The Inclusion, Diversity, Equity and Accessibility audit. A post-occupancy evaluation method to help design the buildings of tomorrow

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ABSTRACT

Notwithstanding the increased number of regulations there is a general lack of awareness about Inclusive Design among building industry professionals. This is partly due to the scarcity of available tools to evaluate occupancy feedback on inclusion, diversity, equity and accessibility.

How can we implement a tool to evaluate occupancy feedback on inclusion, diversity, equity and accessibility that works for the building industry?

This study aims to inform the development of a post-occupancy method to evaluate Inclusion, Diversity, Equity and Accessibility (IDEA) in the built environment.

This article reports the results of a multifaceted Delphi study which culminated with co-designing the IDEA audit, a post-occupancy evaluation method to collect data on people’s perceptions of inclusion, diversity, equity and accessibility.

With the IDEA audit, researchers, building owners, design teams, developers, facility managers, tenants, and organisation leaders can achieve a baseline of understanding of what people feel in regard to inclusion, diversity, equity and accessibility, clearly identify pockets of inconsistency and use data to decide how to address challenges and points of exclusion.

1. Introduction

Designing buildings and environments that accommodate the needs and desires of a wide variety of people according to Inclusive Design (ID) principles, has become an emergent priority [1]. The design urgency was initially focused on design for disability, borne out of the difficulties faced by disabled soldiers in the US Army returning from WWII [2,3].

The growing demand in the second half of the 20th century for the design of assistive products and barrier-free buildings for people with physical disabilities resulted in the development across the world of several standards and regulations [4].

Technical standards and building regulations evolved for the most part as a result of addressing the needs of people with physical and sensory disabilities, such as ANSI 117.1–1961, the first accessible design standard from the American National Standards Institute [5], and the Americans with Disabilities Act [6], which generated documentation that included a variety of new needs of building occupants.

Examples of recent guidelines and technical standards addressing these emergent priorities are the Building for Everyone, A Universal Design Approach [7], the BS 8300:2018, Design of an accessible and inclusive built environment [8], the EN 17210:2021, Accessibility and usability of the built environment [9] and the recent BSI PAS 6463, Design for the mind - neurodiversity and the built environment [10].

Notwithstanding the increased number of regulations and guidance available to support building industry professionals to design and deliver accessible and inclusive built environments, a large number of buildings still fail to provide a fulfilling inclusive experience for their occupants [11,12].

Previous research from the authors highlighted two major challenges that continually impact the design of inclusive buildings and how they are perceived by their occupants. Firstly, education and awareness in relation to ID is limited across the building industry and therefore the traditional design process tends to be less focused on the needs of users, their capabilities and journey, but more on sustainability, form, function and budget [13].

Secondly, there is a manifest lack of evidence-based tools, methods and processes to support building industry professionals in collecting and evaluating unbiased post-occupancy user feedback on ID with a

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focus on equity and diversity principles [14].

The apparent scarcity of tools to assist in collecting accurate data and evaluating the metrics regarding perceptions of ID in the built environment is strongly associated with a lack of awareness of how to design more inclusively [15].

When building industry professionals are not able to access and recognise the correct data, it is difficult to envision a strategy for the design or redesign of an inclusive building other than by ticking the boxes of the minimum requirements within currently available standards and regulations. In order to design or redesign an inclusive building and before any intervention can take place, it is essential to take into account a variety of metrics when evaluating the quality of inclusion, access to spaces, the comfort of occupants with a diverse range of human needs and motivations, and the equity of opportunities. When evaluating the impact of the various interventions it is necessary to correlate the data from the initial stage of life of a new building with data collected at different stages in its lifecycle.

This apparent need, in combination with the scarcity of tools, few metrics to assess ID in the built environment and the general lack of awareness within the building industry, raises a nascent question. How can we implement and deploy a tool to evaluate the perception of inclusion, diversity, equity and accessibility in the built environment across the building industry?

To answer this question, this study aims to inform the development of a post-occupancy method to evaluate inclusion, diversity, equity and accessibility in the built environment.

The objective of this research is to develop knowledge, create tools and methods to support building industry professionals, business leaders, facility managers to embed ID in their working practice.

This study, which embraces the relationships between environment and behaviour as critical aspects in improving human well-being, reports the results of a multifaceted Delphi study by describing the method and data collected with different co-design workshops used to create a solid foundation for the development of an evidence-based post-occupancy method to evaluate the perception of inclusion, diversity, equity and accessibility in the built environment.

2. Post-occupancy evaluation surveys: challenges and opportunities

Post-Occupancy Evaluation (POE) surveys have become widely adopted over the last two decades as procedures for collecting a variety of information from occupants of buildings [16].

