Multistakeholder sustainability assessment of housing estate regeneration schemes: Analysis of a mixed methods survey

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ABSTRACT

Engaging with different stakeholders in decision making over the regeneration of housing estates is a legislative requirement in many countries. Life Cycle Sustainability Assessment (LCSA) methodology and in general, Sustainability Assessment Frameworks (SAFs) are suitable tools to allow for a holistic comparison of different regeneration scenarios and their impacts. Understanding the priorities and meeting the expectations of different stakeholder groups and recognising the disablers and values of a participatory SAF are the main challenges in conducting a multistakeholder holistic sustainability assessment. Towards identifying a suitable stakeholder-driven SAF for decision-making on housing estate regeneration schemes (HERS), this paper has four aims to: 1) explore the perception of different stakeholders on their priorities concerning estate regeneration; 2) identify the barriers to participation; 3) identify the values of a holistic SAF; and 4) evaluate the effectiveness of the available SAFs. These aims have been explored through an extensive review of literature followed by a mixed-methods survey design, employing deductive and inductive approaches with stakeholders of HERS in the UK. The criteria for each section of the survey have been identified through review of literature. The inductive approach involves identifying the perceived importance of the pre-identified criteria through quantitative scoring, and the deductive approach involves qualitative analysis of open-ended questions to identify emerging new codes and themes. Thematic Analysis (TA), coding, Content Analysis (CA), and descriptive statistics were used for analysing the results. Triangulation and consolidation of the analyses reveal the importance of goal and scope definition and relevance of sustainability indicators for a participatory SAF due to the varying priorities of different stakeholder groups. Lack of meaningful engagement, transparent communication, a clear framework, and client interest are identified as the main barriers to a participatory SAF, while inclusivity, transparency, and knowledge advocacy are noted among the highest values. The findings highlighted the importance of ethical considerations and institutional barriers for stakeholder-driven decision-making for HERS, and potential of integrating participatory approaches into assessment frameworks. The participants' low perception of the current SAFs reiterates the necessity of this novel research. We recommend future research to explore these findings outside of the study sample, and further study how the identified implementation gaps can be addressed.

1. Introduction

1.1. Background

The methodology used for assessing the overall sustainability of [building] products and systems, consisting of the assessment of environmental, social, and economic impacts of different scenarios is referred to as LCSA (Klopffer and Grahl, 2014; Sadhukhan et al., 2021). To evaluate the overall impacts and benefit of different building projects, a wide range of relevant sustainability criteria and stakeholder groups should be included in the assessment processes (Guinée, 2016). For decision-making of housing estate regeneration schemes (HERS), priorities of different stakeholder groups, barriers to engaging with the stakeholders, and properties of a holistic LCSA and Sustainability Assessment Framework (SAF) should be fully understood. This research aims to explore the gaps in knowledge through an extensive literature review and a mixed-methods survey with different stakeholders of HERS.

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Acronyms

BREEAM	Building Research Establishment Environmental Assessment Method
BSI	British Standards Institution
EDI	Equality, Diversity, and Inclusion
CA	Content Analysis
CI	Confidence Interval
HERS	Housing Estate Regeneration Schemes
HQM	Home Quality Mark
JRC	Joint Research Centre
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
LCSA	Life Cycle Sustainability Assessment
LEED	Leadership in Energy and Environmental Design
NGO	Non-Governmental Organisation
RT	Research Theme
SAF	Sustainability Assessment Framework
SD	Standard Deviation
SPS	Seven-Point System
TA	Thematic Analysis
TOM	Target and Observation Manager
UCL	University College London

Table 1

A proposed list of criteria for LCSA/SAF identified through a scoping review and a mixed-methods research with community of HERS (Nava et al., 2024).

	Criterion
1	Climate Change
2	Environmental Impacts and Strategies
3	Local Ecologic Impacts and Strategies
4	Material Strategies and Circularity
5	Whole Life Cost
6	Physical Health
7	Accessibility
8	Safety and Security
9	Transport and Movement
10	Community Facilities and Amenities
11	Social Values
12	Maintenance and Management
13	Design and other Matters
14	Mental Health
15	Socioeconomic Values

1.2. Literature review

An extensive review of literature is conducted on recent English-written publications, mostly within the last 10 years and recognised sources of earlier literature. The following search terms were used to retrieve the articles from the databases: Life Cycle Assessment (LCA); Life Cycle Analysis; Life Cycle Inventory; Life Cycle Sustainability Assessment (LCSA); sustainability assessment; sustainability indicators; sustainability impact criteria; Triple Bottom Line (TBL) approach; stakeholder and community involvement in decision-making; retrofit-ting buildings; social housing; and regeneration of estates. The review explored priorities of stakeholder groups for indicator selection and criteria categorisations, barriers to engagement, and properties of a holistic LCSA and SAF.

In the context of building projects, the relevant stakeholders should be involved in the process of decision-making, for ethical purposes and for achieving better outcomes (Souza et al., 2015; Janjua et al., 2020; Karaca et al., 2020). However, for identifying the scope of assessment

Table 2

Some of the key barriers to engagement for holistic SAF.

	Barriers to engagement	Reference
1	Lack of a clear framework	(Kang et al., 2016)
2	Lack of community interest	(Kang et al., 2016)
3	Lack of client team interest	(Sayce and Farren-Bradley, 2011) (Menassa and Baer, 2014)
4	Lack of design team interest	(Menassa and Baer, 2014) (Kang et al., 2016)
5	Absence and lack of clarity of legislative requirements	(Kang et al., 2016)
6	Complexity of undertaking the assessments	(Souza et al., 2015)
7	Time-intensive process of conducting the assessments	(Souza et al., 2015; Kang et al., 2016)
8	High cost of conducting the assessments	(Souza et al., 2015)
9	Lack of familiarity with the assessment methods	(Kang et al., 2016)(Karunaratne and Dharmarathna, 2022)
10	Complexity of communicating the results with the stakeholders	(Sayce and Farren-Bradley, 2011) (Scolobig and Lilliestam, 2016)

Table 3

Properties and values for a holistic participatory LCSA/SAF.

	Properties of a holistic multistakeholder sustainability assessment framework	Reference
1	Being easy to understand	(Reichert et al., 2015)(Karunaratne and Dharmarathna, 2022)
2	Being transparent	(Souza et al., 2015)(Karunaratne and Dharmarathna, 2022) (Menassa and Baer, 2014) (Aubert et al., 2020) (Zanchi et al., 2021)(Angelo and Marujo, 2019)
3	Being cost-effective and feasible	(Menassa and Baer, 2014)(Sala et al., 2018)
4	Involving different stakeholder groups (including the community) in decision making	(Souza et al., 2015) (Aubert et al., 2020) (Sala et al., 2018) (Macombe et al., 2018)(Rogerson and Sadler, 2011)(ZEBAU, 2016)(Nathan and Coles, 2020)
5	Including a diverse group of participants in relation to their age, ability, and ethnicity	(Aubert et al., 2020)(Macombe et al., 2018) (ZEBAU, 2016) (Oliver et al., 2022)(O'Beirne et al., 2020)
6	Allowing voices to be heard equally	(Karunaratne and Dharmarathna, 2022) (Sala et al., 2018) (Macombe et al., 2018)(Lipietz and Wickson, 2017) (ZEBAU, 2016)
7	Enabling the participants to develop their knowledge of different topics of discussion	(Sayce and Farren-Bradley, 2011)(Colombo et al., 2021)(Greater London Authority, 2017) (Lipietz and Wickson, 2017) (ZEBAU, 2016) (Oliver et al., 2022)
8	Including relevant impact criteria for assessment, related to communities and stakeholders needs	(Souza et al., 2015) (Sala et al., 2018)(Tokede and Traverso, 2020) (Nathan and Coles, 2020)(Gasparatos et al., 2008)
9	Considering the lifetime impacts of different criteria for assessment	(Zanchi et al., 2021) (ZEBAU, 2016)(Kang et al., 2016)(Martín-Gamboa et al., 2017)
10	Avoiding double counting of the impact criteria as much as possible	(BRE, 2017) (Dodgson et al., 2009)(Loiseau et al., 2018)(Soares et al., 2006)(Latas et al., 2022)
11	Being scientifically robust	(Souza et al., 2015) (Zanchi et al., 2021) (Angelo and Marujo, 2019) (ZEBAU, 2016)
12	Being compatible with other assessment approaches	(ZEBAU, 2016)

frameworks, the priorities of different stakeholder groups is not always clearly understood and the scopes seldom reflect the concerns of different stakeholders (Souza et al., 2015; Kang et al., 2016). In addition, there are discrepancies in categorisation of the impact criteria which vary from reductionist scopes, categorising environmental; social; and
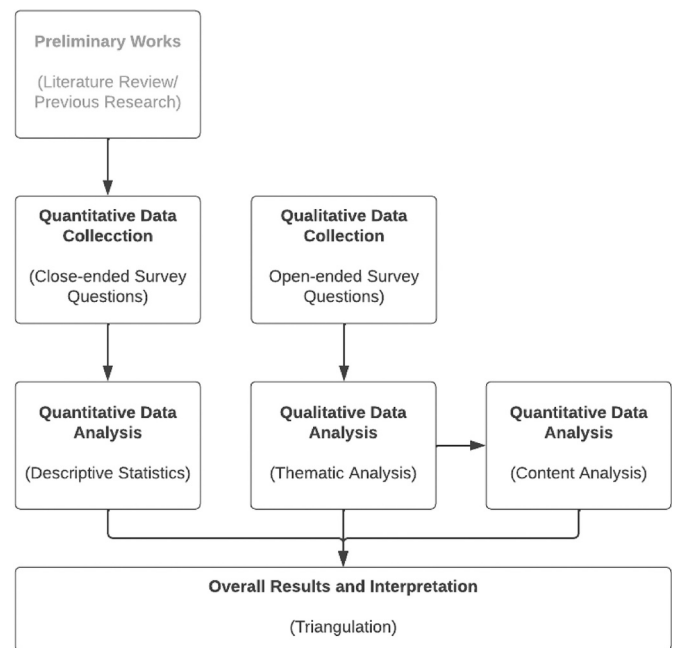
Table 4

Research themes, aims, and objectives.

Research Theme (RT)	Research Aim	Research Objective
1- Regeneration priorities	1- Exploring the priorities of different stakeholders in relation to estate regeneration schemes. The main objective of this theme was to relate these priorities to indicators and previously identified criteria for a sustainability assessment framework	1.1- Identifying the assessment criteria through the literature and previous research 1.2- Exploring the stakeholders' perceived importance of predetermined criteria for regeneration priorities (deductive) 1.3- Exploring the stakeholders' regeneration priorities (inductive)
2- Barriers to engagement	2- Identifying the barriers to a multistakeholder holistic sustainability assessment for estate regeneration schemes.	2.1- Identifying the engagement barriers through the literature 2.2- Exploring the stakeholders' perceived importance of predetermined engagement barriers (deductive) 2.3- Exploring the stakeholders' perceived engagement barriers (inductive)
3- Framework values	3- Identifying the values for a multistakeholder holistic sustainability assessment framework of estate regeneration schemes	3.1- Identifying the engagement barriers through the literature 3.2- Exploring the stakeholders' perceived importance of predetermined engagement barriers (deductive) 3.3- Exploring the stakeholders' perceived engagement barriers (inductive)
4- Evaluating the existing SAFs	4- Evaluating the current sustainability assessment frameworks against the identified values.	4.1- identifying the stakeholders' familiarity with the existing SAFs 4.2- Exploring the stakeholders' evaluation of the current SAFs

Fig. 1. Research flow for each research theme.

(Menassa and Baer, 2014; Scolobig and Lilliestam, 2016), there are further challenges in understanding these methods and communicating the results with different stakeholder groups (Kang et al., 2016). Other practical challenges to a participatory SAF can include the potential resource-intensive processes of engaging with different stakeholders of the projects (Souza et al., 2015; Kang et al., 2016). Table 2 provides a summary of some of the barriers to participation for a holistic SAF identified from the literature review.

For a holistic SAF of building projects, different methodological, practical, and ethical considerations should be in place (ZEBAU, 2016). Scientific robustness (Zanchi et al., 2021), avoidance of double counting of impacts (Dodgson et al., 2009), and considering the lifetime impacts from different stages of the building projects (Martín-Gamboa et al., 2017) are some of the key methodological necessities of any lifecycle-based assessment framework. The ethical properties of any multi-stakeholder assessment framework would require them to ensure equality, inclusivity, and diversity (Ott et al., 2012; Hacker, 2017). In addition to these properties, transparency of the assessment process, its comprehensibility, and feasibility are some of the key practical properties for a meaningful and viable stakeholder-based SAF (Souza et al., 2015)(Menassa and Baer, 2014). A summary of these key properties is presented in Table 3.

The gaps in scope definition and engagement, and properties of a participatory LCSA and SAF have been explored through and extensive review of literature. For a suitable stakeholder-based decision-making in the context of HERS, what lacks scrutiny is identifying the scope, engagement barriers, and framework values with the relevant stakeholders of the studies. These gaps have formed the aims of this study.

1.3. Research aims

To bridge the gaps in knowledge for a relevant and holistic participatory SAF for estate regeneration schemes in the UK, this research aims to explore the stakeholder perceptions on their priorities as potential indicators for the SAF; barriers to engagement; and values of a holistic participatory framework. In addition, this research conducts an evaluation exercise to gain an understanding of the participants' perception of the current SAFs against some of the identified criteria. A mixed-methods survey consisting of open-ended and close-ended questions

economic impacts, to more 'holistic' approaches in which different quantitative and qualitative dimensions of sustainability are integrated (Tokede et al., 2021). To address the later gap, we previously identified a list of criteria for a holistic SAF and LCSA of HERS through a scoping review and a case study with the community[1] of a housing estate (Nava et al., 2024). The identified criteria, presented in Table 1, can be a good benchmark for gaining an overall understanding of the stakeholder priorities and communication of the results.

Although engaging with the communities and other stakeholders for different aspects of decision-making on HERS is a legislative requirement in the UK (Sayce and Farren-Bradley, 2011), there is not enough clarity and authority of the extent and application of such engagements. Existing SAFs and certification schemes are intended for evaluating the sustainability of different building projects. However, as different stakeholders are not always included in these assessment approaches

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[1] In this paper, the term *community*, in the context of housing estates, refers to the collective of residents and local entities of an estate.

