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RESEARCH ARTICLE

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Trends in sustainable architectural design in the United Kingdom: A Delphi study

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Abstract

Despite the prevalence of sustainable and green building in the United Kingdom, there is little agreement on what is required to achieve this status. This research seeks consensus among expert sustainable architects in the United Kingdom on the relative importance of a range of factors in facilitating a sustainable built environment. It identifies key differentiating factors to provide an original typology of sustainable practice. A Delphi technique was used to engage a variety of geographically separated participant in a managed dialogue to achieve consensus. The technique used novel survey techniques and statistical analysis to create a series of parallel sample groups. Thirty practices took part in the study, forming three distinct groups differentiated by contrasting viewpoints. Individual groups were characterised by varying attitudes towards measurability, nature, user focus, and local issues. However, the research found that carbon reduction through fabric first approaches were universally prioritised by all groups to achieve sustainable design. This highlights the limited scope of sustainable design in the United Kingdom, and a tendency to favour global sustainability concerns over more local and regional challenges. This research has significance for professional organisations and policymakers who can shape practice, both in the United Kingdom and internationally. It also has consequences for architectural education as it emphasises the perceived relative importance of these factors in the creation of the built environment.

KEYWORDS
Delphi technique, design practice, green architecture, sustainable development, sustainable practitioners

1 | INTRODUCTION

Sustainability is a key theme in contemporary architectural design. Despite its almost ubiquitous acceptance among professionals, sustainable design encompasses a huge diversity of ideas and attitudes (Guy & Moore, 2007). National policy has focussed on technological solutions to achieve low operational energy demands (Gibbs & O'Neill, 2015); however, the means of implementation and the weighting of associated concerns varies between practices of different sizes, outlooks, and project types (Grover, Emmitt & Copping, 2019).

This research seeks to determine consensus among experts in sustainable architectural design in the United Kingdom using a Delphi study. It looks for a consistent understanding of the factors that facilitate the design of a sustainable built environment. It also explores the range of practice outlooks providing a typology of architectural practice.

2 | BACKGROUND

Since the publication of *Our Common Future* (Brundtland et al., 1987), competing interpretations of sustainable development have been insinuated from its definition. These have produced a broad political discourse (M. Hajer, 1996) across different domains of knowledge (Basiago, 1995). The influential framework proposed by O'Riordan (1989) identified contrasting views on the relationship of humans to nature leading to competing approaches to sustainable development. O'Riordan suggests a linear spectrum of attitudes ranging from the ecocentric to the technocentric. Ecocentrism represents a belief in the primacy of natural order, decentralisation of power, and participatory justice. At its extreme, Gainism is a faith in the primacy of nature and natural ethics (Lovelock, 2000). A more human-centred ecocentrism is described as communalism, which places faith in the self-reliance of communities through "renewable resource use and appropriate technologies" (O'Riordan, 1989). The technocentrist perspective, however, argues for the application of science and free-market economies, retaining the status quo and arguing for greater institutional adaptability. Within technocentrism, accommodation presents a view that institutions will adapt to environmental demands. Interventionism represents extreme technocentrism, which places faith in competition and innovation.

Gough, Scott, and Stables (2000) provide a critique of O'Riordan suggesting that his scalar interpretation of sustainable development requires a simplistic acceptance of competing dominant cultural values. Developing work by Schwarz and Thompson (1990), they argue that the tension between archetypal philosophical outlooks is necessary for each to make sense. Disagreement, therefore, is an essential characteristic of our relationship to the environment, which can be mediated by "clumsy" institutions revealing commonalities (Thompson, 1990). The categorisation of the ecocentric and the technocentric by O'Riordan's initial framework, and later developed into the earth centred and human centred (O'Riordan, 1990), is also brought into question. Gough et al. (2000) point out that all human world views are in some sense anthropocentric. They conclude only a complete trust of "Gaia" can be considered truly ecocentric.

Blowers (1997) frames the argument through the contrasting the visions of ecological modernism and rejections of continued modernisation such as eco-socialism and neo-Marxism. Ecological modernism reflects the accommodation of O'Riordan in which the institutions of development will adapt to meet changing environmental constraints. By contrast, eco-socialism rejects the capitalist status quo and advocates a collective relationship with nature through common ownership of the means of production (Pepper, 1993). It is distinctly anthropocentric, rejecting mystical relationships with Gaia, understanding that nature should be "planned and controlled" (p. 233) for the collective good.

Hopwood, Mellor, and O'Brien (2005) see social and environmental concerns as complementary aspects of the sustainable development debate. By placing these concerns on perpendicular axes, they map the expansion of the field of sustainable development. Over 20 approaches are "mapped" in this manner, categorised through transformational capacity of each.

In the field of architecture, the plural nature of architectural practice is represented by contrasting sustainable building design. Guy and Farmer (2001) identify six "eco-logics" based on an analysis of completed "green" buildings, describing the relationship between "diverse technical design strategies and competing conceptions of ecological place making" (p. 140). A series of "emblematic issues" (Guy & Farmer, 2000) give rise to discourses, collections of "ideas, concepts, and categorisations that are produced, reproduced, and transformed in a particular set of practices" (Hajer, 1995, p. 44). It is through critical dialogue that a wide range of contextual responses to sustainable design may be generated (Guy, 2010). This typology suggests that within the architectural domain, sustainable design is multidirectional. Innovative, performance-driven technologies contrast with low impact vernacular solutions. This pluralism implies simultaneous paradigms that are conflicting and contestable.

Williamson (2003) suggests that a building might adopt one or several of these overarching logics. Williamson presents three "caricatured images" of sustainable building, placing emphasis on the horizon of the architect (the scale of concern): the natural embraces local ecological systems and sensitivity to place; the cultural focuses on local building and expertise; and the technical adopts a global approach emphasising the role of science and technology.

In the United Kingdom, a range of factors has influenced the integration of sustainability into building design. Green building standards have played a key role in determining the focus and interpretation of sustainable design. The discourse set out by national policy has typically framed sustainability as centring around low-carbon design (Gibbs & O'Neill, 2015). This has led to a focus on energy reduction through modification of existing processes, as opposed to holistic change (Boschmann & Gabriel, 2013). Similarly, the emphasis of voluntary standards on low-energy design, such as BREEAM (BRE, 2018) and the Passivhaus standard (Passive House Institute, 2017), has shaped the wider sustainable discourse (Murtagh, Roberts, & Hind, 2016). This is corroborated in the work of Grierson and Moultrie (2011) who used interviews and case studies of Scottish architects to identify common principles and processes in their design work. The findings suggest passive design, energy reduction, and integrated approaches are shared by all practitioners.

Contextual factors including practice size and type have also influenced the value assigned to sustainability. Higham and Thomson (2015) examined the sustainable literacy of construction professionals. They conclude, there is a lack of literacy in the industry that is governed by a "business-as-usual" attitude. A negative view of sustainability is compounded by "profit-led decision making," the risk of instigating change and inadequate regulatory responses. Hay, Samuel, Watson, and Bradbury (2018) interviewed 10 practices, operating in the United Kingdom and overseas, to ascertain their engagement with post-occupancy evaluations. Their findings revealed confusion over the requirements for post-occupancy evaluations as well as a desire by the professions for a more holistic assessment methodology beyond the emphasis on carbon reduction and occupational comfort. Their study shows a range of interpretations of what constitutes sustainable practice, as well as varying implementations dependent on practice type and size. Baba, Mahdjoubi, Olomolaiye, and Booth (2012) examined architects' knowledge of Code for Sustainable Homes using a mixed methods approach involving interviews and questionnaires. They found that most architects had only limited knowledge of Code for Sustainable Homes exposing limitations in information transfer from professional bodies to architects.

External factors from the wider industry have also been observed to influence engagement. Akotia and Opoku (2017) interviewed 21 key practitioners regarding their engagement in sustainable regeneration. They found that there was significant variation in the design stages at which practices became involved in sustainable regeneration due to project type and its requirements. Practitioners who had sustainability assigned to their role were typically the least engaged, seemingly due to the fact that stakeholders and clients of the projects in which they were involved placed little value on sustainable regeneration.

