Neighbourhood Sustainability Frameworks - A Literature Review

Frameworks for assessing the sustainability of the built environment with a focus at the neighbourhood level

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Contents

Abstract

Frameworks for assessing the sustainability of the built environment are entering a new phase with the introduction of neighbourhood scale tools. This paper is a review of the current literature on these frameworks, as well as building-scale tools, to provide a milestone for future studies. Notably, the author found few papers focusing on neighbourhood schemes exclusively with large gaps in our knowledge. Some existing research compares and critiques the content of frameworks; other research focuses on the interaction between a framework and the development process, its actors, and institutions; and other work assesses the real-world performance of developments built using frameworks. Neighbourhood frameworks provide a more holistic approach to sustainable development than building frameworks, covering environmental, social, and economic sustainability. However, there is little consensus on what this means (or should mean) in practice with coverage varying with regional context and design principles, as well as accusations of environmental bias. The evidence that frameworks influence the sustainability of individual projects is mixed (with some criteria more affected than others) though it is thought they have pushed up the standards of sustainability generally. Likewise it is uncertain whether they promote sustainability as a value amongst users. However, they are useful for those committed to sustainability to show their credentials and defend their decisions. As the tools are voluntary and market-based, it is important they provide additional value to developments; this has been shown to be the case. This impact is greater for those already interested in sustainability or looking to promote a 'green' image. This literature review identifies several gaps in the research of Neighbourhood Sustainability Frameworks, these include: their effect on the development process and planning, barriers to their uptake, and improvements to frameworks and the way they are used.

Key words: neighbourhood-scale, sustainable development, frameworks, literature review

1. Introduction

Sustainable neighbourhoods are viewed by some as essential parts of a sustainable city (Sharifi & Murayama 2013a). Indeed, as Jacobs states: 'a sustainable way of living should effortlessly derive from the way we design our neighbourhoods' (Jacobs, 1961). Therefore, understanding the design of community scale developments is important in moving towards more sustainable cities. One way of achieving this is through the use of sustainable building assessment tools, or frameworks.

This paper is a review of the current research on these frameworks. The intention is to identify research gaps to help guide future studies. There is a focus on neighbourhood level tools, though building level frameworks have also been discussed due to the comparatively large amount of research on the topic and frequent overlap of issues. This review is part of an on-going study, and will be updated in subsequent papers.

Three categories emerge from the literature: new frameworks or methods; comparisons or critiques of current frameworks, usually analysis of the details of a framework (the scope, credit weightings, etc.); and application of frameworks, analysing the effects of a framework on 'real world' processes (the effect on planning for example). This paper focuses on the two latter parts, and these are looked at separately in the following sections (3, and 4 respectively).

1.1 Frameworks

The leading sustainable building assessment tools, or frameworks, have been developed by national green building councils (GBC), or similar organisations such as the Building Research Establishment (BRE). The first frameworks were designed for individual buildings (Cole & Larsson 1997) and focused on environmental sustainability (Goh & Rowlinson 2013). However, some argue that due to the complex nature of sustainability complex nature, 'building centric' frameworks cannot adequately describe sustainable development (Spinks 2013; Conte & Monno 2012). Perhaps due to this, there is now a move towards neighbourhood scale assessments, and a more holistic approach to sustainability (Haapio 2012). Most leading building level tools now have a companion neighbourhood level tool. Table 1 provides a summary of neighbourhood assessment tools covered in this review (with the exception of Green Townships, for which no literature could be found). It should be noted that the majority of research into BREEAM Communities is based on the previous (2008) version, which has since been superseded by a 2012 issue.

Most frameworks are voluntary (though some are now mandatory in places through incorporation into local/national planning systems) and provide a market-based solution to sustainable development (as opposed to traditional measures such as national standards or local planning regulations).

The frameworks below, though designed in a national context, have been exported internationally, with various approaches used in adapting them to different contexts. There are a number of frameworks developed for use in specific national contexts not covered by this review, such as for Jordan (Ali & Al Nsairat 2009), Egypt (Nassar 2011), and Sri Lanka (Chandratilake & Dias 2013).

1.2 Methods

The author has acquired information from approximately 80 sources, including academic papers, articles, and other professional publications. A sub-set of approximately 40 of these were then reviewed in greater detail.