Some of the main purposes of POE surveys are to measure the building’s performance [17], assess the perceptions of occupants of the building [18] and to provide insights for building industry professionals and facility managers as to how to improve the design and operations of the built environment [19].

Currently available POE surveys tend to focus on measuring the performance of a building and only very few surveys include a holistic assessment of ID in the built environment.

A previous study from the authors highlighted the existence of surveys that measure specific characteristics of the built environment by using descriptors of the performance, sustainability and objective comfort that a building offers to its occupants [14].

Amongst such surveys some of the most popular are the CBE Occupant Survey, the Occupant Indoor Environmental Quality (IEQ) Survey from the Center for the Built Environment at the University of California, Berkeley, the Building Occupant Survey System Australia (BOSSA), the BUS survey, the Post Occupancy Review of Building Engineering (PROBE), the Building Assessment Survey and Evaluation Study (USEPA), the Sustainable and Healthy Environments (SHE) Survey, the Space Performance Evaluation Questionnaire (SPEQ), the Occupant Comfort & Wellness Survey [20], the Design Quality Indicator for Health 2 (DQIH2), the Leesman Index, the Comfortmeter, the Healthy Building Index (HBI), the Occupant Wellness Survey by Well Living Lab China and the Universal Design-Based Framework to Assess Usability and Inclusion of Buildings.

The CBE Occupant Survey and the Occupant Indoor Environmental Quality (IEQ) Survey are web-based surveys comprising of 10 sections and are designed to assess the performance and success of the design of a space by allowing building occupants to self-report productivity and satisfaction [21,22].

The Building Occupant Survey System Australia (BOSSA) is a tool that contextualises survey results by systematically collecting information on the building and tenancy levels. It considers nine indoor environmental quality dimensions including spatial comfort, indoor air quality, personal control, noise distraction and privacy, connection to the outdoor environment, building image and maintenance, individual space, thermal comfort and visual comfort [23].

The BUS Survey contains up to 45 quantitative and qualitative questions on thermal comfort and ventilation, lighting and noise, personal control, space, design and perceived productivity and measures the occupant self-reported productivity and health for commercial buildings and the lifestyle and environmental issues for domestic buildings [24].

The Post Occupancy Review of Building Engineering (PROBE) is composed of a preliminary questionnaire for the building/facilities manager, the Building Use Studies Occupant Survey, latterly including the journey to work module, the CIBSE TM22 Energy assessment and a building envelope pressure test to CIBSE TM 23 by BRE or BSRIA [25].

The Building Assessment Survey and Evaluation Study (USEPA) was developed as an outcome of the Health Optimisation Protocol for Energy-efficient Buildings (HOPE) project and is an established walk-through survey focused on determining occupants’ satisfaction with regard to comfort (thermal, visual, acoustic and indoor air quality) and their health (Sick Building Syndrome and allergies). Building-averaged collected data are compared to identify correlations between building characteristics and perceived comfort and health [26].

The Sustainable and Healthy Environments (SHE) Survey was developed by the University of Melbourne as a questionnaire to collect data about socio-demographics, occupancy and working arrangements, transportation, indoor environmental quality, water, office layout, ergonomics and aesthetics, nutrition, workplace wellness and engagement, sleep, health and well-being, personality and overall evaluation [23,27].

The Space Performance Evaluation Questionnaire (SPEQ) was developed at the High Performance Environments Lab (HiPE) at the University of Oregon to benchmark buildings against comparative baselines and to evaluate 30 issues using 76 questions classified into seven main categories [28].

The Occupant Comfort & Wellness Survey from the Institute for the Built Environment [20] at Colorado State University focuses on understanding levels of occupant comfort, health, wellness and performance in office buildings. The survey collects information with respect to office layout, workspace adjustability, thermal comfort, air quality, lighting, acoustic quality, building cleanliness, well-being and health conditions.

The Design Quality Indicator for Health (DQIH) is a two-stage approach where ID should be embedded in all stages of the project to assess outcomes and successes in creating accessible and inclusive environments [29].

The Leesman Index is a measurement tool to assess how well workplaces are supporting employees by benchmarking against the index which consists of responses collected from other building occupants. The survey has four standardised sections including work activities, workplace impact, physical features and service features [30].

The Comfortmeter is an online survey to measure feedback from building occupants covering comfort-related topics through 55 questions related to room air temperature, air quality, noise, odour, etc. Two versions are available, one based on Indoor Environmental Quality (IEQ) and the other on WELL, the standard from the International WELL Building Institute [31].
The Healthy Building Index (HBI) was developed by BBA Indoor Environment and DGMR Software to measure the satisfaction of building users by considering thermal comfort, indoor air quality, light, acoustics, personal control, building-related health, self-assessed productivity, ergonomics, layout, cleanliness, nourishment, water, movement and wellness policies [32].