Owen and Lorrimar-Shanks (2015) provide an insight into the "field" of sustainable design in Australia through interviews with 42 architects. Using a sociological model, they uncover the paradoxical nature of sustainable design, which attempts to satisfy requirements in the domains of both arts and sciences. This causes a tension between integration (with the profession) and separation (the realm of green architecture) that, for the authors, is best satisfied by a social approach to sustainable practice.

This research builds on work previously undertaken by (Grover, Emmitt & Copping, 2019), involving interviews with sustainable practices in the United Kingdom. In this research, six competing visions of sustainable design were identified, characterised by opposing attitudes towards technology and participation. The research found that a number of medium sized practices sought to balance the need to create high-performance building fabric with a desire to engage stakeholders in the process of design and operation. Smaller practices tended to take a more low-tech approach relying on natural and local materials, craftsmanship, and passive environmental systems.

3 | AIM OF THE RESEARCH

This research seeks to generate consensus among expert sustainable architects in the United Kingdom on the primary factors for facilitating a sustainable built environment. Not only is a general consensus sought but also an identification of the key differentiating factors between practices. It aims to provide a typology of practice in the United Kingdom identifying the key factors, which characterise different approaches to sustainable building design. Using a Delphi technique, a managed consensus between practices can be reached.

4 | METHODOLOGY

4.1 | The Delphi technique

The Delphi technique was originally developed in the 1950s (Dalkey & Helmer, 1963) as a means of obtaining and distilling knowledge from a group of experts (Ziglio, 1996). It involves controlled feedback mechanisms, which allow experts to reconsider their viewpoints until a general group consensus is approached or sufficient information exchanged (Delbecq, Van de Ven, & Gustafson, 1975). The process involves administering a series of remote questionnaires in which participants are often required to identify problems, outline objectives, provide solutions, or offer predictions (Landeta, 2006). The advantage of a Delphi over other questionnaire techniques is that each subsequent questionnaire assimilates the results of the previous one, offering experts the chance to "refine" their views as the group progress the overall task (Ziglio, 1996).

A Delphi is typically divided into two parts, an exploratory phase and an evaluation phase (Ziglio, 1996). In the exploratory phase, the aim is to examine the discussion around the subject and to provide additional information if required. In this case, the exploratory phase was undertaken a series of interviews with practitioners presented by the authors (Grover, Emmitt & Copping, 2019). The evaluation phase brings together these views and identifies areas of consensus or disagreement. Analysis is via a group statistical response: All opinions reflect the final response and typically they are measured quantitatively and statistically (Landeta, 2006). Analysis of comments may reveal reasons for disagreements (Ziglio, 1996).

4.2 | Sampling

The sampling for a Delphi study requires the commitment of expert participants over a number of consecutive rounds (Ziglio, 1996). All participants were drawn from the United Kingdom. Recruitment of experts was based on several criteria. First, architectural practices who had been awarded at a regional or national level for sustainable building were approached. This constituted seven of the participating practices. Second, architects on the Green Register of Architects (an organisation who certify practices who have undergone training in sustainable design) were contacted constituting 21 participants in the first round of the Delphi. Finally, a snowball method identified two further practices who "self-identified" as sustainable designers. In total, 30 participants took part in the first round and 21 in the second round (Table 1).

4.3 | Delphi protocol

A ranking type Delphi was used as it allows key issues to be identified and assessed in terms of their relative importance (Pare, Cameron, Poba-Nzaou, & Templier, 2013). Best/worst scaling (BWS) was chosen as a Delphi method as it eliminates many of the biases involved in traditional ranking or value-based techniques (Strasser, 2019). It produces statistically significant results, is more efficient than paired comparison methods, and has been shown to be particularly superior to rating scales for cross-cultural analysis (Cohen & Orme, 2004; Kobus & Westner, 2016). BWS asks participants to evaluate a set of statements and identify the best and worst options. Statements are presented in blocks (typically containing between four and seven

TABLE 1 Participants in the Delphi study

Practice	Size	Position in practice	Nature of projects	Link to sustainability	Round 1	Round 2
F	14	Senior partner	Medium scale Education, arts, and culture	Award winning/green branding	Yes	No
G	180–200	Project architect	Medium–large scale Mixed	Award winning	Yes	No
I	10	Architect	Small scale Residential, commercial, and community	Self-identifying	Yes	Yes
M	13	Partner	Medium scale Scientific and cultural	Award winning	Yes	Yes
N	65–70	Architect	Medium–large scale Residential, education, and healthcare	Award winning	Yes	Yes
O	40	Partners	Medium scale Mixed use	Award winning	Yes	Yes
F	14	Senior partner	Medium scale Education, arts, and culture	Award winning/green branding	Yes	No
G	180–200	Project architect	Medium–large scale Mixed	Award winning	Yes	No
I	10	Architect	Small scale Residential, commercial, and community	Self-identifying	Yes	Yes
AA	1.5	Director	Small-scale residential; community	Green Register	Yes	Yes
AB	1	Principal	Small-scale residential; consultancy	Green Register	Yes	Yes
AC	16	Partner and architect	Small–medium scale, mixed	Green Register	Yes	Yes
AD	12	Partner	Medium scale, community, and education	Green Register	Yes	Yes
AE		Architect + associate	Small to medium scale, residential, and education	Green Register	Yes	Yes
AF	3	Project architect	Small-scale, residential, and community	Green Register	Yes	Yes
AG	45	Director	Large-scale residential, commercial, education, and community	Green Register	Yes	Yes
AH	1	Director	Small-scale residential, commercial, education, and community	Green Register	Yes	Yes
AI	18	Director	Small-scale residential, education cultural, community, and leisure	Green Register	Yes	Yes
AJ	12	Office manager	Small-scale residential	Green Register	Yes	Yes
AK	1	Principal	Small-scale residential	Green Register	Yes	Yes
AL	1	Principal	Small-scale and large-scale residential; commercial, community, and leisure	Green Register	Yes	No
AM	3.5	Director	Small-scale residential, commercial, community, and leisure	Green Register	Yes	Yes
AN	45	Architect	Small-scale and large-scale residential; commercial; education culture, community, leisure, and health	Green Register	Yes	Yes
AO	13	Director	Small-scale and large-scale residential; commercial and leisure	Green Register	Yes	Yes
AP	160	Head of sustainability	Small-scale and large-scale residential, education, urban design, and community	Green Register	Yes	Yes
AQ	4	Director	Small-scale residential; commercial, community, and leisure	Green Register	Yes	No
AR	50	Architect	Small-scale and large-scale residential; commercial, education, urban design, community, and leisure	Green Register	Yes	Yes
AS		Director	Small-scale and large-scale residential; commercial, cultural, urban design, and community	Green Register	Yes	No
AT	28	Associate	Small-scale residential and residential; commercial, education, urban design, public and community, and leisure	Green Register	Yes	Yes
AU	350	Associate and head of sustainability	Large-scale residential, commercial, education, cultural, and urban design	Green Register	Yes	No

statements), and the respondent is asked to select the best and the worst options form the block.

BWS relies on the creation of a balanced incomplete block design (BIBD), which allows each statement to repeat and to occur with each other statement an equal number of times (Strasser, 2019). For any number of statements, only a limited number of BIBDs exist, a table of possibilities is provided by Strasser (2019). Table 2 shows the calculated BIBD in *R*, for 13 statements, in

TABLE 2 Statement block design for first round of the Delphi

Block	Position 1	Position 2	Position 3	Position 4
1	Statement 2	Statement 4	Statement 6	Statement 8
2	Statement 1	Statement 8	Statement 10	Statement 11
3	Statement 3	Statement 8	Statement 12	Statement 13
4	Statement 2	Statement 9	Statement 10	Statement 13
5	Statement 5	Statement 7	Statement 8	Statement 9
6	Statement 4	Statement 5	Statement 10	Statement 12
7	Statement 3	Statement 4	Statement 9	Statement 11
8	Statement 1	Statement 4	Statement 7	Statement 13
9	Statement 1	Statement 2	Statement 3	Statement 5
10	Statement 3	Statement 6	Statement 7	Statement 10
11	Statement 1	Statement 6	Statement 9	Statement 12
12	Statement 5	Statement 6	Statement 11	Statement 13
13	Statement 2	Statement 7	Statement 11	Statement 12

13 blocks of four statements. Each statement repeats four times in this design.