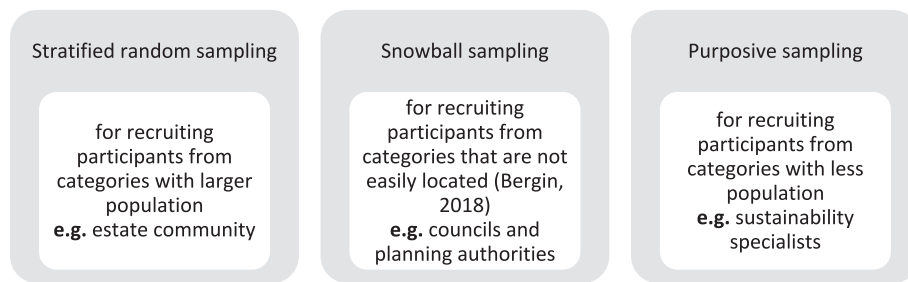| Stratified random sampling	Snowball sampling	Purposive sampling
for recruiting participants from categories with larger population **e.g.** estate community	for recruiting participants from categories that are not easily located (Bergin, 2018) **e.g.** councils and planning authorities	for recruiting participants from categories with less population **e.g.** sustainability specialists

Fig. 2. Different approaches to recruiting survey participants.

was conducted. Relevant stakeholder groups including estate residents and communities, built-environment professionals, client teams and planning authorities, campaign groups, and researchers and academics (Pelsmakers, 2015; BSI, 2022) participated in the survey. The survey was designed around four main research themes (RT1-RT4). Table 4 presents these themes and their related aims and objectives.

2. Methodology

2.1. Survey design

Employing a mixed methods research design, a survey was conducted for a period of approximately six months, between August 2023 and February 2024. The sample for this research was the identified stakeholder groups for estate regeneration schemes in the UK, and more specifically, London. The geographical boundary of this research is mostly due to the location of the main author of the study and their connections for recruiting the study participants.

A mixed methods design has been employed for this research to respond to the multi-faceted aims and objectives of this research (Cara, 2016). Mixing quantitative and qualitative approaches for data collection and analysis allows for better understanding the perspectives of different stakeholder groups and responding to the research question (Cara, 2016). Measurable outcomes from the quantitative findings are expanded with in-depth explorations through qualitative analysis of open-ended questions (Creswell and Plano Clark, 2017). The four main themes of the research are related to the four main aims. The mixed methods survey involved integrating and combining qualitative and quantitative data collection and analysis, and deductive and inductive approaches to research (Creswell and Creswell, 2018). The close-ended questions of the survey allowed for deductive and quantitative exploration of predetermined criteria for the main aims of the study, identified from the literature. The open-ended questions enabled deeper exploration and qualitative analysis of the research areas using an inductive approach for identifying emergent codes (Creswell and Plano Clark, 2017). Fig. 1 illustrates the flow of research, presenting the approaches for data collection and analysis of this study for each research theme and the overall triangulation of the results. Please note that RT4 has not involved any qualitative data analysis.

Survey participants were recruited through purposive, snowball and stratified random sampling. Fig. 2 presents the different methods for recruiting the survey participants of the study.

Microsoft Forms (Microsoft Form, 2024) was the platform for conducting the survey. The main survey page explained its main aims and participant information sheets where shared through University College London (UCL) SharePoint for informed consent which was collected in order to take part in the survey.

3. Methods

3.1. Qualitative data collection and analysis

Qualitative data collection was through open-ended questions in

which the participants could elaborate on their answers in a format of a long text box, without any limitations on word count. For analysis of the qualitative data, Thematic Analysis (TA) has been employed as an iterative process of coding which allowed extracting the most relevant insights from the participants (Bergin, 2018). Coding was done based on spontaneous origins (Bergin, 2018), which is related to the deductive approach of the study. Iterative open coding was conducted through a bottom-up approach. The identified codes emerging from the TA have been categorised into relevant sub-themes, using NVivo (NVivo, 2024) for coding.

Content Analysis (CA) has been conducted to illustrate the presence of certain concepts or categories within the qualitative data (Vaismoradi et al., 2013; Roberts and Edwards, 2022). Microsoft Excel (Microsoft Excel, 2024) have been used for presentation of the results of the TA and CA.

3.2. Quantitative data collection and analysis

Collection of quantitative data was through Seven-Point System (SPS) for scoring the criteria (Kalbar and Das, 2019). In this approach, the participants were asked to attribute a value of 1 to 7 (1 being the lowest value and 7 being the highest value) to each factor under study. These factors were predetermined and identified from the gaps in the field to meet the specific aims and objectives of the project (Bergin, 2018) in relation to indicators and criteria, barriers to engagement, and values for a participatory holistic assessment framework. Analysis of the close ended questions have been through descriptive and observational statistical analysis and Independent Samples' t-test.

Descriptive statistics including calculating mean, median, mode, standard deviation, confidence intervals, and range, were applied where appropriate, and an overview of central tendencies and variability in data has been explored. Grouping respondents based on their stakeholder group, has helped in understanding different stakeholder profiles and their priorities.

Observational statistical analysis has involved bar charts, histograms, and box plots, displaying the distribution of responses for each survey question or the importance ratings of different indicators. The analysis has also included group bar charts displaying the stakeholder groups' answers to criteria rating, barriers to participation, and values for holistic framework.

Independent Samples' T-Test has been conducted to compare the statistical significance of differences between the means of different stakeholder groups.

SPSS (IBM SPSS Statistics, 2024), Microsoft Excel (Microsoft Excel, 2024), and Python (Python, 2024) using Jupyter Lab (Jupyter Lab, 2024) has been used for conducting and presenting the statistical analysis. This is due to their recognition among the research community for conducting statistics, data analysis, and visualisation of the results (Ismaeel, 2018).

3.3. Overall analysis

Triangulation and consolidation have been employed for comparing

Table 5

Summary of different variables of the survey and their description, SAF; Sustainability Assessment Framework.

	Variable	Type	Notes
Study Sample	Stakeholder Group	Categorical	Represents the group the respondent identifies with, such as community members, project managers, government authorities, etc.
	Region Represented	Categorical	Specifies the region the respondent represents, with options for various UK regions and an 'Other' option for specification
RT1: Regeneration Priorities	Priorities for Regeneration	Open Text	An open-ended (long format) response where respondents can elaborate their priorities
	Importance Rating of Criteria	Ordered Categorical/ Ordinal measurement SPS	Respondents rate the importance of various criteria on a scale from 1 to 7, when 1 is the lowest value and 7 is the highest value
RT2: Barriers to Engagement	Barriers to Engagement	Ordered Categorical/ Ordinal measurement SPS	Rating of perceived barriers to engaging with stakeholders for the holistic assessment of estate regeneration schemes on a scale from 1 to 7, when 1 is the lowest value and 7 is the highest value
	Other Barriers to Engagement	Open Text	An open-ended (long format) response where respondents can elaborate on other barriers to engagement and discuss their answers
RT3: Framework Values	Properties/Values for Holistic Assessment	Ordered Categorical/ Ordinal measurement SPS	Respondents rate their priorities for a holistic assessment framework on a scale from 1 to 7, when 1 is the lowest value and 7 is the highest value
	Other Properties/Values for Holistic Assessment	Open Text	An open-ended (long format) response where respondents can explain multiple properties for holistic assessment of estate regeneration schemes
RT4: Evaluating the Existing SAFs	Involvement with other SAFs	Binary	Yes/No - Indicates whether the respondent has experience with other sustainability assessment frameworks
	Naming other SAFs	Open Text	An open-ended (long format) response where participants name and potentially explain other sustainability assessment frameworks they have experience in
	Effectiveness of other SAFs	Ordered Categorical/ Ordinal measurement SPS	Assessment of the effectiveness of these frameworks on a scale from 1 to 7, when 1 is the lowest value and 7 is the highest value

the overall findings from quantitative and qualitative analyses to enhance validity, and integrating the findings in the discussion, explaining how the qualitative insights complement the quantitative findings to respond to this research aims.

3.4. Study variables

Different variables have been employed for this mixed methods survey to respond to the aims and objectives of the study, and to explore the demographics of the survey participants. These variables are summarised in Table 5. The table explains how the variables address the research aims.

4. Findings

4.1. Study sample

4.1.1. Stakeholder groups

Sixty-three participants across different stakeholder groups took part in the survey. The stakeholder group counts and percentages are presented in Table 6 and Fig. 3. Residents, the Design team and related academics, and NGOs and social scientists had a higher number of participants followed by lower number of participants for the client team and Environmental specialist. While this categorisation allows for grouping of the stakeholder participants, different demographics within the groups have not been explored, e.g. residents of the estates comprise of different demographics with varied viewpoints.

4.1.2. Represented regions

Eighty-four percent of the survey participants were from London and Greater London. The remaining participants were spread from North West, East and East Midlands, South East of England. Three people had participated in the survey from the rest of the UK, including Wales and Scotland. Table 7 illustrates the participants' distribution across different UK regions. The participants from outside of London comprised 15.9 % of the survey overall participants. Because of the low sample size and the similarity of the responses in different regions, the answers per region have not been explored further.

4.2. Regeneration priorities

4.2.1. Qualitative analysis of participants' perceived priorities

In an open-ended format, the participants were asked about their priorities in relation to the regeneration of the states. The detailed responses of the sixty-three participants were explored through TA and CA.

Coding of the survey responses was conducted using NVivo (NVivo, 2024) and Microsoft Excel (Microsoft Excel, 2024). Identifying the codes from the responses was done through a deductive approach, without any pre-determined codes. Following the iterative process, eighty-two codes were extracted from the responses. These codes can be used as indicators for assessing the expectations of the stakeholders for different regeneration scenarios. For ease in communication of the results, the identified codes were assigned to fifteen previously identified criteria (Nava et al., 2024). The results of the identified codes and their related criteria based on their highest frequency are presented in Table 8.

The findings of the TA provide a good overall understanding of the stakeholders' main priorities and concerns regarding estate regeneration. As the results illustrate, the majority of concerns were in relation to *Social Values*, *Design Strategies*, *Physical Health and Wellbeing*, *Socioeconomic Values*, *Community Facilities and Amenities*, and *Whole Life Cost*.

To further understand the stakeholders' priorities, it is important to explore the mostly mentioned identified codes and the related stakeholder groups in relation to the codes and criteria too. Fig. 4 provides a diagram of the most important codes based on the frequency of their occurrence. As this diagram illustrates, *improving the overall sustainability of the regeneration schemes* was the most repeated code from all participants, followed by *ensuring affordability for the residents*.

Table 6

Counts and percentages of the survey participants from different stakeholder groups.

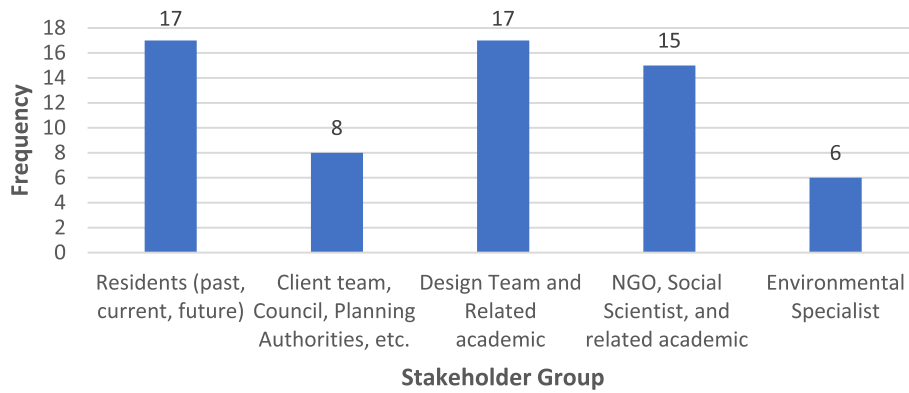|	Stakeholder group description	Count	Percent
1	Residents of current, previous, and future occupant of a housing estate	17	27.0
2	Client team, Councils, Planning authorities	8	12.7
3	Architect, Designer, Engineer, Specialist consultant, Related Academic	17	27.0
4	Campaigner, Community Action Group, NGO, Social Scientist, Related Academic	15	23.8
5	Environmental sustainability specialist	6	9.5
	Total	63	100.0

Fig. 3. Bar chart of the stakeholder group frequencies.

Table 7
Counts and percentages of the survey participants from different UK regions.

Region	Count	Percent
North West (England)	2	3.2
East and East Midlands (England)	2	3.2
London and Greater London	53	84.1
South East (England)	3	4.8
Other (UK-wide)	3	4.8
Total	63	100.0

Including the residents in decision making, creating more green spaces and landscapes, enhancing the sense of belonging and other social impacts, and reducing the climate change impacts were jointly the third most repeated codes.

The distribution of the criteria and different stakeholder groups have been presented in Fig. 5. As this figure illustrates, the priorities of different stakeholder groups widely differ from one another. It is understood that as social and socioeconomic values are the highest concerns for residents, NGOs, and social scientist groups, these criteria are of less import to the client team or the environmental specialist. *Mental Health and Wellbeing* and *Management and Aftercare* criteria have the highest presence in the answers from the residents and the NGO and social scientist group. However, these two criteria have not been noted in any of the answers from the client team.

While exploring the codes or indicators from the perspective of criteria provides a tangible understanding of the stakeholders' overall main priorities, to better understand the identified priorities of different stakeholder groups the codes are explored more closely and the findings of Figs. 4 and 5 are considered together.

The varying priorities of different stakeholder groups in relation to the identified indicators were apparent from the findings of the TA. The priorities of residents and social scientists and NGOs were mostly related to the social and socioeconomic indicators. Different types of disturbance and mental health impacts of regeneration scenarios were mostly solely noted by the residents' group. Similarly, the management and maintenance of the estates were solely noted by the residents' group. Another indicator that was only noted by the resident groups was the request for transparency throughout the process. A number of participants noted that the councils do not clearly communicate their financial incentives for increasing the number of housing. An important indicator that the residents and the design team group had consensus over its importance was in relation to including different regeneration scenarios, most importantly a retrofit scenario, in the scenarios under study.