The Occupant Wellness Survey by Well Living Lab China measures the impact of healthy designs on the perceptions of occupants with regard to environmental conditions and is based on feedback on air and water quality, lighting, thermal comfort, acoustics, ergonomics, space layout and furnishings, maintenance and cleanliness, access to nature, nourishment, well policies, physical activity and stress recovery, productivity and engagement and health status [33].

The Universal Design-Based Framework to Assess Usability and Inclusion of Buildings consists of three main categories of Universal Design (i.e., physical-spatial quality, sensorial-cognitive quality and social quality), eight criteria (i.e., usability, functionality, safety/security, wayfinding, understanding, environmental factors, well-being and social inclusion) and 21 indicators to explore the relationship between human performance and social factors [34].

Notwithstanding the number of POE surveys and the variety of aspects they claim to measure, it appears that data collection methods and key themes of these surveys are not fully addressing the understanding of the complex dimension of inclusion, diversity, equity and accessibility. Some of the overarching issues are related to the lack of emphasis on themes such as the perception of accessibility and inclusion, the ability for the environment to guarantee equity of opportunities and respect for the diversity of human needs and culture. These are some of the aspects that an innovative POE survey could address by providing enough information on accessibility and inclusion. Alongside the POE surveys developed to measure several characteristics of the built environment (which do not include some of the ID criteria), other tools were recently developed to gauge some of these criteria from an organisational point of view.

Amongst different diversity and inclusion questionnaires such as the Global Diversity & Inclusion Survey from PWC (https://www.pwc.com/gx/en/services/people-organisation/global-diversity-and-inclusion-survey.html) and the Diversity & Inclusion Survey from People Insight (https://peopleinsight.co.uk/employee-surveys/diversity-and-inclusion), some have greater significance than others.

The PeopleLOOK Survey is a web-based satisfaction survey designed to assess the perceived satisfaction, activities in various locations and work style preferences of employees [35].

The Organisational Human Factor Benchmark (OHFBB) Workplace Analytics System is a norm-based business risk management instrument that evaluates human capital and workplace risks by asking a series of questions to executives and business risk managers on the topics of performance, efficiency, risks, costs and well-being [36].

The Thrive XM Index is a framework that considers the full range of human experience, in which work is a key element and focuses on examining the root cause of issues by providing insights into the upstream factors that determine employee well-being, performance and productivity [37].

The Kind Quiz and Net Culture Score are tools to measure the values of empathy, integrity, innovation, disruption and agility. The Net Culture Score measures the alignment between an organisation’s stated culture and the organisational values as expressed by stakeholders [38].

A meta-analysis of studies revealed that job satisfaction, well-being, health and productivity are affected not only by other people and their behaviour, but also by the built environment [39–41]. Hence, Post-Occupancy Evaluation (POE) is of key importance for organisations when assessing employee satisfaction and perhaps more crucially in developing action plans to change workplaces for the better.

As highlighted above, there are several POE surveys from the building industry which assess performance, sustainability and comfort, as well as others from the fields of business and management which collect data on team dynamics, productivity and perception of the office culture [42,43].

These two groups of surveys are not mutually exclusive as they both provide insightful information on building performance and people’s perception of satisfaction, however there are several gaps which they do not currently address and a lack of awareness from professionals as to which tool might best serve a specific purpose. As became apparent in earlier research [13], understanding the perception of inclusion, diversity, equity and accessibility in the built environment is becoming an emergent priority for building industry professionals to assist in designing better buildings according to ID principles which satisfy a variety of human needs and enable people to achieve their goals.

With this research we seek to understand what kind of new POE survey could provide an improved picture on the value of inclusion, diversity, equity and accessibility.

3. Rationale, materials and methods

According to Maslow’s theory of human motivation, the needs of human beings form part of each individual’s behavioural motivation [44]. Maslow developed a theory with a hierarchy of five categories of needs which is often presented as a pyramid where basic physiological needs, such as breathing, water, food, sleep, shelter and reproduction form the base of the pyramid because fulfilling these needs is essential for human survival. The second category is the need for safety and security and includes health, employment, resources and property and is followed by the third category of the need for love and belonging which includes friendship, family, intimacy and a sense of connection. The fourth category is the need for self-esteem which includes confidence, a sense of achievement, respect for others and respect by others. The fifth and final category at the top of the pyramid is self-actualisation which includes creativity, spontaneity, lack of prejudice, morality and problem solving. The hierarchy describes how people develop motivations and behaviours in order to grow and thrive as human beings [44]. Maslow argues that humans are motivated by the aspiration to accomplish and preserve the conditions that allow them to satisfy their basic needs which then enables them to develop higher intellectual or psychological needs.