In the initial questionnaire, a range of responses was expected based on the previous research of the authors (THE AUTHORS). This indicated a range of approaches, and this was anticipated in the Delphi. After the first round, panellists were divided into a series of subpanels, based on levels of agreement between statements. Subsequent questionnaires then searched for consensus between subpanels, which represented different areas of the sustainable design model proposed.

4.4 | Bias

BWS forces respondents to make decisions between possible options helping overcome limitations of traditional ranking or value-based techniques such as particularly high numbers of tied answers (Strasser, 2019). BWS also reduces response style biases including social desirability bias (tendency to fake responses), acquiescence bias (desire to agree), and extreme response bias (Paulhus, 1991) by preventing “yea-saying” by forcing trade-offs. Scalar equivalence (the ability to accurately compare the scores given by different respondents) is therefore increased in ranking style approaches (Cohen & Neira, 2003). In normal ranking approaches, participants are only able to rank between three and five statements effectively (Cohen & Neira, 2003), and the approach is not immune to response style biases. These can be largely overcome by using BWS (Kobus & Westner, 2016).

To eliminate bias further, questions were presented in a random order, and statements within each question were also randomised across participants (Lee, Soutar, & Louviere, 2008). BWS does not eliminate the possibility of human response error; however, the repeated nature of the BWS technique accounts for much of this error and has been shown to be more accurate than other techniques (Orme, 2018).

4.5 | Analysis of the data

Analysis was undertaken to determine the level of consensus on statements and the level of stability (between rounds). Initially, a “best minus worst” approach is used to convert the BWS to a ranking. The number of times a statement is chosen as a worst choice is subtracted from the number of times it is a considered a best choice (Kobus & Westner, 2016). The multiple rounds of the Delphi allow a tentative ranking to be formed in the early phases and then be validated by groups of practitioners.

The number of occurrences of each statement (r) was four times in the chosen BIBD; therefore, the maximum and minimum scores a statement can achieve were 4 and −4, respectively. The mean scores of each statement were then calculated. A linear transformation was applied to each mean to give positive values, which are “more familiar” to rating scales (Strasser, 2019). This gave a range of mean scores for each statement between 1 and 9.

To evaluate consensus, the standard deviation and coefficient of consensus were calculated for each statement, consensus value (CV) = (SD/M). In this case, the mean of the population was used, rather than the sample mean. This normalises the coefficient of variation relative to the entire population rather than the scores exhibited by each sample. A CV of less than 0.5 is good consensus. (Strasser, 2019). A CV difference between rounds can also be calculated, and a CV difference of less than 0.1 is considered stable (Dajani, Sincoff, & Talley, 1979).

4.6 | Clustering

Based on the findings of (THE AUTHORS; from which initial statements were drawn), it was anticipated that there would be a degree of convergence on some issues and divergence on others. The categories identified in the interview phase suggested that distinct groups would be formed. After the first round, the data were clustered into three groups, each of which formed a distinct Delphi panel. Principles of Delphi suggest a minimum of five experts per group (Rowe & Wright, 2001). Forming three clusters allowed for a minimum of five participants including possible drop-off in later rounds.

To cluster this multidimensional data, a *K*-means analysis was performed in *R* (MacQueen, 1967). *K*-means uses an iterative algorithm to divide the data into *K* clusters. This method was chosen as it requires a predefined number of clusters, which was decided in this case based on the minimum number of participants to enable each subpanel of Delphi participants ($K = 3$). From this process, three distinct groups could be formed at the end of the first stage of the Delphi to allow the creation of subpanels.

4.7 | Comparing groups and identifying differentiating statements

To identify key statements differentiating groups, a Kruskal–Wallis (*H*) test was conducted. This was used to determine statistically significant differences between independent groups of data. This method is non-parametric so does not require the data to be normalised and can be used with ordinal data (Kruskal & Wallis, 1952). The method is based on ranking and makes only general assumption about the distribution of data (Kruskal & Wallis, 1952). The test was administered by the RealStats Excel plugin (Zaiontz, 2019) and being checked manually. A 0.05 level of certainty (alpha value) was selected, which is standard across social science research.

A further level of analysis was undertaken to identify similarities between statements. This allowed identification of correlations between statements to identify overarching themes with similar response profiles by participant. Hierarchical cluster dendrograms were plotted in *R* using average linkages. In contrast to the *K*-means analysis, this allowed multiple levels of clustering to identify themes and subthemes.

4.8 | Research structure

Each of the two stages of the Delphi involved a questionnaire administered online called first questionnaire (Q1) and second questionnaire (Q2), respectively. The stages are described in Figure 1.

5 | Q1 DESIGN, RESULTS, AND ANALYSIS

The data from a previous study by the authors (THE AUTHORS) were reduced to 13 key statements, which captured the commonest themes.

1. Employing simple and/or vernacular technologies in building design.
2. Integrating innovative technologies and materials in building design.
3. Collaborating with like-minded and motivated clients and stakeholders.
4. Educating clients and stakeholders in sustainable design and operation.
5. Specifying natural building materials.
6. Minimising building waste.
7. Designing with respect for the natural environment.
8. Designing buildings to enable sustainable lifestyles.
9. Reducing embodied and operational energy through passive design and high-performance envelopes.
10. Designing for occupant health and well-being.
11. Measurement and analysis of building performance.
12. Adopting national and international standards and codes (e.g., Passivhaus and BREEAM).
13. Utilising local skills and materials in the building process.

Respondents were asked to indicate what is most important and least important to their architectural practice to enable sustainability for each block of four statements. A box for additional statement or strategies not described in the main questionnaire was also provided.

A pilot study was conducted with three participants to test the Q1 (Hasson, Keeney, & McKenna, 2000) who did not qualify (and were therefore excluded) from the study. Responses highlighted the need to explain the repetition of questions throughout as well as introducing the participants thoroughly to the concept and approach of a Delphi study.

5.1 | Q1 results

An aggregate score for each statement by participant was created (Table 3). CV was calculated using a population transformed mean (5.00) as this reflected the nature of the rating.

Although the CV values all fall below 0.5 representing a good level of consensus (Strasser, 2019), having only one round completed, the stability of statements could not be assessed. The ranked lists of statements for the whole sample is shown in Table 4.

A K-means cluster analysis was undertaken, as described in the methodology using the predefined $K = 3$, the algorithm generated three clusters of 8, 12, and 7 members. The clusters then formed three individual groups that constituted the second round (Q2) of the Delphi (Table 5).

6 | Q2 DESIGN, RESULTS AND ANALYSIS

6.1 | Q2 design

The Q2 assumed the same format as Q1. The purpose of the second round of the Delphi was explained to participants, and they were told they could change their mind on their answers to respond to the results of others. Within each block, statements were ranked in order from the most important to the least important according to the overall mean scores of their respective cluster. At the start of the questionnaire, respondents were also exposed to the overall list of statements ranked in order of most to least important by their cluster. Each question was prefilled with each respondent's previous response