It should be noted that although different codes and indicators can be grouped in similar criteria, the priorities in those criteria may be contradictory. As an example, the *Whole Life Cost* criterion includes indicators related to *Affordability for Residents* and *Profitability*. The former was noted as an important priority for residents, while the latter related

to the clients' concerns. This criterion was the one with the most contrasting results. This example itself illustrates the differing priorities of different stakeholder groups which may result in complications for decision making over the regeneration of the estates.

4.2.2. Quantitative rating of criteria importance

Following the open-ended question of the stakeholders' priorities for estate regeneration, the participants were asked to score the importance of identified criteria from our previous study (Nava et al., 2024) from 1 to 7, 1 being the lowest score and 7 being the highest score. This list is presented in Table 1.

A box plot diagram, Fig. 6, presents the participants' responses to the scoring of criteria by stakeholder group. To determine the most important criteria, median and mean values across all stakeholder groups can be noted. As this figure demonstrates, despite the varying priorities of different stakeholder groups identified through the qualitative part of the survey, the scoring for different criteria is relatively close and high for all stakeholder groups and criteria. Analysis of the results of the sustainability criteria scores by different stakeholder groups illustrated in Fig. 6 highlights the stakeholders' perceived importance of different sustainability criteria. Mean ratings illustrated in Fig. 6 indicate a general agreement on the importance of various criteria. Median values are mostly at 6 or 7, suggesting a high valuation of these criteria by the majority of respondents. The standard deviation values are relatively low, indicating that responses were not widely dispersed around the mean.

In theory statistical tests can be carried out to ascertain whether there are statistically significant differences in the means of each criterion between the groups. However, because the sample sizes of some of the groups are small, the tests are not sufficiently robust to be performed. Fig. 6 provides and overview of the central tendencies. Table 9 presents the descriptive statistics for the total scoring of different sustainability criteria by various stakeholder groups. The data reveals a consensus among stakeholders on the importance of most criteria, indicated by high mean values and low standard deviations and standards errors of mean across groups, reflecting their perceived critical importance.

The stakeholder group mean values for the perceived importance of different criteria have been illustrated in Fig. 7. While the mean values are relatively high for all criteria, comparison of the mean values for each criterion within each stakeholder group, presents which criteria each group finds important on average. The highest mean value within a group for a criterion can suggest that it is of most importance to that group, while conversely, the lowest mean values within each group can indicate the least importance to the group. It can be understood that *Social Values* and *Physical Health and Wellbeing* stand out with high means across all groups. The Independent Samples *T*-Test with 95 % Confidence Interval (CI), has been conducted to compare the statistical significance difference between residents and other group means. The

Table 8
Identified codes and their related criteria ordered based on the frequency of the mention of the codes and their criteria.

Sustainability Criterion	Identified Indicators	Count/	Total
Social Values	Including existing residents in the decision making (at every level)	15	
	Enhancing sense of belonging, pride, empowerment, and cohesion	15	
	Improving the quality of life for the community	11	
	Responding to the needs of existing residents	10	
	Maintaining the estate demographics (majority of the estate to be social housing)	9	
	Ensuring equity, equality, and diversity	8	
	Respecting the dignity of existing residents	6	
	Improving the overall social impacts	5	
	Fostering co-production and co-design (avoiding narrow consultation over limited options)	5	
	Enabling training and knowledge mobility for informed decision making	4	
	Enhancing livelihood	3	91
Socioeconomic Values	Ensuring affordability for existing residents	17	
	Increasing the number of social housing	10	
	Securing tenure	8	
	Considering the overall socioeconomic impact of the schemes for the community	7	
	Reducing poverty	6	
	Revitalising the estate	4	
	Densifying the estates	3	
	Avoiding densification of the estates	3	
	Increasing the number of affordable housing	3	
	Being fit for purpose	3	
	Avoiding segregation of existing and new communities	2	
	Increasing employment within the estate	2	68
Design strategies and Innovation	Improving design quality and meeting design standards (quality, size, etc.)	14	
	Prioritising retrofitting over demolition	13	
	Improving the quality of houses	10	
	Improving the design ad aesthetics in line with the existing character of the estates	5	
	Future proofing the design	5	
	Considering different design scenarios	4	
	Allowing for flexible design and use change/space sharing	4	
	Considering inclusive transformation of existing typologies	3	
	Considering passive and low maintenance design strategies	3	
	Considering diversity in adaptation to the inhabitant's needs and types	2	63
Community Facilities and Amenities	Building and improving outdoor spaces	13	
	Building and Improving recreation and leisure spaces	11	
	Building and Improving amenities	10	
	Improving communal spaces	10	44
Mental Health	Avoiding displacement and disruption as much as possible	10	
	Reducing the negative Impact of regeneration on mental health	8	
	Reducing the stress over implications of regeneration	8	
	Reducing the uncertainties and fear for the future	4	
	Reducing overcrowding	4	
	Retrofitting to meet the wellbeing goals	3	37
Safety and Security	Making safe outdoor spaces	13	
	Making the homes safe	10	
	Making the homes secure	7	
	Enhancing fire Safety	7	37
Transport and Movement	Connecting the estate to the city grid and public transport	12	
	Considering different modes of transport	5	
	Increasing and enabling green modes of transport	3	
	Reducing traffic	1	36
Climate Change	Reducing the overall Climate Change impact of regeneration schemes	15	
	Increasing energy-efficiency and meet the energy goals	7	
	Decarbonising the schemes	7	
	Having low embodied carbon schemes	6	35
Ecological Impacts and Strategies	Creating more green spaces and landscapes	15	
	Improving the biodiversity of the area	6	
	Reducing the ecological impacts at regional and national levels	5	
	Introducing biophilic strategies	3	29
Physical Health	Improving the overall physical health and wellbeing	11	
	Improving indoor air quality and eliminating mould	5	
	Improving the thermal comfort	5	
	Providing adequate lighting	2	
	Improving acoustic comfort	2	25
Management and After Care	Maintaining and managing the estate	11	
	Looking after the outdoor spaces	5	
	Effectively communicating with the community and receiving feedback	4	
	Being transparent in the process and on communicating the outcomes	4	24
Wole Life Cost	Reducing the use costs	7	
	Considering cost efficiency of construction	5	
	Increasing the affordability of retrofit works	4	
	Increasing profitability	3	
	Making sure the schemes are economically viable	2	

(continued on next page)

Table 8 (*continued*)

Sustainability Criterion	Identified Indicators	Count/	Total
	Granting funding	2	23
Other Environmental Impacts and Strategies	Improving the overall Environmental sustainability of regeneration schemes (reducing the overall impacts)	19	
	Improving the clean air around the site	4	23
Materials Strategies, Resilience, and Circularity	Building for longevity and resilience	11	
	Reusing of existing structures and materials	4	
	Recycling	2	
	Recovering of materials	1	18
Accessibility	Improving access and circulation around the estate	10	15
	Improving access for special needs	5	15

results have revealed a statistically significant difference between the group means of the residents' group and the client group for the *Mental Health and Wellbeing* ($p = 0.025$) and *Safety and Security* criteria ($p = 0.017$), between the residents' group and design team for *Social Values* ($p = 0.017$), between the residents' and NGO group for *Social Values* ($p = 0.017$); and between the residents' group and sustainability specialist
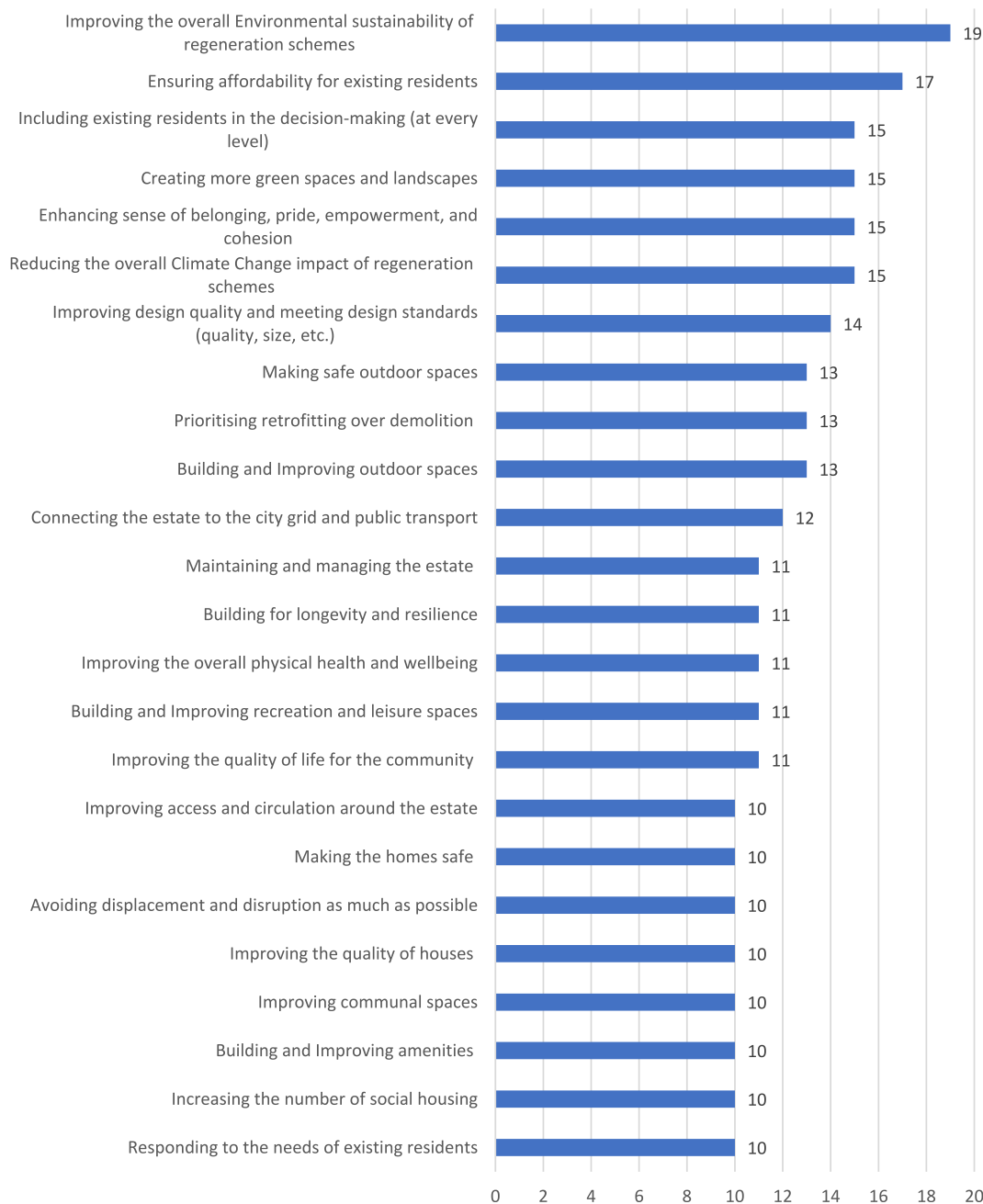

