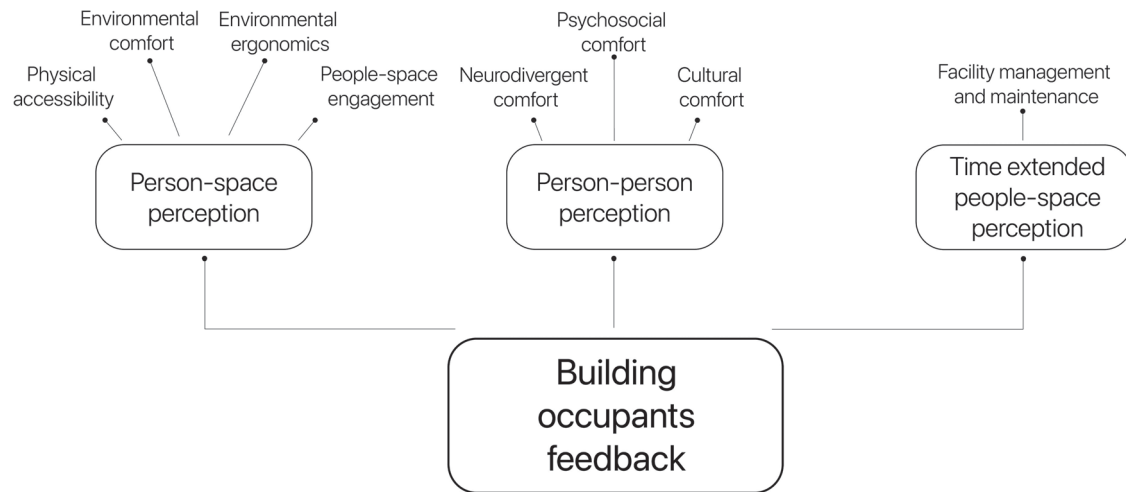
Figure 7. The components of the Inclusive Design Post-Occupancy Evaluation tool.

occupants (Hostetler 2010) and Post-Occupancy Evaluation (POE) can serve to inform future designs and improvements (Hay et al. 2018). The current deficiency in the market of POE tools regarding ID for the built environment (Zallio and Clarkson 2021b) together with the results from this study, reporting a lack of tools to embed ID in the design process and the limited awareness and availability of tools or processes to capture the perception people have of inclusion and accessibility in buildings provide new opportunities to develop tools to support a better understanding of accessibility and inclusion in the built environment in the post-design phase.

According to the research findings a prototype of an Inclusive Design audit tool, as shown in Figure 7, can offer an opportunity to collect feedback on physical accessibility, environmental comfort, environmental ergonomics and people-space engagement, as main components that impact the building occupants experience. These represent four components that strongly impact the perception of interactions between persons and the nearby physical space.

To allow for a comprehensive understanding of the cognitive aspects of human beings and their experience in a building, neurodivergent comfort, psychosocial comfort and cultural comfort in the built environment are three additional components that should be taken into consideration and help to explain the perception of dynamics between people which are affected by the surrounding environment.

An element that strongly impacts inclusion, diversity, equity and accessibility throughout the entire life of a building is the perception from building occupants of facility management and maintenance throughout its extended lifetime. Research reveals that facility management policies and practices are still in their infancy and the limited knowledge generated so far relates only to strategy, performance, operation and innovation (Mari and Poggesi 2014).

The positive feedback on post-design toolkits lays the foundations for developing an Inclusive Design audit tool capable of collecting feedback from building occupants through mixed methods, to gain a comprehensive understanding of such feedback on inclusion, diversity, equity and accessibility in the built environment.

The results of this study emphasized key aspects such as the scarcity of awareness clients have of the benefits of designing inclusively and the continuous need from practitioners to learn and apply ID across different projects. Furthermore, it highlighted the opportunities practitioners have in advocating for ID, and stressed the importance to develop practices and toolkits to improve the design and post-design phases of buildings that guarantee inclusion, diversity, equity and accessibility.

Implications and future work

The work presented is subject to limitations. Notwithstanding the sample size and geographical location, the study collected feedback mostly from practitioners with expertise in ID where most of participants have expertise in ID and hence the results display a positive outlook for the current knowledge of state-of-the-art ID toolkits.

The results may have been biased by the perceptions those experts have of ID and the importance that they place on it. For future studies that aim to reach a statistical significance across different geographies and practitioners, we recommend considering experts with varying expertise and potentially less knowledge of ID. This would broaden the validity of these findings and offer a greatly widened view of the perceptions of practitioners. The overall research, funded under the European Union's Horizon 2020 research and innovation programme, focuses on creating critical knowledge to support practitioners with the design of physical spaces and potentially future virtual spaces that guarantee inclusion, diversity, equity and accessibility for all occupants.