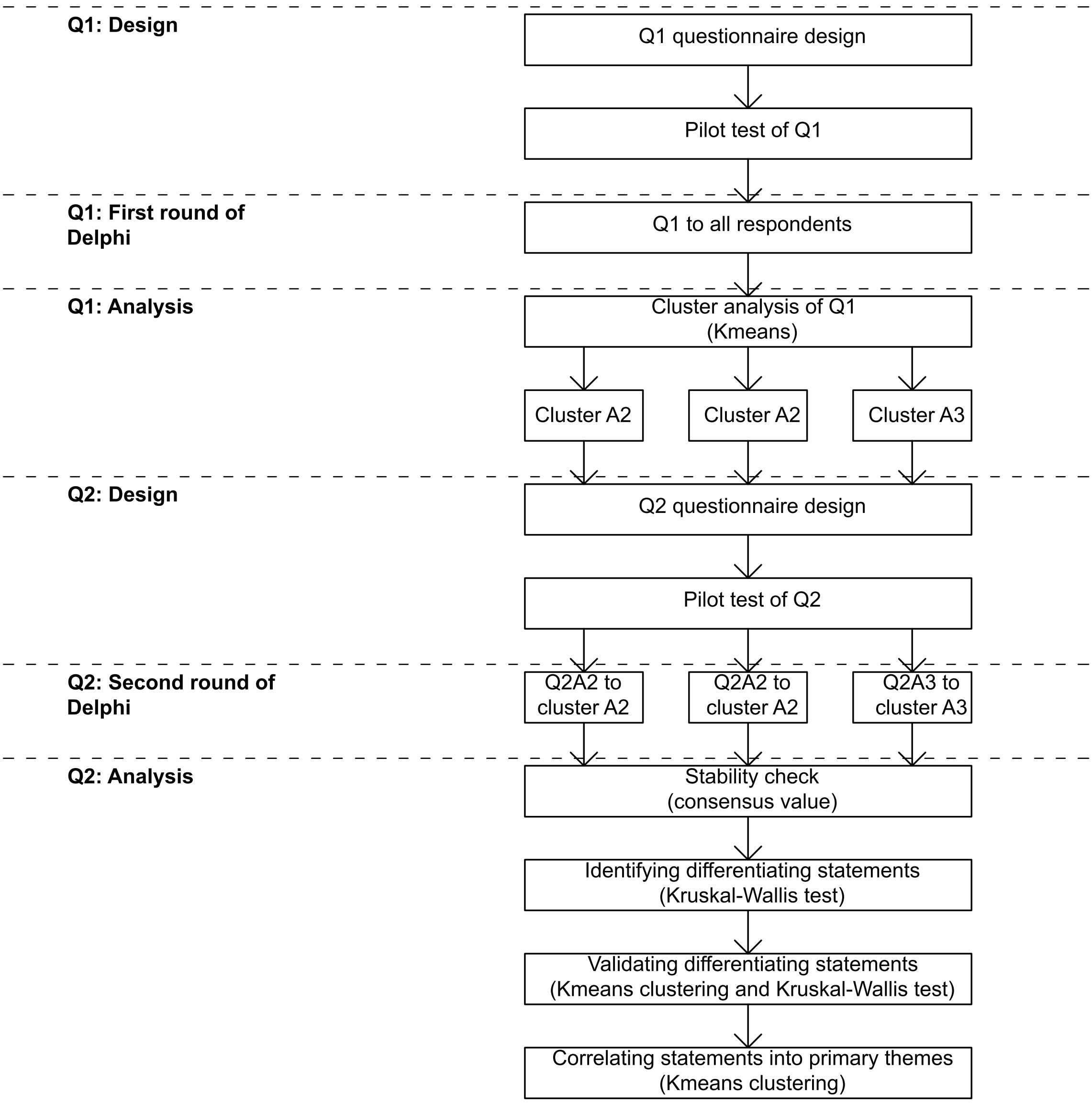

FIGURE 1 Stages of the Delphi technique

and gave them the opportunity to change this response. In response to comments made after the Q1, several statements were altered in their wording (Table 6).

Four new statements were also introduced in a second part to the questionnaire, based on the feedback from Q1. As these were completely new, they could not be included in the block design format but instead existed as standalone Likert-style questions. Respondents were asked to score the following statements on their level of importance.

- Designing holistically
- Using rigorous internal procedures to ensure sustainable design quality
- Integrating renewable technologies
- Designing for future needs and longevity

Q2 was tested before deployment with the same three architects that tested Q1. Being familiar with the question formats, this replicated the process for Q2. In the second round, six practitioners (22%) did not complete the study. Their data were removed from the analysis.

6.2 | Q2 results

Table 7 shows the full results with the final CV. To confirm this stability, the individual CVs for each independent cluster were also examined. Across all statements and clusters, CVs were below the 0.2 threshold. The Kruskal–Wallis test was undertaken across all three groups and in pairwise analyses between groups (Table 8).

The Kruskal–Wallis analysis reveals the statements, which fall outside the probabilistic value of 5% and exhibit the greatest variance. Across all groups, Statements 1, 5, 6, 7, 11, 12, and 13 showed significant disagreement. Pairwise analysis reveals how each cluster differed in response to each statement. This revealed the following:

TABLE 3 Practice scores for each statement from Q1

Practice	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
AA	-3	−1	−1	0	−3	−1	2	3	3	3	1	0	−3
AB	2	−1	−1	3	−1	−1	−2	2	0	2	−4	−2	3
AC	0	−4	3	−1	1	−1	4	0	1	3	−3	−3	0
AD	0	−2	3	3	−3	−4	0	1	4	0	0	0	−2
AE	−3	−1	1	−3	−3	0	2	2	1	3	1	2	−2
AF	2	−2	−3	−1	−1	0	2	2	4	1	−4	−2	2
AG	0	1	−2	0	3	−3	2	−4	2	2	0	−1	0
AH	1	−3	−2	1	0	1	2	1	3	0	0	−4	0
AI	0	−1	−2	3	−1	−2	−4	1	4	1	3	0	−2
AJ	−1	−3	2	3	−2	0	1	2	3	−2	0	−3	0
AK	3	1	3	−2	0	−1	0	−1	0	3	−3	−4	1
AL	−2	−4	−1	1	1	0	1	−3	3	2	0	1	1
AM	1	−2	0	3	−2	−2	1	2	4	−1	0	0	−4
AN	−3	−2	1	2	−2	−4	0	4	0	3	0	2	−1
AO	0	−2	2	3	−1	−2	1	4	2	0	−3	−4	0
AP	1	−1	−1	−1	1	−3	−1	1	1	4	2	−1	−2
AQ	−2	−3	−1	1	−2	0	3	1	3	3	1	−4	0
AR	1	0	3	4	−3	−4	−1	1	−2	1	3	−1	−1
AS	0	−2	−3	0	0	0	2	1	1	0	1	3	−3
AT	−4	−3	−3	−1	1	0	3	3	4	0	0	1	−1
AU	−3	−2	3	2	−3	−1	−1	0	3	2	0	2	−2
M	−2	0	1	0	0	−2	3	2	2	4	−2	−3	−3
I	−2	0	−1	0	4	−3	2	−1	3	1	0	−4	1
F	−1	−2	−2	3	0	0	1	−2	4	1	0	1	−3
G	0	−1	−4	3	−1	−1	0	1	4	2	−2	−1	0
O	−4	−2	−1	3	−3	2	0	2	1	0	4	−1	−1
N	−3	−2	−2	3	−1	0	2	2	4	0	1	0	−4
M	−0.81	−1.63	−0.30	1.19	−0.78	−1.19	0.93	1.00	2.30	1.41	−0.15	−0.96	−0.96
Transformed mean	4.19	3.37	4.70	6.19	4.22	3.81	5.93	6.00	7.30	6.41	4.85	4.04	4.04
SD	1.94	1.31	2.18	1.92	1.85	1.57	1.75	1.90	1.64	1.55	2.05	2.14	1.79
Relative standard deviation	0.39	0.26	0.44	0.38	0.37	0.31	0.35	0.38	0.33	0.31	0.41	0.43	0.36
Ranking	9	13	7	3	8	12	5	4	1	2	6	10.5	10.5

- Statements 2, 3, 8, 9, and 10 had no significant disagreement across clusters.
- Statement 1 differentiated Cluster A1 from Clusters A2 and A3.
- Statements 5, 11, 12, and 13 differentiated Cluster A2 from Clusters A1 and A3.
- Statements 6 and 7 differentiated Cluster A3 from Clusters A1 and A2.
- Statement 4 the level of agreement was inconclusive.

6.2.1 | Additional questions

The four additional Likert-style questions provided at the end of Q2 scored very highly indicating high importance across all three clusters. There was no significant difference between clusters in their Likert responses to these statements (Table 9). The similarity in responses is confirmed by comparing the median scores in Table 10.