Fig. 4. Bart Chart for the most frequent answers (10+) from the coding of the qualitative data on stakeholders' priorities over the regeneration of the estates.
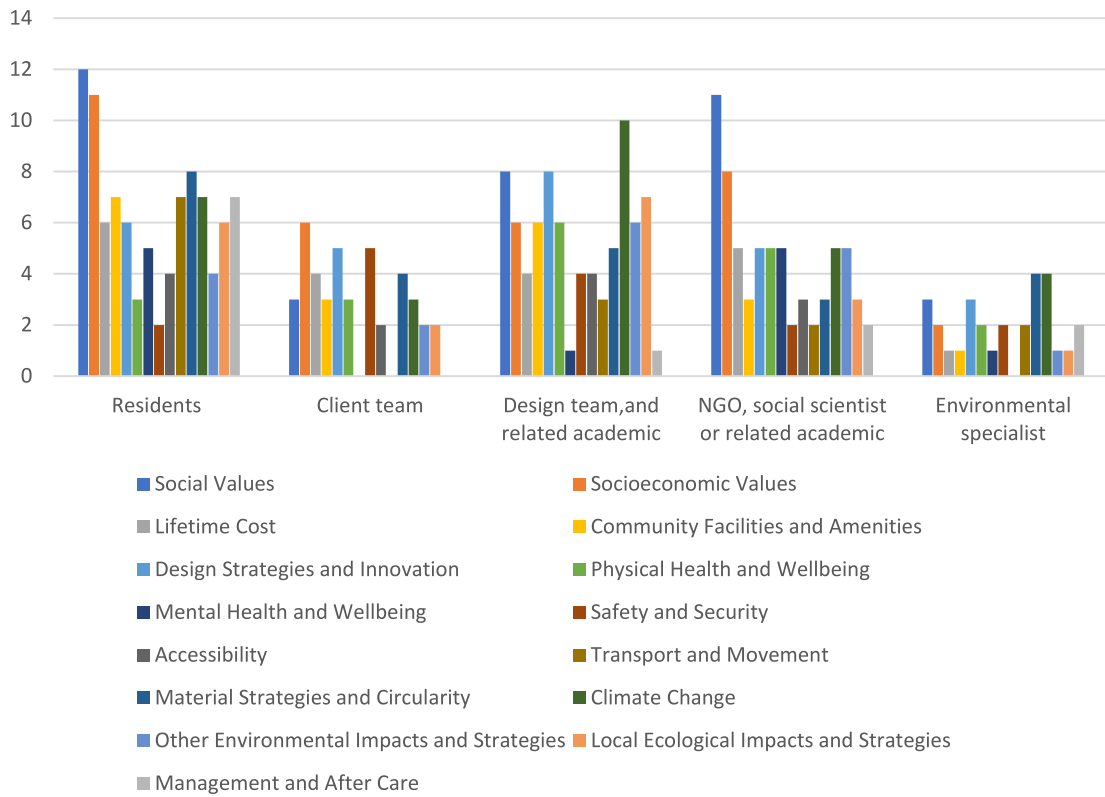
Fig. 5. Content analysis of the findings of the thematic analysis for regeneration priorities based on the coding of the qualitative survey data.
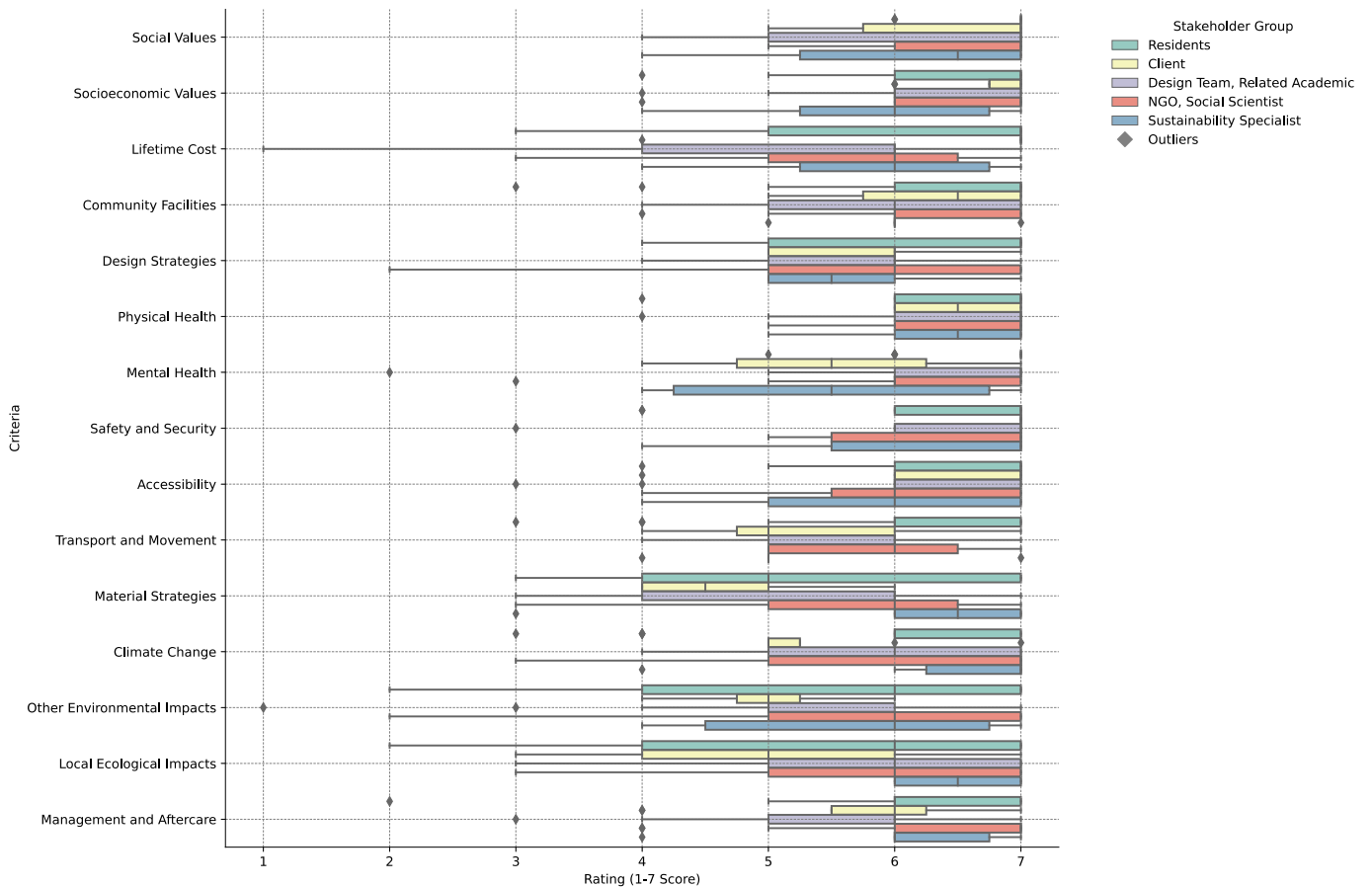

Fig. 6. Box plot diagram for the stakeholder groups' scoring of different sustainability criteria.

Table 9
Descriptive statistics of scoring of criteria (total results).

Criteria Total Results	Social Values	Socioeconomic Values	Lifetime Cost	Community Facilities and Amenities	Design and Innovation	Physical Health and Wellbeing	Mental Health and Wellbeing	Safety and Security	Accessibility	Transport and Movement	Material Strategies and Circularity	Climate Change	Other Environmental Impacts and Strategies	Local Ecological Impacts and Strategies	Management and Aftercare
N	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63
Mean	6.41	6.32	5.71	6.10	5.75	6.51	6.19	6.44	6.17	5.73	5.35	5.90	5.41	5.60	5.89
Std. Error of Mean	0.12	0.11	0.18	0.13	0.14	0.09	0.14	0.12	0.13	0.13	0.17	0.15	0.19	0.17	0.15
Std. Deviation	0.93	0.88	1.42	1.03	1.14	0.74	1.13	0.95	1.02	1.00	1.33	1.17	1.54	1.36	1.19

for *Local Ecological Impacts* ($p = 0.044$). No other statistically significant differences were reported between the responses of these stakeholder groups for the scoring of criteria. For more information on *T*-Tests, please refer to Appendix A.

Findings of the quantitative part of the survey in relation to stakeholders' regeneration priorities demonstrate that the high mean values suggest a general consensus on the perceived importance of all criteria among different groups. This is an important finding when considering the selection and weighting of indicators versus criteria for assessing the overall sustainability of different regeneration schemes.

4.3. Barriers to engagement

Barriers to engagement were previously explored through the review of literature and recruitment of participants in former studies by researchers. These identified barriers are presented in Table 2. To investigate the underlying barriers to full engagement with different stakeholder groups, the participants were first asked to rate the identified barriers. Through an open-ended question, the participants were then asked to discuss additional barriers. Rich qualitative data was collected which was coded and presented in the following sections.

4.3.1. Barriers to engagement – scoring (quantitative)

Upon examining the survey data regarding barriers to engagement within a sustainability assessment framework for regeneration schemes through descriptive statistical analysis, several inferences can be drawn. The results of the scoring of the barriers by different stakeholder groups have been presented as boxplots in Fig. 8. Table 10 summarises the perceived barriers to engagement within the sustainability assessment framework. It can be understood from the mean and median values that overall the most significant barriers, as perceived across all stakeholder groups, appear to be related to issues around the Framework. *Lack of a clear framework, Absence and lack of clarity of legislative requirements, Time-intensive process of conducting the assessments* with mean scores of 5.47, 5.37, and 5.32 respectively. These barriers are also reflected in the median values, indicating a central tendency towards these issues being predominant. The Independent Samples *t*-test revealed a statistically significant difference between the group means of the residents' group and the client group for *Lack of a Clear Framework* ($p = 0.015$), *Lack of Client Team Interest* ($p = 0.001$), *Lack of Design Team Interest* (p = 0.001); between the residents' group and design team for *Lack of Design Team Interest* ($p = 0.002$) and *High Cost of Conducting the Assessments* ($p = 0.023$); and between the residents' group and sustainability specialist for *Lack of Design Team Interest* ($p = 0.010$) (Appendix A). *Lack of community interest, Lack of design team interest,* and *Complexity of communicating the results with the stakeholders* are scored as the least areas of concern among the stakeholders. However, they also present higher standard errors of mean, suggesting less precision in responses.

These findings suggest that for effective stakeholder engagement, there needs to be a well-defined, clear, and time-efficient framework, supported by transparent legislative guidelines. This clarity is essential to identifying a framework for overcoming engagement obstacles and ensuring meaningful participation from all stakeholders.

For a clearer presentation of similarities and dissimilarities of the mean ratings of different stakeholder groups for the engagement barriers, these results are presented in Fig. 9. This diagram complements the previous finding to address the relative similarities of different stakeholder group responses and the differences to the client team and the sustainability specialists.

4.3.2. Other barriers to engagement – (qualitative)

The results of the collected data from the open-ended question to explore further engagement barriers were explored through coding and TA. The results of the TA are presented in Fig. 10. It is understood that the perceived barriers for the participants related to the non-participatory approaches towards engagement. The most noted barrier
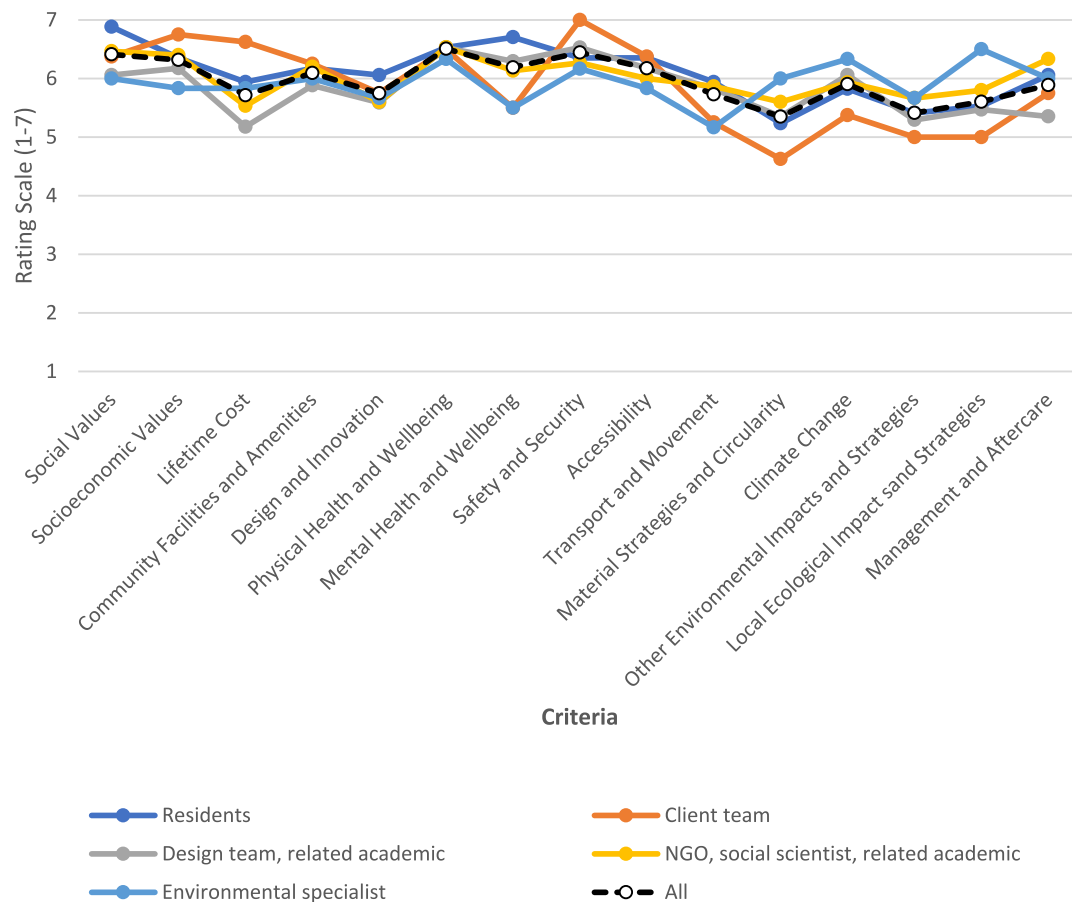
Fig. 7. Stakeholder Group Mean for scoring the importance of different criteria for a holistic sustainability assessment of estate regeneration schemes.

related to shallow engagement, what Arnstein relates to as Tokenism (Arnstein, 1969). This is followed by the lack of transparency over client incentives, and late engagement. These findings align with the previous findings on the lack of a clear framework or clearance in the legislative requirement for engagement.

The frustration in the lack of transparency in communicating the client's main incentives was noted by many of the respondents. Many of the participants from residents and NGO/social scientist groups expressed their perception of clients' main incentives being related to the increase of new housing units for profitability. These findings are aligned with the results of the TA for exploring the priorities of different stakeholder groups, where the participants from the client team stakeholder group had noted profitability and an increase in the number of affordable housing units as their main priorities. There were concerns over such decisions which could change the demographics of the estates.

Fig. 11 illustrates the distribution of responses among different stakeholder groups. As it has been noted in other findings of this research, the main dissimilarity of responses is between the client team group, followed by the environmental specialist group. Shallow engagement is the highest noted barrier among all stakeholder groups, except for clients.

4.4. Framework values

To explore the values and properties for a participatory holistic assessment framework to be used for the decision making on estate regeneration schemes a set of values from the review of literature and experience of the researchers of the study has been identified. These values are presented in Table 3. For this part of the survey, the participants were asked to score the identified values as their potential priorities for a holistic stakeholder-based assessment to be used for the

appraisal of estate regeneration schemes. The participants were later asked to include their further priorities for this holistic assessment framework in an open-ended question format.

4.4.1. Rating of values for a participatory holistic assessment framework – (quantitative)

The survey data reflects stakeholder priorities for a holistic assessment framework intended for the appraisal of estate regeneration schemes. Examining the results, it's apparent that certain priorities are uniformly held in high regard across all stakeholder groups, as shown by the means and medians of the scores provided illustrated in Figs. 12 and 13. Table 11 details the stakeholders' ratings of various values for a participatory holistic assessment framework. High scores for values such as *Being transparent* (mean 6.57, standard error 0.11), *Involving different stakeholder groups in decision making* (mean 6.44, standard error 0.10), *Including a diverse group of participants* (mean 6.29, standard error 0.12), and *Being easy to understand* (mean 6.22, standard error 0.13) underline the importance placed on transparency, inclusivity, and easiness. These values highlight the consensus on the necessity of clear and easy communication and inclusive processes.

The lowest mean scores with the highest standard errors and SD scores across all stakeholder groups are related to *Being compatible with other assessment approaches, Avoiding double counting of the impact criteria as much as possible,* and *Being scientifically robust.* This indicates a divergence in views on some practicalities and scientific robustness of the methodology.