With this research we aimed at expanding the results identified from previous studies to further deepen the knowledge of the scientific as well as the expert's communities.

The specific contribution of this study is to shed light on the current state of inclusion, diversity, equity and accessibility when designing buildings and to provide insights into the factors that hinder or promote the creation of accessible and inclusive buildings.

The study also aims to deepen the knowledge of the scientific community in order to provide context information to develop

new opportunities for building industry professionals to create more inclusive and accessible buildings, such as the use of new tools, best practices, technologies, and collaborate with diverse stakeholders by incorporating inclusive design principles in the early stages of the design process.

This study contributes to the growing body of research on inclusive design and provides valuable insights into the challenges and opportunities that building industry professionals face when designing inclusive and accessible buildings.

By understanding these challenges and opportunities, future designers and scholars can develop new strategies and tools to overcome the challenges and take advantage of the opportunities to promote inclusive design in the building industry.

Finally, the methodology chosen, and the research findings can be applied beyond this case study. Quantitative methods are a commonly used in social research and have been used in a variety of contexts to explore attitudes, behaviours, and experiences of different groups of people. As an example, a study published in the Journal of Sustainability describes the use of a quantitative tool to depict the level of accessibility in the area of the built environment (Marín-Nicolás and Paz Sáez-Pérez 2022). Similarly in the healthcare field, there have been attempts to map physical accessibility scales through quantitative methods (Groenewegen, Kroneman, and Spreeuwenberg 2021).

The methodology of using quantitative methods, such as questionnaires and similar tools to gather data on challenges and opportunities regarding accessibility and ID can be applied beyond the situation studied with successfully results.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Declaration of interest statement

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Data availability statement

The data that support the findings of this study are available from the corresponding author, MZ, upon reasonable request.

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References

American Standards Association, National Society for Crippled Children, & United States. President's Committee on Employment of the Physically Handicapped. 1980. *American Standard Specifications for Making Buildings and Facilities Accessible To, and Usable By, the Physically Handicapped.* California Department of Rehabilitation.

Ayhan, H. Öztaş. 2011. "Non-probability Sampling Survey Methods." In *In International Encyclopedia of Statistical Science*, edited by Miodrag Lovric, 979–982. Berlin: Springer Berlin Heidelberg.

Barrett, D., and R. Heale. 2020. "What are Delphi Studies?" *Evidence Based Nursing* 23 (3): 68–69. http://doi.org/10.1136/ebnurs-2020-103303.

Basnak, M. B., B. Tauke, and S. Weidemann. 2015. "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, IL, USA.

Bichard, Jo-Anne, and Rama Gheerawo. 2013. "Inclusive Design." *The Design Journal* 16 (2): 133–137. https://doi.org/10.2752/175630613X13584367984785.

BSI. 2005. *BS 7000-6:2005 - Design Management Systems. Part 6.* London: Managing Inclusive Design Guide.

BSRIA. 2015. "Soft Landings."

Chrysikou, Evangelia. 2018. "Why we Need new Architectural and Design Paradigms to Meet the Needs of Vulnerable People." *Palgrave Communications* 4 (1), https://doi.org/10.1057/s41599-018-0171-z.

Clarkson, P. J., and R. Coleman. 2015. "History of Inclusive Design in the UK." *Applied Ergonomics* 46 (Pt B): 235–247. https://doi.org/10.1016/j.apergo.2013.03.002.

Coleman, Roger. 1994. "The Case for Inclusive Design an Overview." Paper Presented at the 12th Triennial Congress. International Ergonomics Association and the Human Factors Association of Canada, Toronto, Canada.

Daniel, Ryan, Katja Fleischmann, and Riccardo Welters. 2017. "Professional Development in the Creative Industries: Methods and Insights from Regional Practitioners." *Australian Journal of Career Development* 26 (3): 113–123. https://doi.org/10.1177/1038416217720780.

Durosaiye, Isaiah Oluremi, Karim Hadjri, and Champika Lasanthi Liyanage. 2019. "A Critique of Post-Occupancy Evaluation in the UK." *Journal of Housing and the Built Environment* 34 (1): 345–352. https://doi.org/10.1007/s10901-019-09646-2.

Eaden, J., M. K. Mayberry, and J. F. Mayberry. 1999. "Questionnaires: The use and Abuse of Social Survey Methods in Medical Research." *Postgraduate Medical Journal* 75 (885): 397–400. https://doi.org/10.1136/pgmj.75.885.397.

EIDD. 2020. *Design for All Europe: Stockholm Declaration*. Accessed November 12, 2020. https://www.designforalleurope.org.