6.2.2 | Universal characteristics

Despite conducting three independent Delphis at Q2, the statements and question structures were the same across all studies. This allowed direct comparison between clusters, revealing statements with significant disagreement or consensus. The overall ranked list of statements is in Table 11.

After the second round, there was consensus on the importance of five statements across all three clusters (Table 12). These statements

TABLE 4 Ranked list of statements across all participants

Statement number	Rank	Transformed mean	RSD	Statement
9	1	7.30	0.33	Reducing embodied and operational energy through passive design and high-performance envelopes
10	2	6.41	0.31	Designing for occupant health and well-being
4	3	6.19	0.38	Educating clients and stakeholders in sustainable design and operation
8	4	6.00	0.38	Designing buildings to enable sustainable lifestyles
7	5	5.93	0.35	Designing with respect for the natural environment
11	6	4.85	0.41	Measurement and analysis of building performance
3	7	4.70	0.44	Collaborating with like-minded and motivated clients and stakeholders
5	8	4.22	0.37	Specifying natural building materials
1	9	4.19	0.39	Employing simple and/or vernacular technologies in building design
12	10.5	4.04	0.43	Adopting national and international standards and codes (e.g., Passivhaus and BREEAM)
13	10.5	4.04	0.36	Utilising local skills and materials in the building process
6	12	3.81	0.31	Minimising building waste
2	13	3.37	0.26	Integrating innovative technologies and materials in building design

TABLE 5 Practice codes organised into the three clusters (number shown in figure A2 in parentheses)

Cluster A1	Cluster A2	Cluster A3
AA	AB	AD
AE	AC	AI
AL	AF	AJ
AS	AG	AM
AT	AH	AN
F	AK	AR
O	AO	AU
N	AP	
	AQ	
	M	
	I	
	G	

TABLE 6 Modified statement in Q2

Statement number	Original statement	New statement
2	Integrating innovative technologies and materials in building design	Integrating innovative technologies, construction techniques, and materials in building design
6	Minimising building waste	Reducing demolition and construction waste
8	Designing buildings to enable sustainable lifestyles	Designing contextually to enable sustainable lifestyles

showed no significant disagreement universally in the Kruskal–Wallis Test nor in pairwise Kruskal–Wallis tests between clusters. Statement 9—reducing embodied and operational energy through passive design and high-performance envelopes (weighted mean 7.43)—and Statement 10—designing for occupant health and well-being (weighted mean 6.29)—were considered the most important and ranked first and second, respectively, overall. Statement 8 (designing contextually to enable sustainable lifestyles) ranked fourth with a weighted mean of 6.28, whereas Statement 3 (collaborating with like-minded and motivated clients and stakeholders) ranked seventh.

6.2.3 | Cluster A1

Cluster A1 was differentiated from Clusters A2 and A3 by a single statement (Table 13). Statement 1 (employing simple and/or vernacular technologies in building design) was strongly rejected by the cluster, scoring 1.82 lower than the overall average (4.10). It ranked last of all the statements for this cluster. Statement 9 (reducing embodied and operational energy through passive design and high-performance envelopes) was the deemed the most important, consistent with the overall consensus.

The pairwise Kruskal–Wallis analyses show values of below 0.05 for both pairwise comparisons with Clusters 2 and 3, indicating this can be considered a significant differentiating statement.

6.2.4 | Cluster A2

Cluster A2 was differentiated from Clusters A1 to A3 through four different statements, which all demonstrated significant disagreement in the Kruskal–Wallis test at a universal and pairwise level. These are outlined in Table 14.

TABLE 7 Q2 full results and consensus values

Practice	Cluster	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
AA	A1	−3	−1	−1	0	−3	−1	2	2	4	3	1	0	−3
AE	A1	−1	−1	2	−3	−3	−2	2	2	1	3	0	2	−2
N	A1	−3	−2	−2	3	−1	0	2	2	4	0	1	0	−4
AT	A1	−4	−2	−2	0	1	1	3	1	4	−1	0	2	−3
O	A1	−4	−2	−1	3	−3	0	0	1	4	1	3	−1	−1
I	A2	−3	1	−1	1	3	−3	2	−1	4	1	0	−4	0
M	A2	−3	0	2	−1	−1	0	3	1	2	4	−1	−4	−2
AF	A2	−1	−3	−3	−1	3	0	3	1	4	0	−3	0	0
AB	A2	2	−1	−3	4	−1	0	0	2	0	2	−4	−2	1
AH	A2	1	−3	−2	1	0	1	2	1	3	0	−1	−4	1
AC	A2	0	−4	3	0	1	−1	4	0	1	3	−3	−3	−1
AK	A2	3	1	3	−1	0	−1	0	−1	0	2	−3	−4	1
AG	A2	0	1	−2	0	3	−3	2	−4	2	2	0	−1	0
AO	A2	0	−2	1	3	−1	−2	1	4	1	2	−3	−4	0
AP	A2	−1	−3	−4	−1	1	−1	1	1	2	4	3	0	−2
AJ	A3	0	−3	2	4	−3	−1	1	3	2	0	−1	−3	−1
AN	A3	−3	−2	1	2	−2	−4	0	4	0	3	0	2	−1
AM	A3	1	0	0	3	−3	−3	−1	2	4	−1	2	0	−4
AR	A3	1	0	3	4	−3	−4	−1	1	−2	1	3	−1	−1
AD	A3	−1	−3	2	3	−3	−3	0	0	4	0	3	0	−2
AI	A3	0	−2	−1	3	−1	−2	−4	1	4	1	3	0	−2
M		−0.90	−1.48	−0.14	1.29	−0.76	−1.38	1.05	1.10	2.29	1.43	0.00	−1.19	−1.24
Transformed mean		4.10	3.52	4.86	6.29	4.24	3.62	6.05	6.10	7.29	6.43	5.00	3.81	3.76
SD		2.00	1.50	2.22	2.08	2.12	1.53	1.80	1.76	1.82	1.54	2.30	2.09	1.51
Relative standard deviation (Q1)		0.39	0.26	0.44	0.38	0.37	0.31	0.35	0.38	0.33	0.31	0.41	0.43	0.36
Relative standard deviation (Q2)		0.40	0.30	0.44	0.42	0.42	0.31	0.36	0.35	0.36	0.31	0.46	0.42	0.30
Consensus value		0.01	0.04	0.01	0.03	0.05	0.01	0.01	0.03	0.04	0.00	0.05	0.01	0.05

TABLE 8 Kruskal–Wallis test after Q2

Statement	1	2	3	4	5	6	7	8	9	10	11	12	13
Kruskal–Wallis A1/A2/A3	0.027	0.927	0.229	0.039	0.004	0.023	0.013	0.212	0.262	0.725	0.018	0.014	0.009
Kruskal–Wallis A1/A2	0.014	0.951	0.854	0.806	0.032	0.426	0.951	0.126	0.086	0.594	0.023	0.012	0.008
Kruskal–Wallis A1/A3	0.022	0.715	0.068	0.068	0.648	0.018	0.018	0.927	0.361	1.000	0.523	0.411	0.273
Kruskal–Wallis A2/A3	1.000	0.745	0.193	0.015	0.002	0.023	0.007	0.175	0.704	0.444	0.020	0.024	0.026
Difference to 0.05 certainty	A1				A2	A3	A3				A2	A2	A2

Note: The highlighted cells represent probabilistic differences between groups to a 5% certainty.

Statements 5 (specifying natural building materials) and 13 (utilising local skills and materials in the building process) had enhanced importance in Cluster 2 compared with the overall average with means increased by 1.20 and 1.34, respectively. By contrast, the measurement and analysis of building performance (Statement 11) and the adoption of national and international standards and codes (Statement 12) were considered unimportant scoring 1.89 and 1.82 lower than the mean scores for these statements.

6.2.5 | Cluster A3

Statements 7 and 6 differentiated Cluster A3 from Clusters A1 and A2. This cluster was characterised by reduced importance being placed upon designing with respect for the natural environment (−1.756 from weighted overall mean) and reducing demolition and construction waste (−1.422 from the weighted overall mean) (Table 15).