In general, most priorities suggest that there is generally a good level of agreement among stakeholders on the importance of each priority, suggesting a strong consensus, especially on the importance of clarity and inclusivity. The perceived results are less harmonious around methodological robustness merits. Transparency, enabling EDI, and the
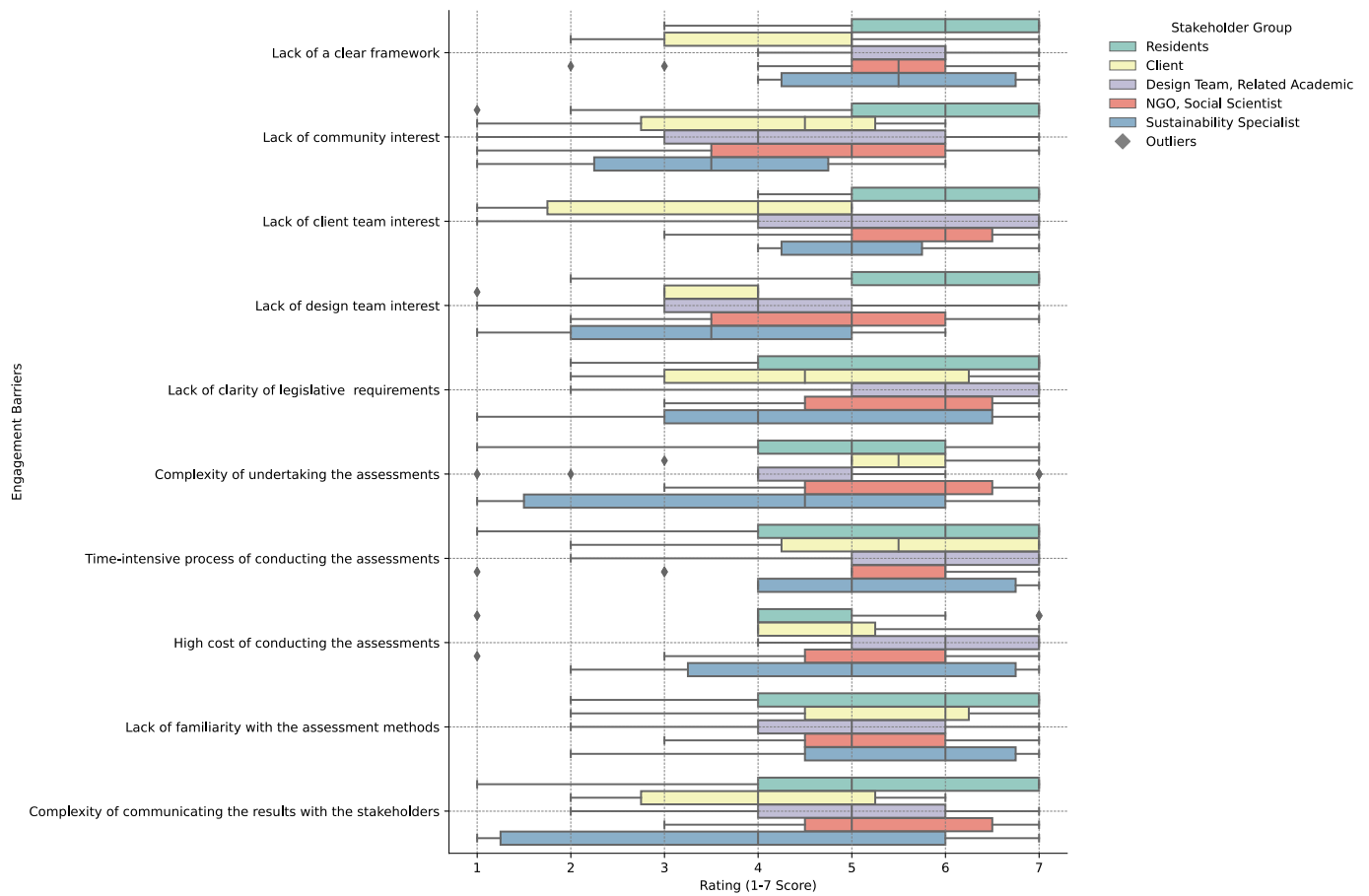
Fig. 8. Box plot diagram for the stakeholder groups' scoring of different barriers to engaging in a holistic participatory sustainability assessment framework for regeneration schemes.

Table 10
Descriptive statistics of scoring of engagement barriers (total results).

Engagement Barriers Total Results	Lack of a clear framework	Lack of community interest	Lack of client team interest	Lack of design team interest	Absence and lack of clarity of legislative requirements	Complexity of undertaking the assessments	Time-intensive process of conducting the assessments	High cost of conducting the assessments	Lack of familiarity with the assessment methods	Complexity of communicating the results with the stakeholders
Mean	5.47	4.52	5.16	4.45	5.32	5.02	5.37	5.10	5.29	4.83
Std. Error of Mean	0.18	0.25	0.20	0.22	0.21	0.21	0.20	0.19	0.19	0.22
Std. Deviation	1.39	1.98	1.61	1.72	1.67	1.68	1.62	1.47	1.53	1.71

relevance of impact criteria appear to be the participants' highest values for a holistic SAF.

The Independent Samples *t*-test revealed a statistically significant difference between the group means of the residents' group and the client group for *Being Easy to Understand* ($p = 0.022$), *Enabling the Participants to Develop their Knowledge of Different Topics of Discussion* ($p = 0.035$), *Avoiding Double Counting of the Impact Criteria as much as Possible* ($p = 0.028$), and *Being Compatible with other Assessment Approaches* ($p = 0.041$); between the residents' group and design team for *Involving Different Stakeholder Groups in Decision making* ($p = 0.034$) and *Including relevant Impact Criteria for Assessment* ($p = 0.036$); Between the residents' and NGO group for *Being Transparent* ($p = 0.043$); and between the residents' group and sustainability specialist for *Allowing Voices to be Heard Equally* ($p = 0.024$) and *Enabling the Participants to Develop their Knowledge of Different Topics of Discussion* ($p = 0.006$) (Appendix A).

4.4.2. Qualitative analysis of participants' other perceived values for a participatory holistic assessment framework

The findings of the TA for further explorations of the participants' priorities concerning a participatory holistic assessment framework for decision making of estate regeneration schemes are presented in Figs. 14 and 15.

While the counts for the added priorities in relation to the framework values are considerably lower to make a universal conclusion, these results somehow support and complement the previous findings on the importance of inclusivity and engagement with the communities. The need for knowledge mobility and advocacy was noted by 8 participants widely spread across stakeholder groups. Similarly, the inclusion of refurbishment scenarios and transparency and inclusivity were noted as some of the priorities, although they had already been included in the scoring section of the survey.
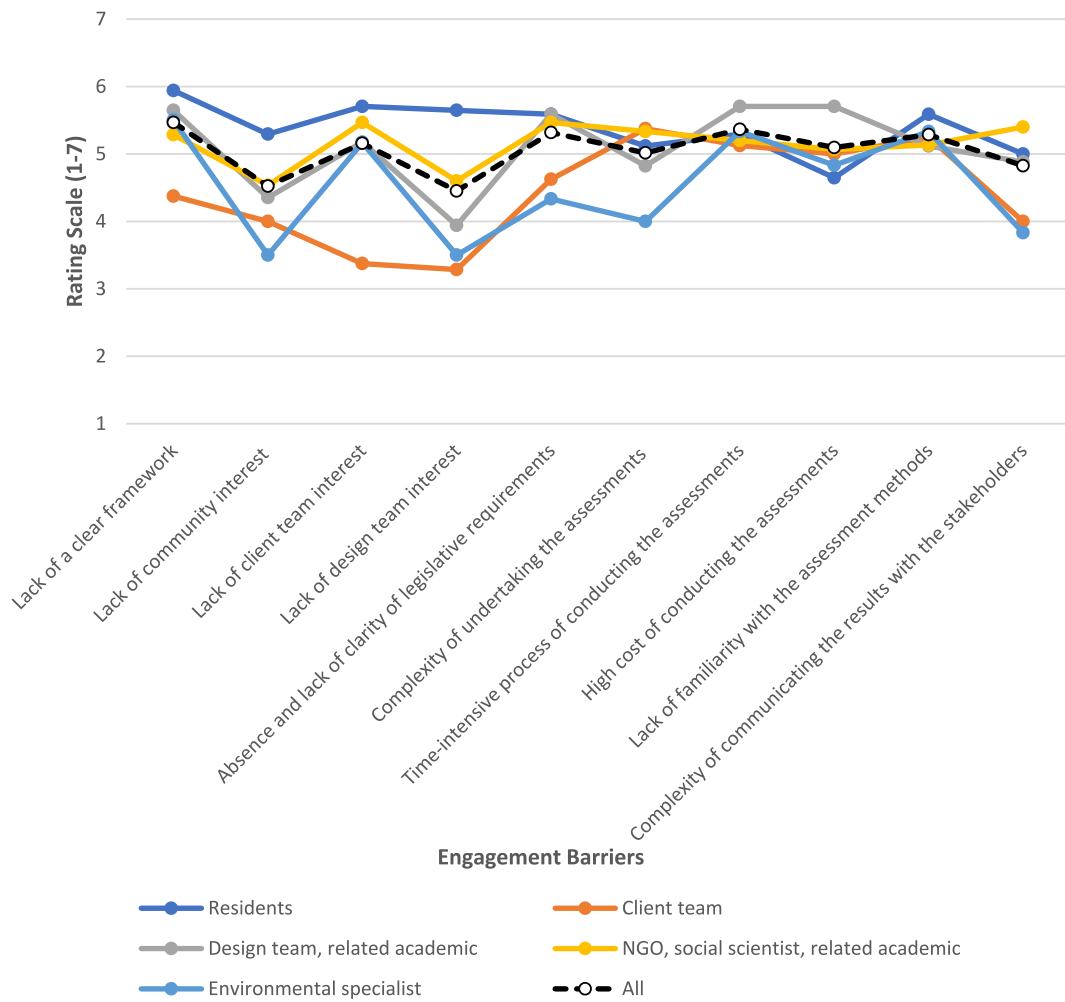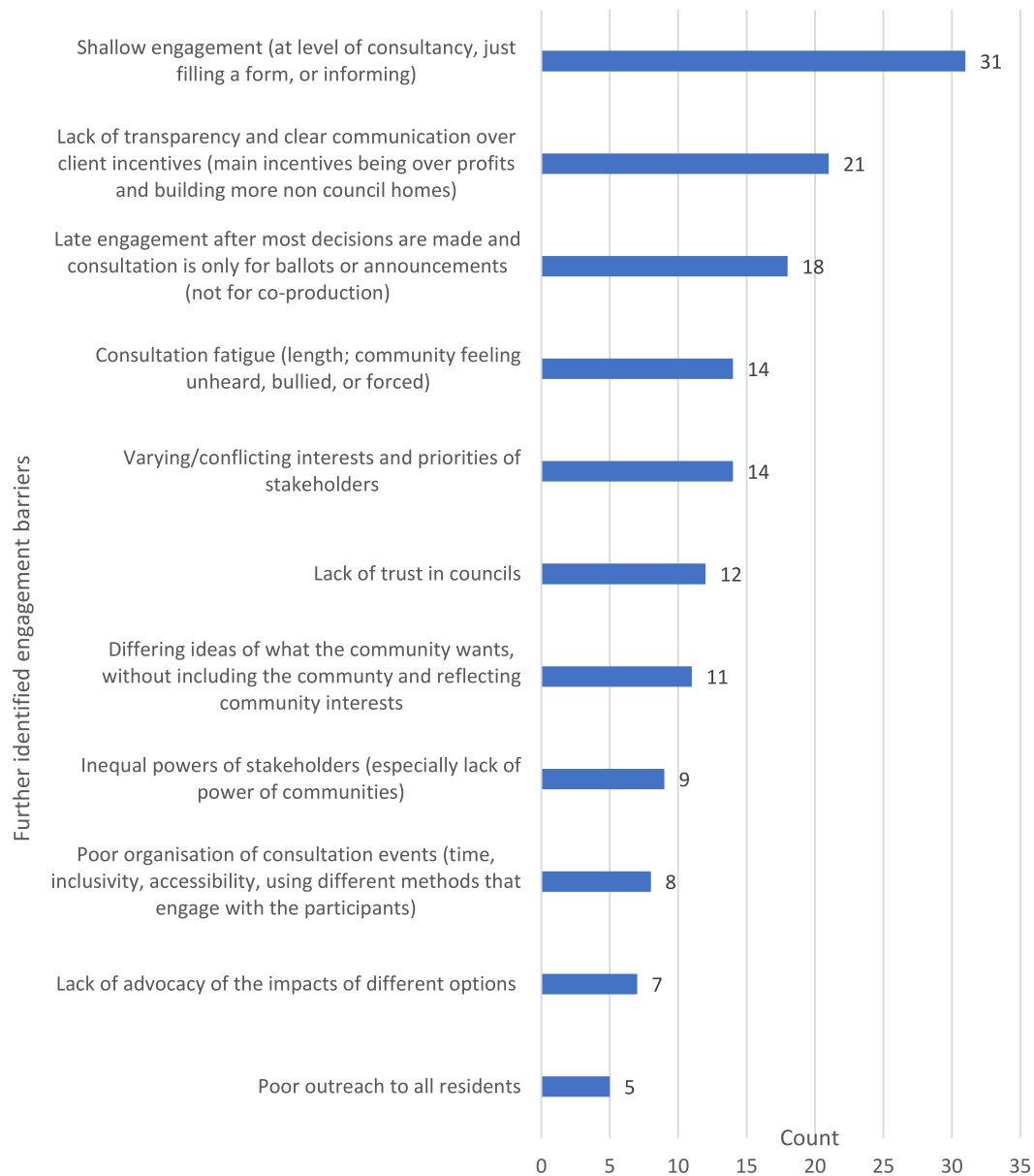
Fig. 9. Stakeholder Group Mean of rating for identified engagement barriers for a holistic participatory sustainability framework for estate regeneration schemes.

Fig. 10. Bar Chart of the most frequent answers (+5) from the coding of the qualitative data on stakeholders perceived further engagement barriers for a participatory holistic assessment of the estates' regeneration schemes.

4.5. Evaluating the existing SAFs

Fourteen of the sixty-three participants stated that they had been involved in different SAFs. Table 12 presents the spread of the participants with this involvement across different stakeholder groups.