Notwithstanding Maslow’s thorough description of the hierarchy of needs, limitations emerge when this theory is contextualised within contemporary society. Self-actualisation can be perceived differently by individualistic or collectivist societies [45]. The needs of people from individualistic societies tend to be more self-centred and focus on an individual’s growth, whereas in collectivist societies the need for a sense of belonging, inclusion and acceptance of diversities may take precedence over individual and self-centred needs.

The German word ‘Selbstverwirklichung’ which translates as ‘self-realisation’ may reveal a further dimension to self-actualisation [46] and in this regard full self-realisation for a human could occur by giving “oneself to something beyond oneself” [47], here Maslow was referring to transcendent needs as being the very highest and most inclusive or holistic level of human consciousness, rising or transcending above self and relating to other human beings, species and entities in nature as part of a wider whole [48,49].

This theory becomes significant when describing the relationships between motivations, behaviour, human needs and actions. Motivation is not a synonym for behaviour, but it can influence a change in people’s behaviour, in confluence with the biology of humans, their culture, context, situations and interactions with other humans (self-actualisation), thereby generating different human needs and plans of action to address them.

When designing or assessing a built environment, it is important to understand the variety of human needs, either physical, sensory or cognitive, however they are not sufficient to satisfy the higher needs of occupants. It is essential to go beyond the hierarchical scale of human needs.
needs and to target other transcendent needs of building occupants in order to increase motivation as an enabler for positive behaviour change.

Self-realisation, the highest need, seen as the necessity to go beyond self-actualisation and perceive a sense of belonging, heavily impacts the understanding of diversity and inclusion both at biological and sociological levels [50], and informs how people move about and through their socially stratified worlds [51].

Within this picture we can argue that the built environment strongly influences motivations and behaviours and accounts for the fulfilment of different levels of human needs (see Image 1).

Haynes emphasises that the behavioural environment is an integrated dimension of an office environment and it affects the behaviour of occupants and the social environments which are created and developed by office workers [52].

Workplace layout and perceived comfort are components of the physical environment, whilst interactions with others, concentration and distractions are part of the behavioural environment [52].

Both environments influence productivity, the sense of belonging and inclusion. In the past organisations have not paid enough attention to the impact that the built environment, either physical or virtual, has on motivations, behaviours and human needs [53].

Business leaders are now challenged to define what an accessible and inclusive workplace could look like, how the environment influences team dynamics, fosters equity and diversity and how the space can motivate a positive behaviour change among employees [54].

This research project identified this emerging priority through a multifaceted Delphi study composed of three research stages. A series of systematic interactions with a panel of experts was organised in the form of structured interviews, surveys and workshops.

Based on previous case study research [55,56] and literature review [4,14] a panel of experts across Europe and North America was created and individuals were selected and recruited for a qualitative study [13].

The findings from the study were shared amongst the pool of experts and a further quantitative study was deployed to achieve a more statistically significant dataset [15].

Based on the findings from the qualitative and quantitative studies a third research stage was implemented involving a brainstorming activity to co-design and evaluate practical solutions to solve the identified challenges in relation to the post-occupancy evaluation of built environments. The materials, methods and results of the third stage of the research project are reported in this article.

3.1. Method

This article reports the results of the final phase of a Delphi study where two co-design workshops, an activity that sparks critical understanding of data and new insights [57], were organised to co-create and test concepts with a user-centred approach.

A pool of expert stakeholders from the building and construction industry were invited to take part in the study according to the ethical protocols approved by the University of Cambridge.

Building industry professionals with expertise and interest in ID, Diversity, Equity and Inclusion (DEI) practices and a knowledge of accessibility and inclusion standards were contacted via email and selected through a snowball sampling approach. Ten prospective participants expressed their interest in taking part in the workshops.

Six female and four male participants, ranging between 40 and 75 years of age, from the United Kingdom and Europe, including access consultants, architects or design managers who have been active practitioners in the field of ID, joined the online workshops. The age range suggest that there may be differences in responses of the participants since they belong to different age groups.

After an initial 2-htwo-hours pilot test, the workshops were organised with two separate sessions where participants were divided into one group of four and another of six individuals of mixed gender and conducted via remote meeting platforms according to user preference (Zoom and Microsoft Teams).

The sessions lasted one and a half hours and began by introducing the team and the project, outlining the expectations of the study, followed by providing background information from previous research, setting up brainstorming sessions, recording data, revising data with stakeholders and closing the workshop as illustrated in the research and data protocol illustration (Image 2).

Feedback was collected via note-taking and journey mapping using online collaboration platforms (Miro and Google Docs). Questions about the challenges and opportunities when using a POE method for ID, the characteristics and themes of such a tool and its applications were asked by using HMW (How Might We) questions to spark creative thinking and discover new solutions [58].

Through an initial divergent process, followed by more convergent discussion, comments were elicited and successively consolidated into
clusters that allowed for a thematic analysis of data.