TABLE 9 Round 2 Likert-style questions across all groups

Statement	Overall mean	Overall standard deviation	Overall median	Kruskal–Wallis A1/A2/A3	Kruskal–Wallis A1/A2	Kruskal–Wallis A1/A3	Kruskal–Wallis A2/A3
Designing holistically	4.62	0.49	5	0.697	0.540	0.411	0.745
Using rigorous internal procedures to ensure sustainable design quality	4.00	0.67	4	0.272	0.142	0.523	0.303
Integrating renewable technologies	4.10	0.59	4	0.457	0.462	0.715	0.233
Designing for future needs and longevity	4.67	0.48	5	0.826	0.540	0.715	0.828

TABLE 10 Round 2 Likert-style questions median scores across clusters

Statement	A1 median	A2 median	A3 median
Designing holistically	5	5	4.5
Using rigorous internal procedures to ensure sustainable design quality	4	4	4
Integrating renewable technologies	4	4	4
Designing for future needs and longevity	5	5	5

TABLE 11 Ranked list of all statements across all participants

Statement number	Overall weighted rank	Overall weighted mean	Overall absolute mean score	Statement
9	1	7.43	7.29	Reducing embodied and operational energy through passive design and high-performance envelopes
4	2	6.42	6.29	Educating clients and stakeholders in sustainable design and operation
10	3	6.29	6.43	Designing for occupant health and well-being
8	4	6.28	6.10	Designing contextually to enable sustainable lifestyles
7	5	5.92	6.05	Designing with respect for the natural environment
11	6	5.39	5.00	Measurement and analysis of building performance
3	7	4.92	4.86	Collaborating with like-minded and motivated clients and stakeholders
12	8	4.22	3.81	Adopting national and international standards and codes (e.g., Passivhaus and BREEAM)
5	9	3.83	4.24	Specifying natural building materials
1	10	3.82	4.10	Employing simple and/or vernacular technologies in building design
6	11	3.59	3.62	Reducing demolition and construction waste
2	12	3.48	3.52	Integrating innovative technologies, construction techniques and materials in building design
13	13	3.46	3.76	Utilising local skills and materials in the building process

Statement 4 appeared inconclusive. Its overall Kruskal–Wallis test showed significant disagreement between all clusters; however, in the pairwise analysis, there was only a significant difference between Clusters A2 and A3 (Table 16).

However, it can be noted that Statement 4 has an A1/A3 pairwise Kruskal–Wallis test very close to 0.05, and the C2/C3 test is already below this threshold.

6.2.6 | Correlating statements

A hierarchical cluster dendrogram divided at Level 12 (Figure 2) identified six themes: technology, collaboration, measurability, nature and well-being, performance, and user focus. Themes were named by contraction of statements. The technology theme was characterised by a concern for the physicality and materiality of design. Within

TABLE 12 Statements with universal consensus

Statement number	Weighted overall rank	Weighted mean score	Kruskal–Wallis test	Statement
9	1	7.43	0.262	Reducing embodied and operational energy through passive design and high-performance envelopes
10	3	6.29	0.725	Designing for occupant health and well-being
8	4	6.28	0.212	Designing contextually to enable sustainable lifestyles
3	7	4.92	0.229	Collaborating with like-minded and motivated clients and stakeholders
2	12	3.48	0.927	Integrating innovative technologies, construction techniques, and materials in building design

TABLE 13 Differentiating statement for Q2, Cluster A1

Statement number	Rank	*M*	Difference from weighted mean	Overall Kruskal–Wallis test	Kruskal–Wallis A1/A2	Kruskal–Wallis A1/A3	Statement
1	13	2.00	−1.82	0.027	0.014	0.022	Employing simple and/or vernacular technologies in building design

TABLE 14 Differentiating statements for Round 2, Cluster A1

Statement number	Rank	*M*	Difference from population mean	Overall Kruskal–Wallis test	Kruskal–Wallis A1/A2	Kruskal–Wallis A1/A3	Statement
5	4	5.80	+1.20	0.004	0.032	0.002	Specifying natural building materials
13	8	4.80	+1.34	0.009	0.008	0.026	Utilising local skills and materials in the building process
11	12	3.50	−1.89	0.018	0.023	0.020	Measurement and analysis of building performance
12	13	2.40	−1.82	0.014	0.012	0.024	Adopting national and international standards and codes (e.g., Passivhaus and BREEAM)

TABLE 15 Differentiating statements for Round 2, Cluster A3

Statement number	Rank	*M*	Difference from weighted mean	Overall Kruskal–Wallis test	Kruskal–Wallis A1/A2	Kruskal–Wallis A1/A3	Statement
7	9	4.17	−1.756	0.013	0.018	0.007	Designing with respect for the natural environment
6	13	2.17	−1.422	0.023	0.018	0.023	Reducing demolition and construction waste

technology, two clear subhemes emerged of non-pollution and cultural context.

Considering the statements that differentiated the groups (in italics), concerns for non-polluting materials, cultural context, and measurability emerged as the most divisive themes as both statements within each theme were differentiating. Measurability also split between Levels 14 and 15 on the dendrogram the earliest division of themes indicating it was least well correlated to the other themes. By contrast, collaboration and performance had universal consensus. Nature and well-being and user-focussed design shared both differentiating and consensual statements.

Performing hierarchical clustering on the differentiating statements only provides a clearer picture on the how statements that characterised each group of practices related (Figure 3).

Dividing the clusters at the third level based on the length of the longest branch of the dendrogram produces four distinct themes. Nature, user focus, and measurability remained key differentiating themes, whereas a theme containing statement concerned with local

TABLE 16 Statement 4 comparison

Statement number	Overall rank	M	Weighted mean	Overall Kruskall–Wallis test	Kruskall–Wallis A1/A2	Kruskall–Wallis A1/A3	Kruskall–Wallis A2/A3	Statement
4	2	6.29	6.42	0.039	0.806	0.068	0.015	Educating clients and stakeholders in sustainable design and operation