The participants who expressed involvement with the SAFs were then asked about involvement with the most well-known sustainability rating and certification schemes in the industry. They were asked to score the effectiveness of BREEAM (BREEAM, 2024), LEED (LEED, 2024), HQM (HQM, 2024), and other frameworks against the previously identified and scored priorities. In the *Other* category the respondents added and rated WELL Certifications (Buildings and Communities) (WELL, 2024), PassivHaus (Passivhaus, 2024), TOM's Social Value Toolkit (TOMs, 2024), London Sustainable Development Framework

(London Sustainable Development Framework, 2024), fitwel (Fitwel, 2024), Living Building Challenge (Living Building Challenge, 2024), NABERS (NABERS, 2024), Green Star (Green Star, 2024), Estidama (Estidama, 2024), and other in-house frameworks. Table 13 presents a summary and description of the SAFs that were rated in this study.

The descriptive statistic results of the participants' inputs have been presented in Table 14 and Fig. 16. As the results demonstrate, the scores are relatively low among all stakeholder groups. Although the *Other* category score slightly higher than the most recognised frameworks, all frameworks present their lowest scores on inclusivity, transparency, and relevance of the impact criteria for assessment.

The relatively high standard errors for most measures indicate more variability in stakeholder perceptions. However, the results confirm the gap in transparency and engagement in the existing SAFs and the need
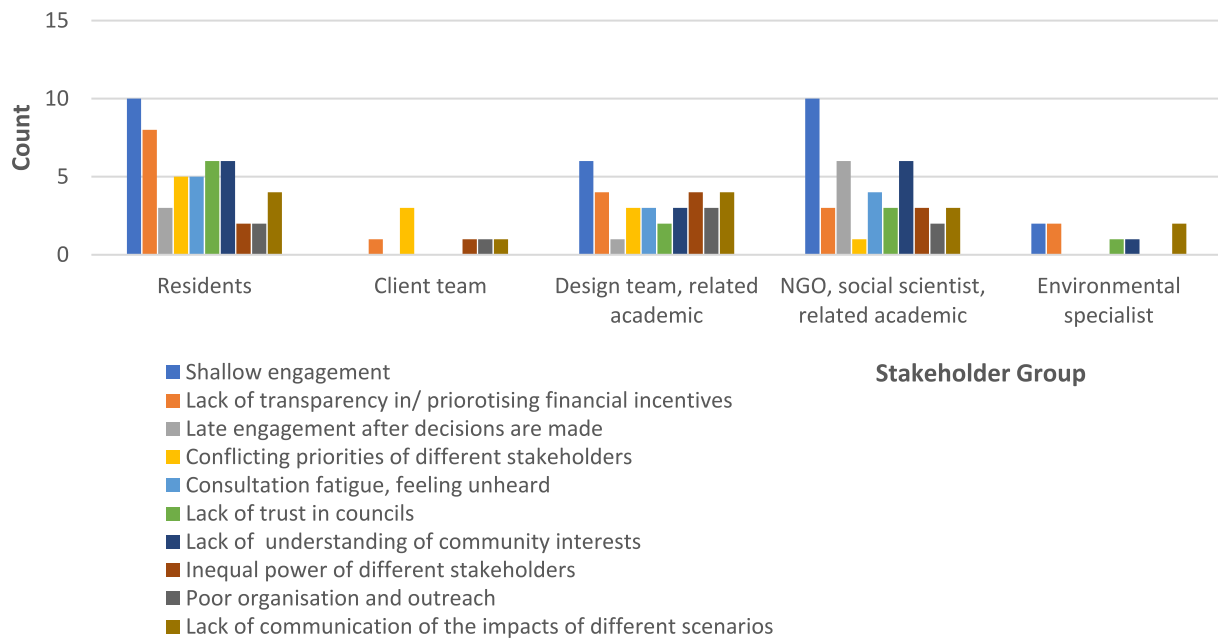
Fig. 11. Content analysis of the findings of the thematic analysis for other barriers to engagement based on the coding of the qualitative survey data.
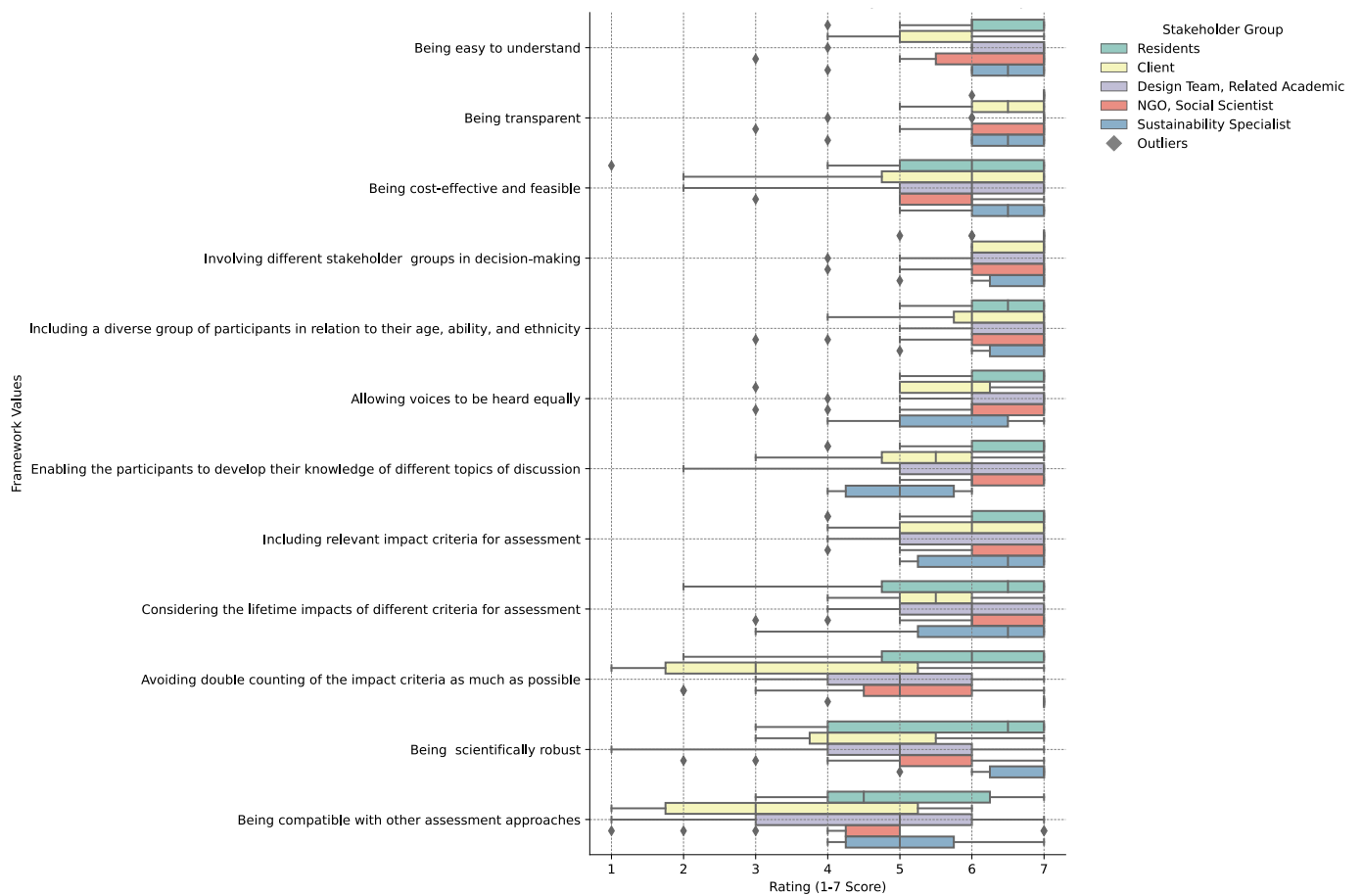

Fig. 12. Box plot diagram for the stakeholder groups' scoring of previously identified properties/values for a holistic participatory sustainability assessment framework for regeneration schemes.
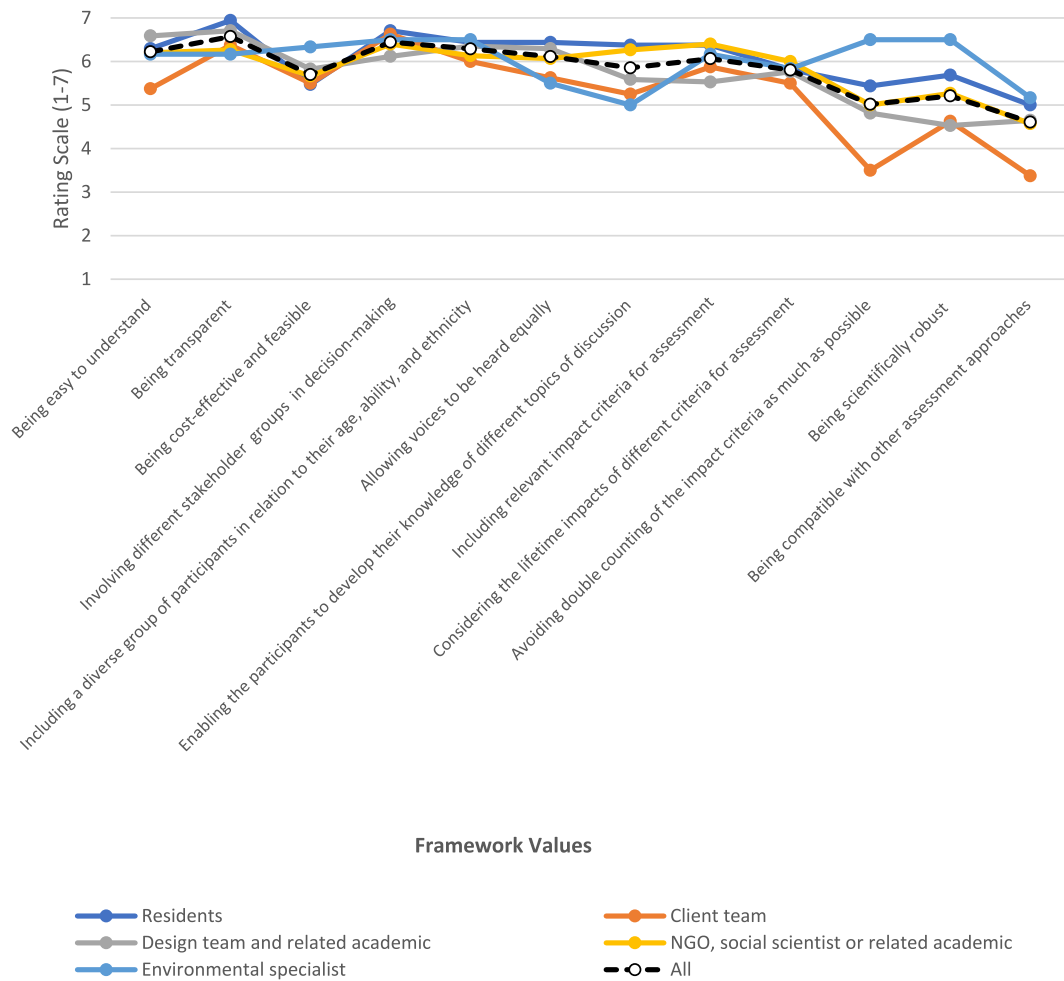
Fig. 13. Stakeholder Group Mean of rating for identified properties/values for a holistic SAF for estate regeneration schemes.

Table 11
Descriptive statistics of scoring of framework values (total results).

Framework Values Total Results	Being easy to understand	Being transparent	Being cost-effective and feasible	Involving different stakeholder groups in decision making	Including a diverse group of participants in relation to their age, ability, and ethnicity	Allowing voices to be heard equally	Enabling the participants to develop their knowledge of different topics of discussion	Including relevant impact criteria for assessment	Considering the lifetime impacts of different criteria for assessment	Avoiding double counting of the impact criteria as much as possible	Being scientifically robust	Being compatible with other assessment approaches
N	63	63	63	63	62	62	62	62	61	61	62	61
Mean	6.22	6.57	5.70	6.44	6.29	6.11	5.85	6.06	5.80	5.02	5.21	4.61
Std. Error of Mean	0.13	0.11	0.17	0.10	0.12	0.14	0.15	0.14	0.16	0.22	0.21	0.22
Std. Deviation	1.01	0.86	1.36	0.80	0.93	1.09	1.17	1.10	1.28	1.76	1.65	1.73

for more clarity and inclusivity for SAF to be used for decision making on estates' regeneration.

5. Discussions

5.1. Regeneration priorities

Results of the TA in relation to the stakeholder groups' priorities illustrate the differing priorities of the participants from different stakeholder groups. The resident groups were hugely concerned over inclusion in all aspects of decision making. The priorities of the client team were mostly related to costs and profitability, as well as resilience and safety, and had less interest in exploring different regeneration scenarios, improving the current condition of the estates, and reuse of materials and buildings. This contrasts with the priorities of the design team and NGO/social scientists which shared more interests with the resident group in social and socioeconomic values and in understanding and prioritising the community interests. The sustainability specialists while having their highest interests in Climate Change impacts and overall sustainability, shared more similarities with other stakeholder groups, except the client team group. It shall be noted that issues such as maintenance and refurbishment of the current state which were dominantly raised by the resident group can have a noticeable impact on any future scenario.

Triangulation of the results of the mixed methods survey questions in relation to regeneration priorities of different stakeholder groups highlights the importance of indicators as opposed to criteria. Identifying and exploring the priorities of different stakeholder groups in broad terms of criteria is a good tool for communication and summarising the results, and it can provide an overview of a broad range of criteria being included and discussed for assessment. However, the findings of TA illustrate the varying and sometimes contrasting priorities of different stakeholder groups. At the same time, the results of the descriptive statistical analysis demonstrate the relative consensus among different stakeholder groups on the perceived importance of different criteria.

These findings can indicate the need to focus on the selection of relevant indicators instead of criteria or the broader Social, Environmental, and Economic categorisation of indicators. In identifying the indicators for LCSA of estates, it needs to be noted that not all regeneration projects can be assessed through the same lens and metrics. While studies on participants from different study samples can contribute to bridging the gaps in knowledge for priorities of different stakeholder groups, identification and selection of indicators for assessment should be on a case-by-case basis.

5.2. Barriers to engagement

Findings of the quantitative scoring of the predetermined barriers to engagement highlight the importance of a lack of a clear framework, client interest, clear legislation and resource-intensive process of conducting a holistic participatory SAF, as the main perceived barriers by participants. The results of the TA reveal hidden barriers such as shallow engagement, lack of transparency in communicating the incentives, and late engagement as the consensus further barriers to engagement for a participatory framework. Most stakeholder groups share similar concerns, except for the client team and the sustainability specialist groups which have varied views to the other groups.