Following a double diamond approach, where researchers explored the issue more widely (divergent thinking) and then taking focused action (convergent thinking), the results of the Delphi study [14,15] were first discussed among the research team and then combined with the results from the co-design workshops to shape the POE method and quantify the relevance of thematic areas that constituted the structure of the method.

4. Results and findings

During the workshops participants were involved in brainstorming and journey mapping activities, structured by means of the ladderling technique which allowed for taking suggestions and investigating in greater depth the reasons behind them [59].

Table 1 summarises the results of the brainstorming activities from the workshops analysed through a thematic analysis which identified and helped to interpret the emergent themes. The analysis focused on information redundancy and was performed by considering the background of participants and their feedback by using the established six-step process of thematic analysis [60].

Inputs from participants were coded and clustered within three overarching themes according to their relevance, as highlighted by participants, and frequency, as noted during the conversations. Different feedbacks were reported within each theme to maintain the granularity of collected information and an additional column with a ‘take-home’ message was identified to highlight strengths and weaknesses of the solutions.

During the sessions participants brainstormed several areas of information regarding the applications, opportunities, relationships and purpose within current standards and themes to be considered when developing a POE method that evaluates inclusion, diversity, equity and accessibility in the built environment.

According to the feedback from participants a POE method should serve two main purposes:

1. The first to inform and educate with insights about the characteristics of the built environment, the occupants’ perception of the space and highlight points of exclusion experienced by users. The added value of the tool would be to offer a clear understanding of the mismatch between how the building is, the prediction of how the building should be and how the building will be.

2. The second to provide evidence to help professionals and facility managers prioritise actionable plans based on subjective insights with a timeline of actions to foster ID as a form of social sustainability.

The thematic areas this POE method should include range from some commonly acknowledged by the literature and practice, including sustainability, comfort and well-being, to more nuanced themes that characterise the perception of the built environment and people dynamics.

The feedback from the sessions highlighted possibilities to envision a POE method composed of different subjects regarding people-space perception (including thermal and air quality, visual, acoustic, olfactory and spatial comfort, spatial accessibility, maintenance, etc.) and people dynamics perception (including psychosocial, cultural, neurodivergent comfort, etc.).

The co-design workshops reinforced the findings from previous research and highlighted a further crucial challenge that current POE methods and surveys raise. As previously noted, people’s motivations can influence a behaviour change, which generates different human needs and plans of action to address those needs.

The POE method should not be deployed in a simplistic way within the framework of current standards but should go beyond numbers, collect the emotional responses of users and provide a subjective evaluation of the perception of the space and its attributes by reporting user feedback beyond those garnered from just a simple questionnaire.

Collecting feedback with surveys, polls and questionnaires through predefined variables is not sufficient to fully understand the impact the built environment has on the perception of inclusion, diversity, equity and accessibility. Surveys are a powerful tool to collect attitudinal data [61], however, they struggle to offer comprehensive real-world scenario insights on the behaviour of occupants, which inevitably generate diverse needs for each individual and a degree of bias is also present when submitting the survey to building occupants at different times during their occupancy.

Considering these inputs, this POE method should reduce bias and offer professionals a greater understanding of attitudinal and behavioural data regarding building occupants by embedding other procedures of data collection within the process. Examples are the integration of qualitative data collection procedures (observation, interviews, task analysis, etc.) with quantitative data collection procedures (surveys, self-reports, etc.) and the implementation of ambient intelligence sensors to monitor the use of space and people dynamics.

The integration of these three data collection procedures, and potentially others in the future, can reduce bias and offer more nuanced information according to different behavioural and attitudinal data.

For a POE method on ID in the built environment to be effective there is a need to make the voice of people heard [21] over time, with useful data for building industry professionals, facility managers or company leaders, that provide insightful plans of action to help people satisfy their basic, psychological, self-fulfilment and other transcendent needs.

5. The Inclusion, Diversity, Equity and Accessibility (IDEA) audit

Assessing the concept of Inclusion, Diversity, Equity and Accessibility (IDEA) in the built environment has strong potential for not only precisely understanding the perceptions of building occupants, but also for guiding future developments of DEI practices, the design of inclusive buildings and the development of standards and guidelines for buildings that accommodate everyone’s needs.