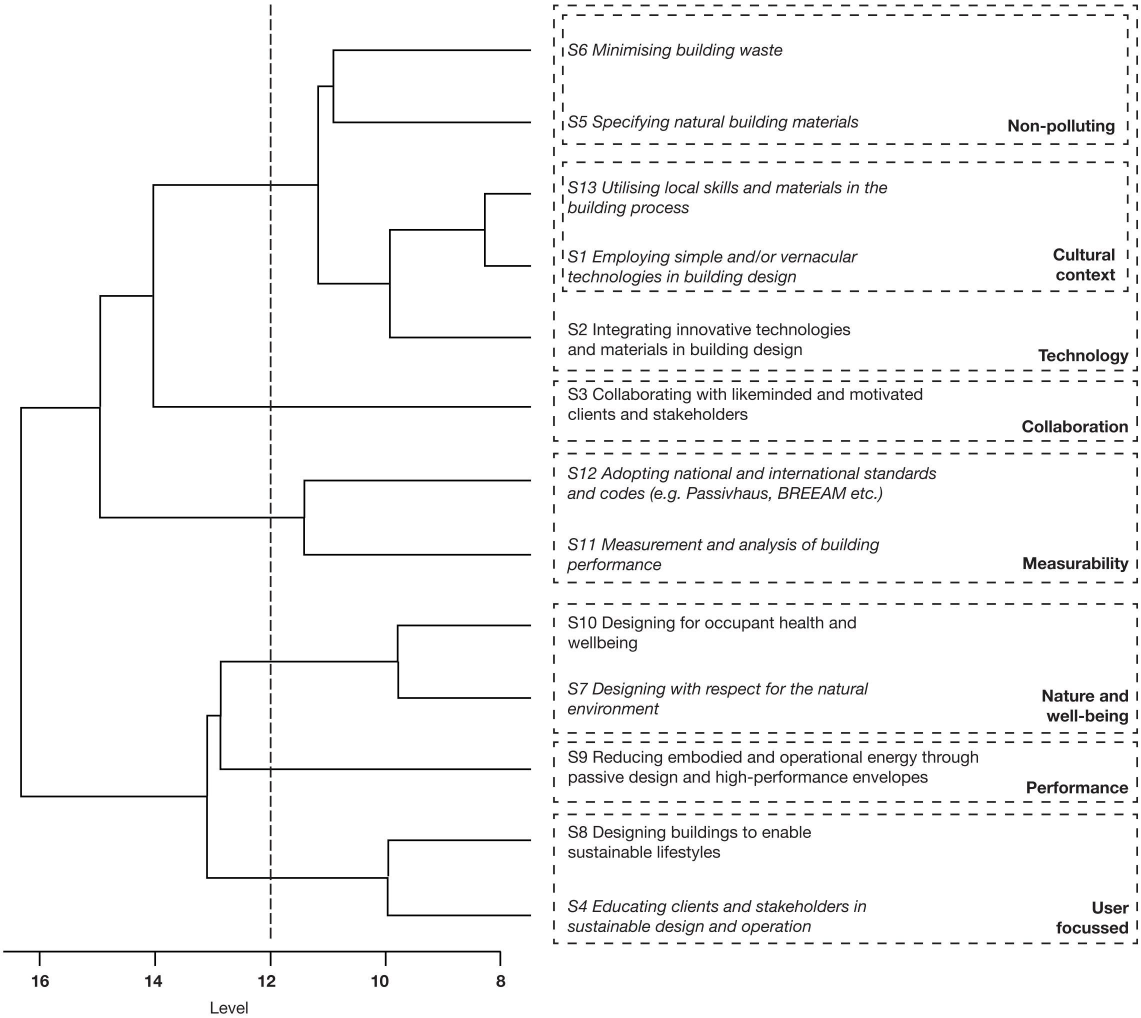

FIGURE 2 Cluster dendrogram showing diminishing clustering of statements and groupings by theme. Differentiating statements are highlighted in italics

impact was also identified. These included local skills, vernacular influence, using natural materials, and minimising building waste.

7 | DISCUSSION

7.1 | Universal characteristics

Shared concern among participants for constructing high-performance envelopes that minimised energy loads, suggests the reduction of carbon is the primary motivator for sustainable architectural design in the United Kingdom. This supports the assertion that building standards and certification schemes has placed most emphasis on carbon reduction (Awadh, 2017) and have shaped the discourse around sustainable design (Gibbs & O'Neill, 2015; Murtagh et al., 2016). However, the statement also implies a concern for building performance and passive design strategies. When contrasted with the almost universal rejection for integrating innovative technologies as a means to achieve sustainable design, this suggests an approach, which relies on passive and holistic systems. Indeed, this was supported by the universal agreement for the need to design holistically. One interpretation is that this statement might

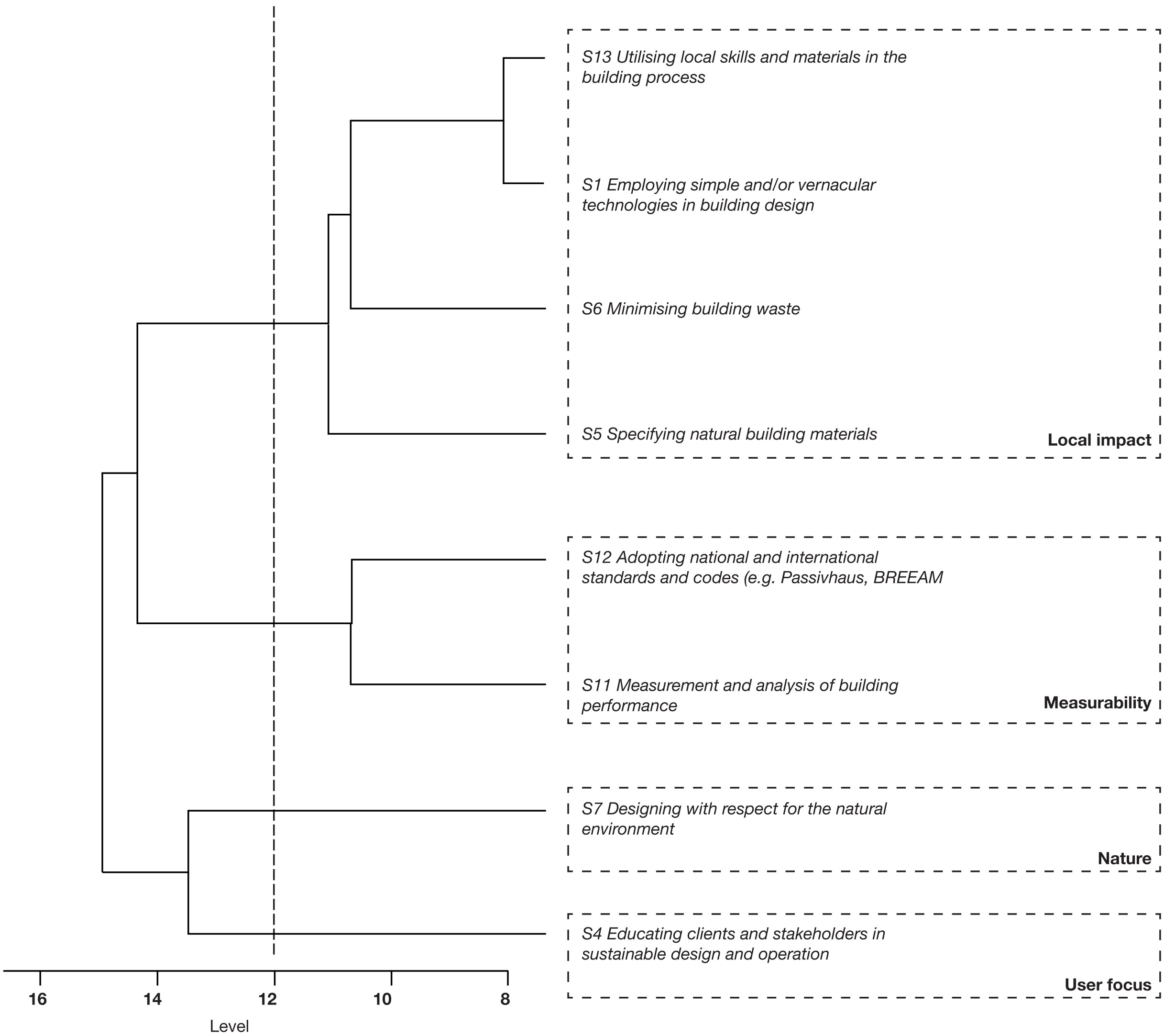

FIGURE 3 Cluster dendrogram showing diminishing clustering of differentiating statements (identified in earlier analysis) and groupings by theme

be considered as a challenge to holistic integration, which was considered universally important. However, it might also capture a profession-wide rejection of "technical" solutions as a means to enable sustainable design.

There was strong consensus on the importance of the building user in creating sustainable buildings. This was captured by two correlating statements: designing contextually to enable sustainable lifestyles and designing for occupant health and well-being. This suggests a human-centred approach, focussing on those engaging directly with the building was common across all practices.

7.2 | Differentiating themes

The research identified four themes, which differentiated each individual cluster through relative importance: measurability, nature, local concerns, and user focus. This reflects the findings of previous research by the the authors in which a range of sustainable design approaches were identified, categorised by differing attitudes towards technology, nature, participation, and place.

However, in the Delphi, clusters of individual practices did not oppose each other in their responses but rather placed different weightings on the value of these sustainable themes. The three groups of practices identified in the research (A1, A2, and A3) were characterised by differing attitudes towards these themes. The three clusters can be mapped onto a radar diagram displaying relative importance of the themes (Figure 4).