Fernandez, C., M. Zallio, D. Berry, and J. McGrory. 2021. "Towards a People-First Engineering Design Approach. A Comprehensive Ontology for Designing Inclusive Environments." In *Proceedings of the International Conference on Engineering Design (ICED21)*, Gothenburg, Sweden, 16-20 August 2021. https://doi.org/10.1017/pds.2021.579.

Følstad, Asbjørn, and Knut Kvale. 2018. "Customer Journeys: A Systematic Literature Review." *Journal of Service Theory and Practice* 28 (2): 196–227. https://doi.org/10.1108/JSTP-11-2014-0261.

Franke, Nikolaus, and Frank Piller. 2004. "Value Creation by Toolkits for User Innovation and Design: The Case of the Watch Market." *Journal of Product Innovation Management* 21 (6): 401–415. https://doi.org/10.1111/j.0737-6782.2004.00094.x.

Gerber, David A. 1994. "Heroes and Misfits: The Troubled Social Reintegration of Disabled Veterans in "The Best Years of Our Lives"." *American Quarterly* 46 (4): 545–574. https://doi.org/10.2307/2713383.

Goldsmith, S. 1963. Designing for the Disabled: A Manual of Technical Information".

Goldsmith, Selwyn. 2000. *Universal Design: A Manual of Practical Guidance for Architects*. Edited by Selwyn Goldsmith. London: Reed Educational and Professional Publishing Ltd.

Graham, Lindsay T., Thomas Parkinson, and Stefano Schiavon. 2021. "Lessons Learned from 20 Years of CBE's Occupant Surveys." *Buildings and Cities* 2 (1): 166–184. https://doi.org/10.5334/bc.76.

Gray, D. B., M. Gould, and J. E. Bickenbach. 2003. "Environmental Barriers and Disability." *Journal of Architectural and Planning Research* 20 (1): 29–37.

Groenewegen, Peter P., Madelon Kroneman, and Peter Spreeuwenberg. 2021. "Physical Accessibility of Primary Care Facilities for People with Disabilities: A Cross-Sectional Survey in 31 Countries." *BMC Health Services Research* 21 (1), https://doi.org/10.1186/s12913-021-06120-0.

Hamilton, Rebecca, and Linda L. Price. 2019. "Consumer Journeys: Developing Consumer-Based Strategy." *Journal of the Academy of Marketing Science* 47 (2): 187–191. https://doi.org/10.1007/s11747-019-00636-y.

Hashim, Ahmad Ezanee, Siti Aida Samikon, Faridah Ismail, Hikmah Kamarudin, Md Nadzri Mohd Jalil, and Norrimah Mad Arrif. 2012. "Access and Accessibility Audit in Commercial Complex: Effectiveness in Respect to People with Disabilities (PWDs)." *Procedia - Social and Behavioral Sciences*, https://doi.org/10.1016/j.sbspro.2012.08.049.

Hay, Rowena, Flora Samuel, Kelly J. Watson, and Simon Bradbury. 2018. "Post-occupancy Evaluation in Architecture: Experiences and Perspectives from UK Practice." *Building Research & Information* 46 (6): 698–710. https://doi.org/10.1080/09613218.2017.1314692.

Heylighen, A., V. Van der Linden, and I. Van Steenwinkel. 2017. "Ten Questions Concerning Inclusive Design of the Built Environment." *Building and Environment* 114: 507–517. http://doi.org/10.1016/j.buildenv.2016.12.008.

Hostetler, Mark. 2010. "Beyond Design: The Importance of Construction and Post-Construction Phases in Green Developments." *Sustainability* 2: 1128–1137. https://doi.org/10.3390/su2041128.

Imrie, R., and P. Hall. 2001. *Inclusive Design: Designing and Developing Accessible Environments*. London: Spon Press.

Institute, American National Standards. 1980. *Specifications for Making Buildings and Facilities Accessible to Usable to Physically Handicapped People*. Edited by President's Committee on Employment of the Handicapped. National Easter Seal Society. United States of America. 2nd ed. New York: ANSI.

Kim, Hae-Young. 2017. "Statistical Notes for Clinical Researchers: Chi-Squared Test and Fisher's Exact Test." *Restorative Dentistry & Endodontics* 42 (2): 152–155. https://doi.org/10.5395/rde.2017.42.2.152.

Kuitert, Lizet, Leentje Volker, and Marleen H. Hermans. 2019. "Taking on a Wider View: Public Value Interests of Construction Clients in a Changing Construction Industry." *Construction Management and Economics* 37 (5): 257–277. https://doi.org/10.1080/01446193.2018.1515496.