IDEA is an extended concept where the inclusion of people in a built environment is guaranteed by allowing everyone to feel accepted, respected, supported, appreciated and to partake in decision-making and development opportunities within an organisation.
<table>
<thead>
<tr>
<th>Overarching theme</th>
<th>Feedback</th>
<th>Take-home message</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose and applications</td>
<td>1. The method should support professional education to understand what the building offers and its limitations.</td>
<td>A method to offer insights of what a building offers, what people perceive a building really is and prioritise an action plan to shape the design process.</td>
</tr>
<tr>
<td></td>
<td>2. The method helps to shape the structure of the design process by providing professionals with the knowledge they require.</td>
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<td></td>
<td>3. The method should show the designer how to consider inclusive design: what are the challenges of every space and suggest how to define new design characteristics.</td>
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<td></td>
<td>4. A successful method does not only uncover issues but offers a plan to prioritise the findings and a timeline of action.</td>
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<td></td>
<td>5. The method should offer understanding of the mismatch between the prediction of how the building should be and how the building will be.</td>
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<tr>
<td></td>
<td>6. The method should link inclusive design with the value of social sustainability.</td>
<td></td>
</tr>
<tr>
<td>Opportunities and relationships with standards</td>
<td>1. Standards (e.g., BS8300) are somewhat dry, so the method should focus on the emotional responses of users by collecting subjective information in addition to what the standards offer.</td>
<td>The method should provide a subjective evaluation of the emotional responses of users about a building, by providing additional information to that which the standards currently offer.</td>
</tr>
<tr>
<td></td>
<td>2. The method should not just mimic the standards; it should present additional information to the standards and help professionals to understand more about the built environment.</td>
<td></td>
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<td></td>
<td>3. Designers are visual people; the method should provide visual analytics on the perceptions of users about building characteristics.</td>
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<td></td>
<td>4. The method should be related to significance levels, e.g., not valid to compare acoustic perceptions of users in a workplace with those of a school environment.</td>
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<tr>
<td></td>
<td>5. The method should go beyond numbers and provide subjective evaluation as it is fundamentally about people.</td>
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<td></td>
<td>6. The method should allow for reporting of user feedback beyond that gathered from a simple questionnaire, which may be limited.</td>
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</table>

To effectively track and evaluate IDEA it is essential to constantly understand people’s perceptions and motivations and ensure that professionals, managers and organisations can quickly receive actionable insights and implement them in a timely fashion.

To achieve this, it is important to clarify the subjects, topics and themes composing the IDEA audit, their weight and significance, the procedures employed for data collection and how data will be analysed to provide actionable insights. To do this, the results from the co-design workshops were reviewed and correlated with the results from an earlier study, where quantitative data from a survey run across building industry professionals was collected [15].

The IDEA audit is framed as a mixed methods building occupant feedback collection system composed of three major subjects including people-centred data, perceptions of people-space and people dynamics. Each of the three subjects includes different topics, themes and subsequent sub-themes that constitute the core of the IDEA audit.

The people-centred data is composed of informative demographic data and cultural questions (e.g., age, gender, marital status, geographical location, etc.) and this data is valuable in order to contextualise the survey results with respondents.

The people-space perception includes specific characteristics of the built environment divided into topics on physical accessibility, such as location and spatial comfort, others based on IEQ parameters and additional sensorial experiences including ergonomic configuration,
spatial aesthetics, and maintenance and management.

The people dynamics perception includes themes regarding the person-to-person engagement, including equity and inclusion, engagement with diversity, neurodiversity in space, mental and physical well-being, and behaviour and people’s empowerment.

To establish the level of significance between the topics, we revisited the literature review of standards [14] and most importantly the results from a previous study in which expert participants expressed their feedback on the relevance of the topics according to a five-point Likert scale questionnaire [15].

A summary of the results from the above-mentioned study is listed in Table 2.

To comprehend the significance of the topics, we considered the mean, which overall was high with values above 4 for all thematic areas, and the standard deviation which indicated how close the responses were to the mean. The mean values \( \bar{x} \) were divided by the standard deviation \( \sigma \) of each topic which then determined the percentage. The obtained value was divided by the sum of all the mean values divided by the standard deviation of each thematic area. The equation used is as follows:

\[
\left( \frac{\bar{x}}{\sigma} \right) \times \frac{100}{\sum_{i=1}^{n} \left( \frac{\bar{x}_i}{\sigma_i} \right)}
\]

Equation (1). Equation used to comprehend the significance of the topics.

According to the data calculation each topic should have a different impact in the IDEA audit. Table 2 shows that physical accessibility features would impact at around 17%, enhancing senses features at 15%, person-space engagement at 15%, person-to-person engagement at 14%, mental and physical well-being at 14%, maintenance and management at 13% and inspirational and motivational features at 12%.

The IDEA audit utilises a broad and multi-faceted definition of inclusion which goes beyond the performance, sustainability and perceived comfort of the building and considers mental and physical well-being, people dynamics and motivational descriptors as the foundations to evaluate the impact that the built environment has on people’s perception of inclusion, diversity, equity and accessibility.

To accurately represent the emotional responses and subjective perceptions of inclusion, diversity, equity and accessibility of building occupants, a mixed methods approach, composed of three different stages is envisioned for the IDEA audit.