Integration of the results of the quantitative and qualitative part of the survey in exploring the stakeholders' perception of barriers to engagement for a holistic participatory SAF, reiterates some of the previously identified barriers, especially on framework, legislation, and familiarity regarding SAFs. The findings also highlight the importance of deep collaboration among the stakeholders, and support the need for this research.

The identified codes from the review and survey for engagement barriers can be divided to four sub-themes. This categorisation and
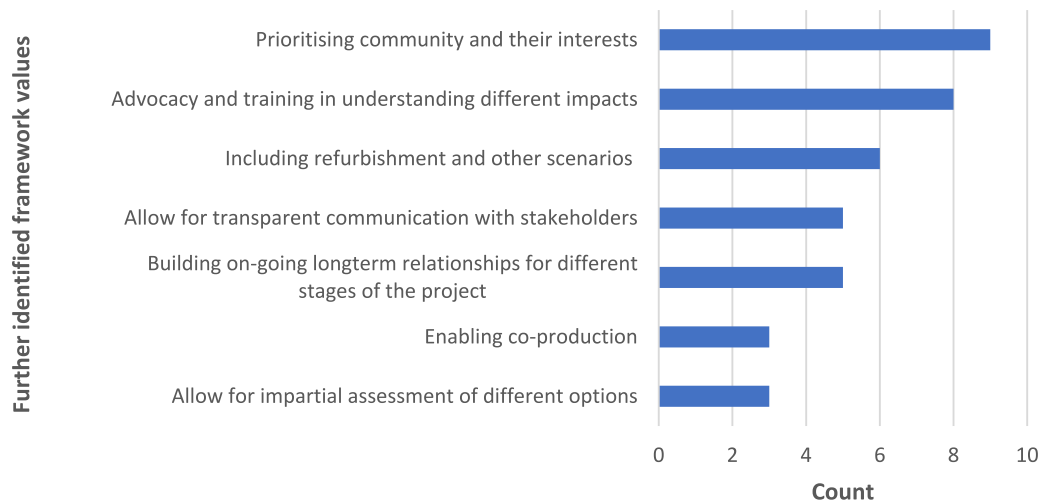
Fig. 14. Bar Chart of the most frequent answers (+3) from the coding of the qualitative data on stakeholders' perceived further values for a holistic SAF for estate regeneration schemes.
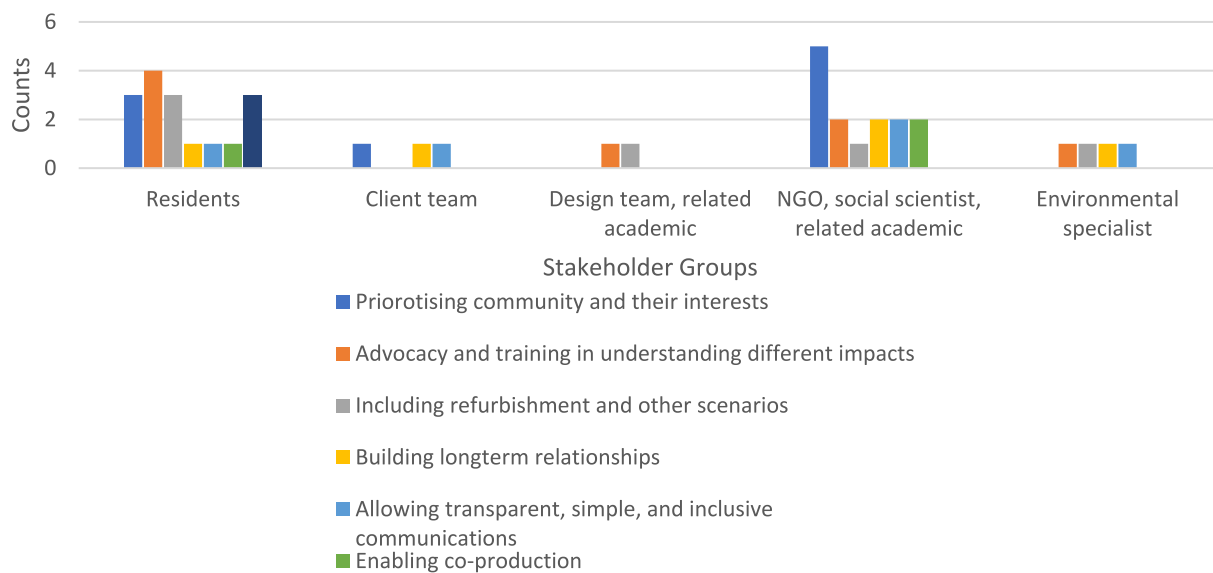

Fig. 15. Content analysis of the findings of the thematic analysis for other barriers to engagement based on the coding of the qualitative survey data.

Table 12
Involvement with sustainability assessment frameworks across different stakeholder groups.

	Stakeholder Group Description	Count
1	Residents of current, previous, and future occupant of a housing estate	1
2	Client team, Project manager, Planning authority, Local or central government	1
3	Architect, Designer, Engineer, Specialist consultant, Related Academic	8
4	Campaigner, Community Action Group, NGO, Social Scientist, Related Academic	1
5	Environmental sustainability specialist	3
	Total	14

comparison of the results of the thematic analysis of this study with the findings from the literature review is presented in Table 15. The blue cells present the newly identified codes from the survey. Comparison of Table 15 with Fig. 10 illustrates that *Shallow Engagement* and *Predetermined Decisions*, the two of the newly identified codes with the highest counts belong to *Institutional and Structural Barriers*. *Lack of Transparency* (from *Process and Communication Barriers*) also scores

among the highest rated barriers to engagement. Many of the new emerging codes belong to *Implementation Barriers* sub-theme. There are inter-relations between the codes related to engagement barriers. This interrelation shows that if a framework clearly enables participation and transparency, and if legislation enforces the application and implementation of such frameworks, the main identified gaps to engagement can be bridged.

5.3. Frameworks values

These results are consistent with the previous findings on the stakeholder priorities on regeneration and the participants' perceived engagement barriers. The importance of transparency and ethical issues related to EDI was unanimous with the lowest variance noted from the survey results. Findings to enable in-depth community engagement and knowledge advocacy support the previous findings and provide further evidence on the importance of these values for some of the participants spread across different stakeholder groups. Through mobilising different types of knowledge, better understanding of sustainability issues can be developed and awareness of local contextual issues can arise.

Table 13

Summary description of the rated SAFs.

SAF/Certification Scheme	Focus of the framework	No. of Responses
BREEAM	Different sustainability measures	14
LEED	Different sustainability measures	8
HQM	Different sustainability measures	3
(Other) WELL Certifications	Different sustainability measures	2
(Other) PassivHaus	Environmental sustainability	1
(Other) TOM's Social Value Toolkit	Social sustainability	1
(Other) London Sustainable Development Framework	Different sustainability measures	1
(Other) fitwel	Health and well-being impacts	1
(Other) Living Building Challenge	Different sustainability measures	1
(Other) NABERS	Energy efficiency performance	1
(Other) Green Star	Different sustainability measures	1
(Other) Estidama	Environmental Sustainability	1
(Other) In-house Frameworks	Different sustainability measures	2

The findings of this section of the survey provide evidence for the need and necessity of a framework to advocate for issues such as knowledge mobility, being transparent and easy to understand, allowing different stakeholders to engage, and allowing different voices to have equal values. These values can suggest that some of the identified gaps can be bridged by moving towards coproduction in decision making over the regeneration of the estates and that a suitable framework would be one that fully allows coproduction. The findings also support the need for clarity, easiness, and efficiency in the SAF.

The codes identified from the literature review and the survey can be categorised to three main sub-themes. This categorisation is presented in Table 16. The new emerging codes, presented in blue cells, all belong to *Ethical Properties* sub-theme. Comparison of Table 16 with Figs. 12–15 on the highest scores and counts of codes highlights the importance of ethical considerations for the stakeholders.

5.4. Evaluating the existing SAFs

Evaluation of the recognised SAFs and other tools used by the survey participants support and complement previous findings on the gaps in inclusivity and transparency. The pattern in the low scoring of the available frameworks on the relevance of the impact criteria for assessment, further confirms the necessity of this research and its findings on identifying the priorities of the stakeholders to be used as the sustainability indicators for assessment, and enabling inclusivity and opportunities for coproduction.

5.5. Policy and practical implications

The findings of this research can assist the researchers in developing a stakeholder-based LCSA/SAF for decision-making of HERS. The new framework can be a variation of the stages of Life Cycle Assessment (LCA) methodologies introduced by Klopffer and Grahl (2014) for assessing the lifetime environmental impacts of products and processes, while integrating engagement activities for in-depth consultation with the stakeholders. Knowledge attainment and exchange can be through the co-production workshops with the stakeholder, followed by setting goals and selection of indicators. Co-design can be integrated for developing the regeneration scenarios. The impact assessment can be conducted by specialists and the results can be discussed with the stakeholders. Through discussion of the assessment results and integration of MCDA, the stakeholders can have equal input to make informed decisions through a transparent process. A schematic diagram of existing lifecycle-based stages based on ISO 14040:1997/2006 (Klopffer and Grahl, 2014) and integration of engagement processes have been presented in Fig. 17 and Fig. 18. Integrating the participatory approaches into the LCA stages can address many of the stakeholders' perceived concerns over barriers and properties of a holistic assessment framework and enable a pathway towards a transparent and just decision-making over HERS.

5.6. Consolidation of the results

The consolidation of analyses reveals important interconnections between stakeholder priorities, engagement barriers, and framework values. The newly identified codes from both barriers and values analyses cluster predominantly around ethical considerations and institutional structures, suggesting these as fundamental areas for framework development.

The relationship between identified barriers and values is particularly noteworthy - where barriers highlight deficiencies in transparency and meaningful engagement, the framework values emphasise these same elements as essential properties. This alignment validates the identified gaps whilst pointing towards concrete solutions through framework design. The study's insights into the communication of client incentives and legislative clarity, suggest that clear policy directives could address these challenges. This aligns with the recommendations of previous studies, which call for frameworks that bridge legislative gaps and promote participatory approaches (Oliver et al., 2022).

The evaluation of existing SAFs further strengthens these findings, with current frameworks scoring lowest precisely in areas that stakeholders identify as most critical: transparency, meaningful engagement, and relevance of indicators. This triangulation of evidence through multiple analytical approaches reinforces the necessity for new methodological approaches to LCSA/SAF development for HERS to enable stakeholder engagement.

These consolidated findings suggest that advancing LCSA methodology requires careful attention to the interplay between institutional structures, stakeholder engagement processes, and framework properties. The emphasis on ethical considerations across all analytical themes indicates that frameworks must prioritise participatory processes and transparent communication to achieve their intended outcomes. This can be achieved through integration of participatory approaches into assessment frameworks. By addressing these gaps, this research affirms the potential of assessment methodologies to advance stakeholder-driven decision-making in estate regeneration. Incorporating ethical considerations and contextual adaptability within the framework can strengthen its applicability, ensuring the process reflects the lived realities of all involved.

6. Conclusion

This study offers a comprehensive analysis of stakeholder perspectives on their priorities, barriers and values for a participatory LCSA and SAF of HERS. The findings emphasise the need for frameworks that facilitate transparency, inclusivity, and adaptability to varying stakeholder needs, aligning with previous research on limitations of LCSA frameworks (Souza et al., 2015).

Lack of transparency of client incentives and legislation to inform a suitable holistic SAF, lack of deep engagement and ethical concerns are perceived as the barriers in participation and their presence to be the

Table 14

Descriptive Statistics for Evaluation of the existing SAFs.