Lifchez, Raymond, and Barbara. Winslow. 1979. *Design for Independent Living: The Environment for Physically Disabled People*. New York: Whitney Library of Design.

Mace, R. L., G. J. Hardie, and J. P. Place. 1991. "Accessible Environments:Toward Universal Design." In *In Design Intervention: Toward a More Humane Architecture*, edited by J. C. Vischer, W. E. Preiser, and E. T. White, 67–71. New York: Van Nostrand Reinhold.

Mari, M., and P. Poggesi. 2014. "Facility Management: Current Trends and Future Perspectives." *International Journal of Globalisation and Small Business* (3/4): 177–192. https://doi.org/10.1504/IJGSB.2014.067506

Marín-Nicolás, José, and Mª Paz Sáez-Pérez. 2022. "An Evaluation Tool for Physical Accessibility of Cultural Heritage Buildings." *Sustainability* 14 (22): 15251. https://doi.org/10.3390/su142215251.

Nations, United. 2008. "International Standard Industrial Classification of All Economic Activities." In *Series M No.4/Rev.4*, 29–32. New York: United Nations.

Osterwalder, Alexander, and Yves Pigneur. 2010. *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. Hoboken, NJ: Wiley.

Pappas, Cleo, and Irene Williams. 2011. "Grey Literature: Its Emerging Importance." *Journal of Hospital Librarianship* 11 (3): 228–234. https://doi.org/10.1080/15323269.2011.587100.

Persad, U., P. Langdon, D. Brown, and P. J. Clarkson. 2007. "*Cognitive Scales and Mental Models for Inclusive Design.*" In *Universal Access in Human Computer Interaction. Coping with Diversity. UAHCI 2007. Lecture Notes in Computer Science*, edited by C. Stephanidis. vol. 4554, 235–239. Berlin: Springer.

Pirkl, J. J., and A. L. Babic. 1988. *Guidelines and Strategies for Designing Transgenerational Products: A Resource Manual for Industrial Design Professionals*. Acton, MA: Copley Publishing Group.

Ponto, J. 2015. "Understanding and Evaluating Survey Research." *Journal of Advanced Practitioner in Oncology* 6 (2): 168–171.

Ryhl, C. 2014. "The Missing Link in Implementation of Universal Design: The Barrier Between Legislative Framework and Architectural Practice." In *Three Days of Creativity and Diversity*. Vol. 35, edited by H. A. Caltenco, A. Larsson, P.-O. Hedvall, K. Rassmus-Gröhn, and B. Rydeman, 433–434. IOS Press.

Schelings, ClÈmentine, and C. Elsen. 2017. "A Method for Architectural Inclusive Design: The Case of Users Experiencing Down Syndrome." *Advances in Life Sciences* 9: 201.

Smith, B. N., J. S. Hornsby, P. G. Benson, and M. Wesolowski. 1989, Spring. "What Is in a Name: The Impact of Job Titles on Job Evaluation Results." *Journal of Business and Psychology* Vol. 3 (No. 3): 341–351. https://doi.org/10.1007/BF01023051.

Tofan, D., M. Galster, and P. Avgeriou. 2013. "Difficulty of Architectural Decisions. A Survey with Professional Architects." *Paper Presented at the ECSA 2013, LNCS 7957*.

Usable Buildings Trust. 2021. *BUS Methodology*. Accessed June 15, 2021. https://busmethodology.org.uk/.

Van der Linden, V., H. Dong, and A. Heylighen. 2016. "From Accessibility to Experience: Opportunities for Inclusive Design in Architectural Practice." *Nordic Journal of Architectural Research* 28 (2): 33–58.

Winkler, J., and R. Moser. 2016. "Biases in Future-Oriented Delphi Studies: A Cognitive Perspective." *Technological Forecasting and Social Change* 105: 63–76. http://doi.org/10.1016/j.techfore.2016.01.021.

Zallio, M., and P. J. Clarkson. 2021a. "Inclusion, Diversity, Equity and Accessibility in the Built Environment: A Study of Architectural Design Practice." *Building and Environment* 206: 108352. https://doi.org/10.1016/j.buildenv.2021.108352.

Zallio, M., and P. J. Clarkson. 2021b. "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)*. Gothenburg, Sweden. https://doi.org/10.1017/pds.2021.491

Zallio, M., and P.J. Clarkson. 2022a. "The Inclusive Design Canvas. A Strategic Design Template for Architectural Design Professionals." In *Proceedings of the Design Society 2022*.

Zallio, M., and P. J. Clarkson. 2022b. "The Inclusion, Diversity, Equity and Accessibility Audit. A Post-Occupancy Evaluation Method to Help Design the Buildings of Tomorrow." *Building and Environment* 217: 109058.