The IDEA audit is developed with a scalable and flexible approach to allow for a widespread use in different settings [18] and is structured according to hierarchical levels [62] with 3 major subjects, 8 topics, 26 themes, 59 sub-themes and 106 statements (Image 3).

As an example, under people-space perception (subject 2), it is possible to discover the perception people have about physical accessibility (topic 2), and focusing on location and amenities (theme 8) and access to the building (sub-theme 4), the statement 14 “The building is easy to find, and accessible entrances for people of all abilities or with impairments” will provide a detailed feedback on accessible entrances [63].

To reduce respondent fatigue, increase the clarity of gained insights and render the tool more effective, the IDEA audit is deployed within three different stages as shown in image 4 and with a variable number of statements depending on the collected answers.

The first stage consists of a survey which collects people-centred, people-space perception and people dynamics perception information and takes the form of a pulse survey offering a brief number of statements that can be evaluated in a short time by building occupants to gain their perceptions over time.

To decrease bias that may occur with questions and binary answers, the statements are evaluated using a Likert scale level of agreement which gives a quantitative value to a subjective aspect. Once the data has been collected and analysed, an evaluation of the points of inclusion and inclusion is undertaken. This approach provides building occupants, facility managers or other professionals with clear insights as to whether the building offers a positive perception of inclusion, diversity, equity and accessibility or whether challenges exist.

After this initial stage, if the insights identify a high number of points of exclusion, an in-depth survey (between 15 and 20 minutes long) is shared among the sample of building occupants. This survey has a higher number of statements pertaining to each topic which allows for a better understanding of the challenges that people are experiencing. At this stage an additional reporting method is activated when a response is below average (dissatisfies the user). Once a response is recorded as negative, an opportunity to provide further feedback regarding a particular challenge is offered via a text box, voice recorded file or picture upload. The approach of using three different methods to collect qualitative feedback (text, audio or picture) is fundamental in overcoming the previously mentioned challenges that traditional POE methods exhibit when using questionnaire-based reporting approaches, but more importantly allows for people with diverse abilities and experiences to express their ideas.

Once data has been collected and analysed an in-depth report of points of exclusion is developed with insights about challenges, pain points and aspects of the building and the people perception of the environment that need to be improved. If the report highlights a high number of points of exclusion with an internal complexity, a third stage of evaluation is recommended.

The third phase suggests that an expert auditor or researcher evaluates the data from previous surveys and sets up a tailored strategy composed of mixed methods research, including observation, task analysis, interviews and access and inclusion audits, with the support of other data from environmental technologies, to provide the facility manager, a professional team or the company leadership with a bespoke action plan to bridge the inclusion, diversity, equity and accessibility gap. A further rationale behind the decision to utilise a mixed methods approach is to collect more detailed information regarding the challenges experienced, rather than just the overall attitudes to the building. This approach additionally helps to surmount the low answer rate from building occupants that other POE methods currently have [64].

These three stages are at the core of the success of the IDEA audit; however, we believe that the integration of ambient intelligence technologies will provide a more objective evaluation of space usage, usability, utility and people dynamics which can be correlated with current data from the IDEA audit.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Adjusted percentage of the significance of thematic areas.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topic</td>
<td>Participants’ response</td>
</tr>
<tr>
<td>Physical accessibility features</td>
<td>92.1%</td>
</tr>
<tr>
<td>Enhancing senses features</td>
<td>87.7%</td>
</tr>
<tr>
<td>Person-space engagement</td>
<td>84%</td>
</tr>
<tr>
<td>Person-to-person engagement</td>
<td>86%</td>
</tr>
<tr>
<td>Mental and physical well-being</td>
<td>86%</td>
</tr>
<tr>
<td>Maintenance and management</td>
<td>81.2%</td>
</tr>
<tr>
<td>Inspirational and motivational features</td>
<td>78.9%</td>
</tr>
</tbody>
</table>
The IDEA audit will be deployed as a standalone web-based system to offer an accessible and inclusive experience to all users with diverse abilities and plans to increase the number of features through third-party applications and services in cooperation with businesses.

The IDEA audit, over and above offering new insights about built environments and the perceptions of their occupants, tackles a challenging issue present amongst other POE surveys. Currently several of them compare data collected from a building against the average results of previous surveys related to many different buildings. These results are normally averaged, which seemingly means that the benchmarking will be potentially less biased, however, there is a methodological inadequacy in this process.

As each single building can be considered as a unique prototype, developed as a result of a bespoke process, it can impact the occupants and their behaviour in several ways. The geographical location, structure, distribution, layout, materials, colours, furniture and aesthetics of a building strongly influence the occupants who all have different needs, motivations and perceptions of the space.