Clusters were not characterised by opposing stances to the different themes. That is, across pairwise analysis, no single issue had polarised responses. This supports the assertions of Williamson (2003) who suggests practices combine ideological outlooks to form individual approaches. For example, a concern for human and cultural context was only distinct as a nonimportant factor for Cluster A1. It was, however, considered significantly important in Clusters A2 and A3. Indeed, only two themes (non-polluting materials and respect for the natural environment) were polarised across two clusters

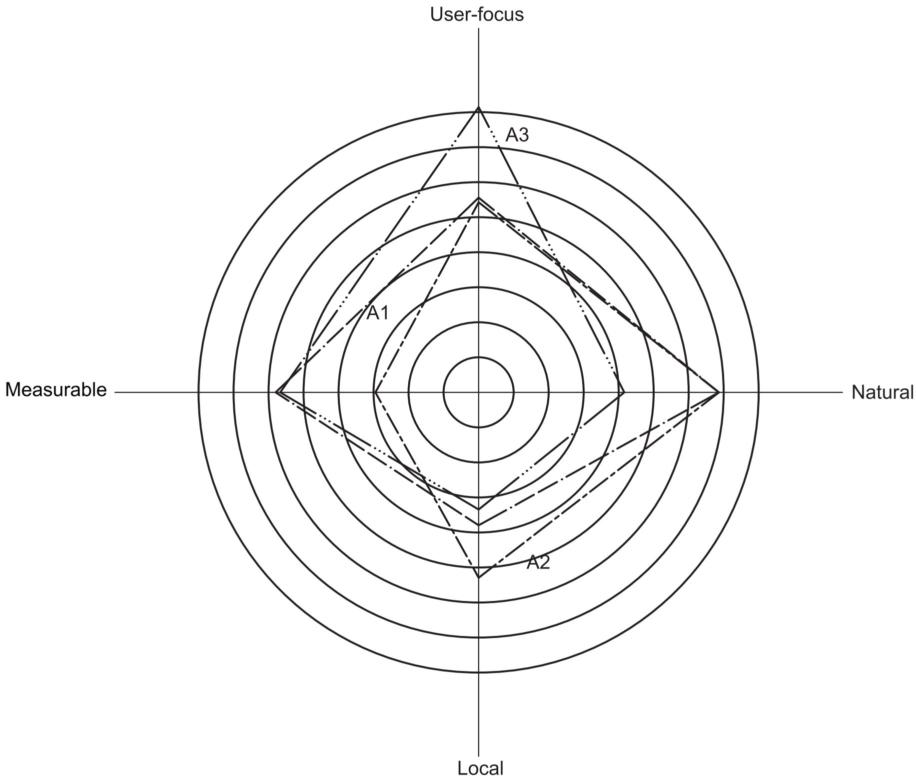

FIGURE 4 A radar diagram of sustainable practice based on the mean rankings for associated statements

(A2 and A3). The data showed that rather than competing groups characterised by opposing opinions, each group was defined by a relatively unique combination of factors.

7.3 | Cluster A1—"Measurable"

Cluster A1 was relatively well balanced across differentiating themes. It was differentiated by a rejection of traditional and vernacular approaches to sustainable design and accordingly, diminished importance placed on local concerns and users. This was complemented by an enhanced importance placed on national and international standards, the need for building measurement and the need for high-performance building fabrics, an emphasis on respecting nature through quantifiable outcomes. This approach is consistent with a worldview captured by ecological modernism (Blowers, 1997) placing faith in institutional adaption and minor changes. It shares similarities with the notion of accommodation (O'Riordan, 1989); an area of "modest reform" to the status quo. This cluster also valued the respect for the natural environment, which might be interpreted as a movement towards an interventionist approach, which values large-scale globalised environmental issues (O'Riordan, 1989). This would be consistent with an emphasis on carbon reduction and building performance.

7.4 | Cluster A2—"Environmental"

Cluster A2 was differentiated by placing heightened importance on the natural and the local. Simultaneously, there was a rejection of top-down and quantitative measures. This cluster was consistent with ecocentrism (O'Riordan, 1989). At its extreme, the Gaianist philosophy (Lovelock, 2000) places humankind within a wider ecological narrative, whereas more conservative communalism places faith in self-reliant communities based on renewable resources and appropriate technologies. It is this faith in self-reliance that may explain the rejection of top-down or authoritative measures. The statement correlation between non-polluting natural building and a concern for local and cultural context implies a concern for issues that affect a local and regional sustainability. It is this shared concern for locality and nature that encompasses the ecocentric approach.

7.5 | Cluster A3—"Social"

Cluster A3 was differentiated by diminished importance on non-polluting materials and respect for the natural environment in favour of greater importance on client and stakeholder education. Education as a means for achieving sustainable design falls outside the ecocentric/technocentric spectrum (O'Riordan, 1989). It closely maps to the notion of eco-socialism (Guy & Farmer, 2001; Pepper, 1993) through the implication of user empowerment. This reflected the results of all respondents in placing concerns of users and stakeholders of high importance for sustainable design. However, the responses fell short of indicating the importance of genuine participatory processes, which were not mentioned in any of the open text comments.

Cluster A3 was distinguished by the lack of importance placed on broader concepts of nature. This cluster sits outside the typology of

O'Riordan (1989). The emphasis on social action suggests this may be mapped to the communalist paradigm, defined by the development of self-reliant communities. However, these characteristics also imply a human-centred attitude, which diminishes the natural environment. This might be considered to capture an interventionist attitude, which values faith in the application of science and human ingenuity (O'Riordan, 1989). Similarly, Guy and Farmer (2001) describe these different paradigms as eco-technic and eco-social, respectively. This suggests a possible hybrid approach that focuses transformation of social systems, however, does not distinguish between participatory action and top-down social intervention.

7.6 | Anomalous themes

Respect for nature and the use of non-polluting processes, appear similar in sentiment, yet there was only limited correlation between these themes. Arguably, these statements may be interpreted through competing lenses. On the one hand, a respect for nature may capture ecocentric tendencies, embodying buildings that sit in harmony with nature, correlating with a use of natural building materials and the reduction of building waste (Guy & Farmer, 2001). Alternatively, respecting nature may be interpreted as an interventionist attitude through a belief that the natural environment must be harnessed to enable sustainable development (O'Riordan, 1989). It is perhaps these competing interpretations that explain why the statement "designing with respect for nature" offered the least disagreement among clusters and poorly correlated with other statements. Indeed, in Clusters A1 and A2, it ranked second and third, respectively, whereas in Cluster A3, it ranked ninth of 13 statements still placing in the third quartile for ranked statements. This indicated a degree of universality among respecting nature.

8 | CONCLUSION

The findings show that practices did not conform to a single strong individual paradigm but exhibits a mix of weighted concerns across the range of themes examined. Designing high-performance building envelopes that seek to limit operational energy and carbon emissions is a defining trend of sustainable architectural practice in the United Kingdom, indicating global environmental concerns being considered most important in the field of sustainability.

Rather than a series of competing values, there was a relatively homogenous outlook across practices. Practices were differentiated by minor differences in relatively few issues. Where differences did occur, these were under three key themes of ecocentric (nature), human centric (society), and technocentric (measurability).

The lack of diversity in approaches to sustainable design shows a narrow focus dealing with a limited number of issues. This is typically limited to broadly global challenges. Although these are clearly important, there is a risk of neglecting more localised concerns on which building design may play a more significant role. Diversifying approaches and rebalancing the importance of these issues may encourage more contextualised responses that effect sustainable living across a broader range of scales.

In part, the lack of variety may be due to the limitations of the research. The sample was mostly drawn from a single organisation (the Green Register). Although its members represent a large number and diverse range of practices, as a certification body, this might engender a more limited understanding of sustainable design. Similarly, the sample size, although important for the prolonged engagement of the Delphi technique and the reaching of consensus, may have excluded more extreme or outlying views. These were also moderated by the emphasis on achieving consensus. Further research could expand this sample set and seek to gauge the opinions of under-represented practices, outliers, members of alternative organisations, or architects not specialising specifically in sustainable design.

This research has implications for professional organisations who may shape practice through regulation or engagement. Encouraging dialogue between practice and a diverse range of stakeholders may help broaden the emphasis of sustainable design to address more of the sustainable development goals. Broadening approaches may be implemented in architectural education, which could provide a forum for exploring diverse sustainable design scenarios.

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