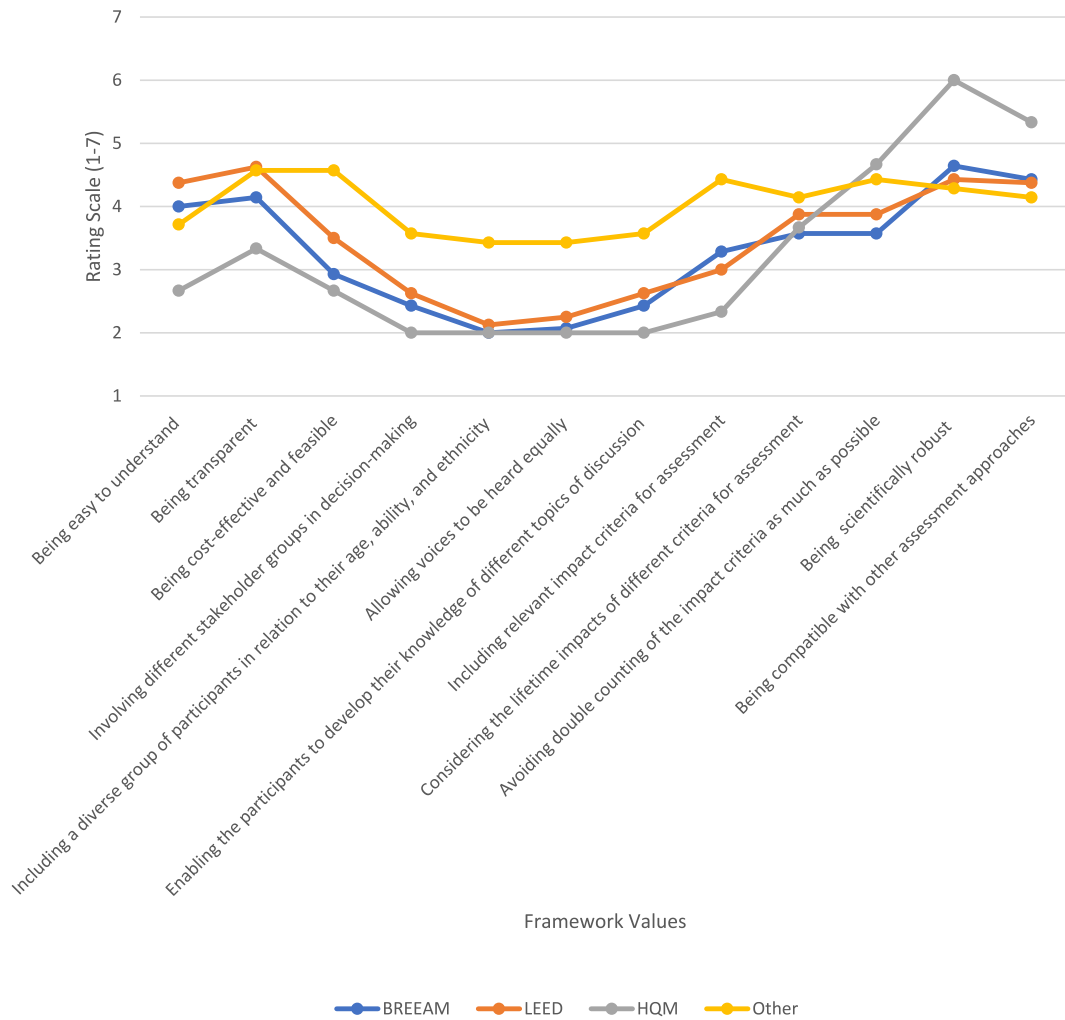| Evaluation Criteria SAF	Being easy to understand	Being transparent	Being cost-effective and feasible	Involving different stakeholder groups in decision making	Including a diverse group of participants in relation to their age, ability, and ethnicity	Allowing voices to be heard equally	Enabling the participants to develop their knowledge of different topics of discussion	Including relevant impact criteria for assessment	Considering the lifetime impacts of different criteria for assessment	Avoiding double counting of the impact criteria as much as possible	Being scientifically robust	Being compatible with other assessment approaches
BREEAM												
N	14	14	14	14	14	14	14	14	14	14	14	14
Mean	4.00	4.14	2.93	2.43	2.00	2.07	2.43	3.29	3.57	3.57	4.64	4.43
Median	4.00	4.00	3.00	2.00	1.00	2.00	2.00	3.00	4.00	4.00	5.50	5.00
Std. Error of Mean	0.41	0.46	0.35	0.40	0.38	0.34	0.45	0.44	0.54	0.50	0.56	0.45
Std. Deviation	1.52	1.70	1.33	1.50	1.41	1.27	1.70	1.64	2.03	1.87	2.10	1.70
LEED												
N	8	8	8	8	8	8	8	8	8	8	7	8
Mean	4.38	4.63	3.50	2.63	2.13	2.25	2.63	3.00	3.88	3.88	4.43	4.38
Median	5.00	5.00	3.50	2.50	2.00	2.00	3.00	3.50	4.00	4.00	4.00	3.50
Std. Error of Mean	0.46	0.63	0.33	0.56	0.40	0.37	0.38	0.53	0.69	0.79	0.75	0.71
Std. Deviation	1.30	1.77	0.93	1.60	1.13	1.04	1.06	1.51	1.96	2.23	1.99	2.00
HQM												
N	3	3	3	3	3	3	3	3	3	3	3	3
Mean	2.67	3.33	2.67	2.00	2.00	2.00	2.00	2.33	3.67	4.67	6.00	5.33
Median	1.00	3.00	2.00	1.00	1.00	1.00	1.00	2.00	3.00	6.00	7.00	7.00
Std. Error of Mean	1.67	1.45	1.20	1.00	1.00	1.00	1.00	0.88	1.20	1.86	1.00	1.67
Std. Deviation	2.89	2.52	2.08	1.73	1.73	1.73	1.73	1.53	2.08	3.21	1.73	2.89
Other												
N	7	7	7	7	7	7	7	7	7	7	7	7
Mean	3.71	4.57	4.57	3.57	3.43	3.43	3.57	4.43	4.14	4.43	4.29	4.14
Median	4.00	5.00	4.00	3.00	3.00	3.00	4.00	4.00	5.00	5.00	4.00	4.00
Std. Error of Mean	0.57	0.69	0.72	0.75	0.81	0.81	0.65	0.65	0.63	0.69	0.75	0.34
Std. Deviation	1.50	1.81	1.90	1.99	2.15	2.15	1.72	1.72	1.68	1.81	1.98	0.90

Fig. 16. Stakeholders Rating of Different Sustainability Assessment Frameworks.

Table 15
Comparison of the thematic analysis results for engagement barriers with findings from literature. Blue cells in the table present the newly identified codes from the survey.

Theme	Sub-theme	Identified Code
Barriers to Engagement	**Process and Communication Barriers**	Complexity of communicating the results with the stakeholders
		Need for tangible and accessible materials
		Lack of transparency from clients/councils
	Behavioural Barriers	Lack of community interest
		Lack of client team interest
		Lack of design team interest
		Shallow levels of involvement
		Frustration with feeling unheard
		Lack of trust in clients' incentives
		Unequal power
	Institutional and Structural Barriers	Lack of a clear framework
		Absence and lack of clarity of legislative requirements
		Shallow engagement
		Pre-determined decisions/late engagement
	Implementation Barriers	Time-intensive process of conducting the assessments
		High cost of conducting the assessments
		Complexity of undertaking the assessments
		Lack of familiarity with the assessment frameworks
		Divergent priorities among stakeholders
		Differing ideas of what the community wants
		Poor organisation of engagement activities
		Lack of advocacy of the impacts of different options
		Poor outreach

Table 16
Comparison of the thematic analysis results for framework properties with findings from literature. Blue cells in the table present the newly identified codes from the survey.

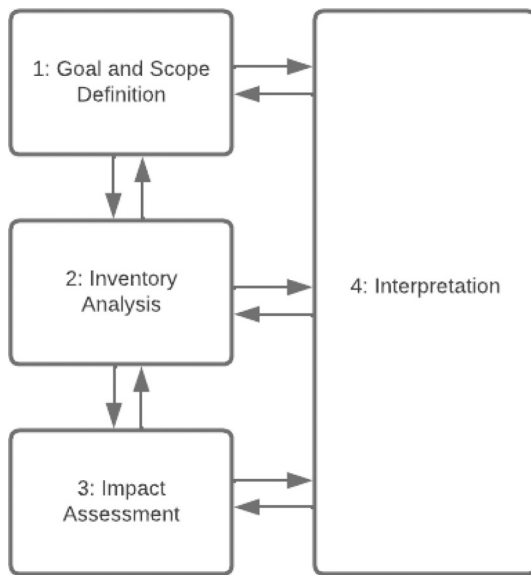| Theme	Sub-theme	Identified Code
Framework Values	**Methodological Properties**	Being transparent
		Being scientifically robust
		Considering the lifetime impacts of different criteria for assessment
		Avoiding double counting of impact criteria as much as possible
		Being compatible with other assessment approaches
	Ethical Properties	Being easy to understand
		Allowing voices to be heard equally
		Including a diverse group of participants in relation to their age, ability, and ethnicity
		Involving different stakeholder groups (including the community) in decision-making
		Including relevant impact criteria for assessment, related to stakeholders' needs
		Prioritising community and their interests
		Including refurbishment and other scenarios/Allow for impartial assessment of different options
		Allow for transparent communication with stakeholders
	Practical Properties	Being cost-effective and feasible
		Enabling the participants to develop their knowledge of different topics of discussion

Fig. 17. Reproduction of 4 stages of LCA framework based on ISO 14040:1997/2006 (Klopffer and Grahl, 2014).
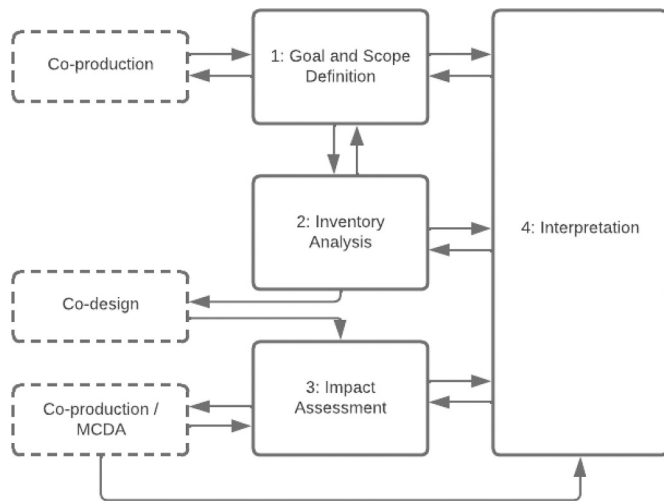

Fig. 18. Potential integration of participatory approaches into LCA stages. The dotted rectangles represent the proposed participatory approaches.

stakeholder-driven decision-making for HERS.

Overall, the findings of this mixed-methods study have been consistent in supporting the need for this research to encourage holistic stakeholder engagement at all stages of the decision-making processes, ensure transparency, advocate knowledge mobility, and facilitate coproduction in decision making over the regeneration of estates. By doing so, a holistic participatory SAF enables more collaborative, equitable, and sustainable estate regeneration practices, and allow for better understanding different types of knowledge to be mobilised. The findings can assist the researchers in developing a stakeholder-based LCSA/SAF for decision-making of HERS. The new framework can be a variation of the stages of LCA methodologies introduced by Klopffer and Grahl (2014), while integrating engagement activities for in-depth consultation with the stakeholders.

While the findings of this novel study assist researchers in developing a relevant and holistic participatory approach to sustainability assessment of HERS, the sample of this study was limited to participants in the UK. In addition, the categorisation of the stakeholder groups was not developed further to include demographics within each group, especially for residents that can comprise of different tenancy and lease types with varied priorities. We recommend future research to consider the viewpoints of different demographics within stakeholder groups and to explore study samples outside of the UK. Future research should also scrutinise how to address the identified implementation barriers and test the findings of this study on a multistakeholder LCSA/SAF framework for decision-making of HERS.

Data statement

Supplementary data related to this paper are available upon request. To access these resources, interested researchers are encouraged to contact Sahar Nava (s.nava@ucl.ac.uk). The provision of these data is subject to the relevant data protection regulations and institutional policies. We are committed to facilitating the sharing of our research data to advance the field, while ensuring the privacy and ethical considerations are fully met.

Declaration of competing interest

The authors wish to confirm that there are no known conflicts of interest associated with this publication.

Data availability

The data that has been used is confidential.

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values for a holistic participatory LCSA/SAF. The importance of institutional, behavioural, process, and implementation barriers have been explored and their interconnection with methodological, ethical, and practical values have been discussed. The results underline the necessity for a participatory approach that is inclusive, transparent, easy, and efficient, and supports the need for coproduction in decision-making over the regeneration of estates. The evaluation of existing sustainability assessment frameworks is consistent with previous findings in highlighting the gaps in inclusivity, equitability, and relevance of available SAFs. This research contributes significantly to understanding the role of ethical considerations and institutional barriers in

Appendix A. The results of the Independent Samples *T*-Tests have been interpreted as below

1. **Levene's Test for Equality of Variances**: If the *p*-value (Sig.) > 0.05, equal variances are assumed; if the p-value <0.05, equal variances are not assumed.
2. **_t_-test Results**: If the 2-sided $p < 0.05$, there are statistically significant differences between the groups' means.

Indicator		Levene's Test for Equality of Variances	t-test for Equality of Means	— —
		Sig.	Two-Sided p	
Independent Samples Test (Scoring of Sustainability Criteria - Residents and Client Group)				
	Equal variances assumed	0.006	0.002	
Mental Health and Wellbeing	Equal variances not assumed		0.025	
	Equal variances assumed	0.002	0.082	
Safety and Security	Equal variances not assumed		0.017	
Independent Samples Test (Scoring of Sustainability Criteria - Residents and Design Team)				
	Equal variances assumed	0.000	0.013	
Social Values	Equal variances not assumed		0.017	
Independent Samples Test (Scoring of Sustainability Criteria - Residents and Social Scientists/NGO/Community Group)				
	Equal variances assumed	0.000	0.026	
Social Values	Equal variances not assumed		0.035	
Independent Samples Test (Scoring of Sustainability Criteria - Residents and Sustainability Specialist)				
	Equal variances assumed	0.003	0.171	
Local Ecological Impact sand Strategies	Equal variances not assumed		0.044	
Independent Samples Test (Scoring of Engagement Barriers - Residents and Client Group)				
	Equal variances assumed	0.448	0.015	
Lack of a clear framework	Equal variances not assumed		0.033	
	Equal variances assumed	0.101	0.001	
Lack of client team interest	Equal variances not assumed		0.007	
	Equal variances assumed	0.392	0.001	
Lack of design team interest	Equal variances not assumed		0.001	
Independent Samples Test (Scoring of Engagement Barriers - Residents and Design Team)				
	Equal variances assumed	0.771	0.002	
Lack of design team interest	Equal variances not assumed		0.002	
	Equal variances assumed	0.796	0.023	
High cost of conducting the assessments	Equal variances not assumed		0.023	
Independent Samples Test (Scoring of Engagement Barriers - Residents and Sustainability Specialist)				
	Equal variances assumed	0.059	0.010	
Lack of design team interest	Equal variances not assumed		0.053	
Independent Samples Test (Scoring of Framework Values - Residents and Client Group)				
	Equal variances assumed	0.802	0.022	
Being easy to understand	Equal variances not assumed		0.033	
Enabling the participants to develop their knowledge of different topics of discussion	Equal variances assumed	0.625	0.035	
	Equal variances not assumed		0.054	
	Equal variances assumed	0.115	0.028	
Avoiding double counting of the impact criteria as much as possible	Equal variances not assumed		0.060	s
	Equal variances assumed	0.294	0.041	
Being compatible with other assessment approaches	Equal variances not assumed		0.075	
Independent Samples Test (Scoring of Framework Values - Residents and Design Team)				
	Equal variances assumed	0.091	0.034	
Involving different stakeholder groups in decision-making	Equal variances not assumed		0.036	
	Equal variances assumed	0.560	0.036	
Including relevant impact criteria for assessment	Equal variances not assumed		0.036	
Independent Samples Test (Scoring of Framework Values - Residents and Social Scientists//NGO/Community Group)				
	Equal variances assumed	0.000	0.026	
Being transparent	Equal variances not assumed		0.043	
Independent Samples Test (Scoring of Framework Values - Residents and Sustainability Specialist)				
	Equal variances assumed	0.155	0.049	
Allowing voices to be heard equally	Equal variances not assumed		0.128	
Enabling the participants to develop their knowledge of different topics of discussion	Equal variances assumed	0.512	0.012	
	Equal variances not assumed		0.012	

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