Benchmarking the results of a POE survey which collects information from users about their attitudes (a personal view or thoughts, beliefs, feelings, perceptions), in a given context (e.g., a specific building in a certain geographical location), against a mass of attitudinal data from other building occupants with different geographies may present misleading information as to how a building performs and what people really think about it.

To overcome this challenge which may decrease the validity of a POE survey, the IDEA audit evaluates the perception of the same occupants about a selected building over time. Only by comparing the data from the occupants of a specific building, in the same context, is it possible to understand at a granular level the challenges people experience, reduce...
bias, margin for error and create a bespoke action plan to improve the well-being, comfort and perception of inclusion, diversity, equity and accessibility within a specific building.

The objective is to not just develop a rating or assessment system which may lead to data with only negative perceptions of a building, but to provide insight into how people really think and feel about a building via a series of statements focusing on how a building can enhance inclusion for all.

The IDEA audit aims to assist with taking a snapshot of the building, in its given context and with its occupants and provide a view of people’s perception with the ultimate goal being to help researchers, building owners, design teams and organisational leaders understand points of exclusion, challenges and pain points experienced by users and enable actions that will increase the quality of life for the building’s occupants.

6. Conclusions and future implications

Although there has been a strong focus from both academic and industry sectors on assessing the performance and sustainability of buildings in recent years, the way people access and use buildings along with their perceptions of them would seem to have been paid less attention.

The emergent need from companies and business leaders to understand more about how the workplace can offer a better and more inclusive experience to all employees, recently initiated various endeavours to establish new metrics for measuring DEI [65].

As companies, building regulators and the building industry are increasingly paying more attention to fulfilling both the basic and higher needs of building occupants, including comfort, safety, inclusion and personal satisfaction and the opportunity to offer new insights to those who have the responsibility for securing built environments suitable for all is now gaining greater traction.

This paper bridges the gaps identified by a large-scale study which reports the results of a Delphi study to frame the vision of an innovative post-occupancy evaluation method to evaluate the perception of inclusion, diversity, equity and accessibility in the built environment.

The IDEA (Inclusion, Diversity, Equity and Accessibility) audit aims to answer a simple question: how can we make improvements and what helps people to enjoy their time spent in an inclusive built environment?

The IDEA audit is a mixed methods feedback collection instrument for building occupant feedback which takes a snapshot of the building, in its given context and with its occupants, and offers insights about people’s perception of inclusion, diversity, equity and accessibility.

Its goal is to provide businesses and professionals with meaningful information so they can be used to improve the well-being, comfort, and perception people have within a building, not just by benchmarking feedback from building occupants, but by fully understanding the points of exclusion, challenges faced by users and the pain points.

With the IDEA audit researchers, building owners, design teams, developers, facility managers, tenants and organisational leaders can achieve a baseline of understanding of what people feel in regard to inclusion, diversity, equity and accessibility, clearly identify pockets of inconsistency and use data to decide how to address challenges with bespoke action plans to improve the built environment or develop HR policies that effect a positive behaviour change and promote a culture of well-being.

The IDEA audit seeks to listen to the voice of people and enable self-reflection in order to suggest meaningful actions that increase equity and diversity at a behavioural level, implement mechanisms (either physical or virtual) to improve inclusion and accessibility in the built environment and to ensure that processes, both at the building and human level, are inclusive and implemented in a timely manner.

Once the meaningful actions have been gathered by stakeholders it is essential to have the support of practical tools and methods in order to improve IDEA in both physical and virtual environments and some of these are listed in the Inclusive Design Canvas [66] and the Inclusive Design Toolkit [67] as a means of quickly raising the bar of inclusion.

Notwithstanding this research have gone through various stages involving hundreds of experts, it is subject to limitations. This research was carried out using both qualitative and quantitative research methods, however we urge to say that more research could be done to further improve the findings.

The IDEA audit has to be continuously tested and improved across different locations in the world and with the most varied group of people.

We are currently testing and evaluating the efficacy and accuracy of the IDEA audit with several businesses to further increase the adoption of stage 3 in the working practice and develop an IDEA index which will inform future releases and updates of the current version of the IDEA audit.

As a final comment, POE surveys are generally used to assess high-end brand-new buildings, with the associated costs this process entails and this has therefore not led to widespread adoption across communities. This challenge widens the equity gap by reducing the genuine opportunities to make a positive impact not only to high-end buildings in developed countries, but more importantly across underrepresented communities and developing areas worldwide.

The IDEA audit seeks to democratis the process of understanding the value of ID within all communities by increasing awareness and education about inclusion, diversity, equity and accessibility across all people and geographies.

To this end, the IDEA audit not only offers the opportunity to discover the possibilities of inclusion but has the potential to become a form of social sustainability for future generations.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Further reading