Framework	Organisation	Country	Latest Publication Year
BREEAM (Communities)	Building Research Establishment	United Kingdom	2012
LEED(-ND)	US Green Building Council	United States	2009
CASBEE(-UD)	Japan Green Building Council, Japan Sustainable Building Consortium	Japan	2007
DGNB(-NSQ)	German Sustainable Building Council	Germany	2013
Green Star (Communities)	Australian Green Building Council	Australia	2012
Green Townships	Indian Green Building Council	India	2013
HQE2R	European Commission	European Union (France)	2004
EcoCity	European Commission	European Union	2005
EarthCraft Communities	EarthCraft, Greater Atlanta Home Builders Association, Southface	United States	2013

Table 1 Summary of Frameworks

2. Definitions

Different terms are used interchangeably by different authors. The following will be used throughout this review.

2.1 Framework

Alternatively known as an 'environmental assessment method', or 'sustainability assessment tool' (Sharifi & Murayama 2013a) a framework is a tool designed to assess and guide sustainable building developments.

Framework 'level' is defined as the scale at which it is designed to be implemented, for example, at the individual building level. Unless stated otherwise, a framework will refer to a neighbourhood level tool in this paper.

2.2 Sustainability

While there is no agreed definition of sustainability or sustainable development (Sharifi & Murayama 2013a; Berardi 2013; Spinks 2013), it is often described in terms of the three pillars of

sustainability: society, economics, and the environment. Thus, a sustainable development would be one that improved (or at least did not diminish) any one of these pillars.

A fourth 'pillar' covering the institutional or governance dimension is also suggested by some authors (Hamedani & Huber 2012; Sharifi & Murayama 2013a). This includes how institutions affect the development, as well as criteria such as 'governance, decentralisation, legal frameworks and instruments, information systems, and research and education to institutionalise sustainable development' (Sharifi & Murayama 2013a p. 76).

i) Sustainability Coverage

The breadth and depth of sustainability topics covered in a framework. As there is no defined limit as to what could or should be covered, it is subjective.

2.3 **Themes**

Sharifi (2013) describes themes as 'broad topics of concern to sustainability', for instance, energy and resource use.

They are also referred to as 'issues' (Lee 2013),' categories' (BREEAM Communities Manual), and 'domains' (Chandratilake & Dias 2013).

2.4 **Criteria**

Criteria are technical concepts; 'parameters used to evaluate the contribution of a project to meet the required objective' (Sharifi, 2013), for instance, carbon emissions reduction.

These are also referred to as 'categories' (Lee 2013), and 'sectors' (Chandratilake & Dias 2013).

2.5 **Indicators**

Indicators are individual credit-scoring 'variables that provide specific measurements' (Sharifi, 2013).They are targets for which credits are awarded if they are met. For instance a requirement to reduce carbon emissions by 10% will be rewarded with x credits.

These are also referred to as 'criteria' or 'sub-criteria' (Lee 2013).

3. **Comparing and Critiquing the Frameworks**

A significant amount of research either compares frameworks (to one another or to some ideal of sustainability), or attempts to understand and critique their details. This section will review these types of study.

These studies vary in purpose, though, in general, it is suggested that understanding how schemes compare will allow for more transparency and credibility (Lee, 2013), address their inherent subjectivity, and identify their strengths and weaknesses. While many studies are largely descriptive, (e.g., Eberl, 2007; Haapio, 2012; Hamedani, 2012) some undertake limited analysis of the effects of, or reasoning behind, these physical characteristics (e.g., Chandratilake, 2013).

3.1 **Comparability**

The frameworks tend to be organised in different ways making analysis of scope difficult, indeed Haapio and Viitaniemi (2008) note that the complexity of frameworks and their different structures may even make them impossible to compare. For instance BREEAM Communities has five themes (with three 'sub-themes', while LEED-ND has three themes (Kyrkou, 2011), and DGNB-NSQ has five (Hamedani & Huber 2012). Likewise, criteria within themes are described and grouped differently.

Possibly because of this variation, papers often use theoretical benchmarks of ideal sustainability to compare frameworks. However, these also vary from paper to paper. In particular, sustainability

coverage is often compared to a set of themes provided by the author: Luederitz (2013) developed nine principles for 'sustainable urban neighbourhood development'; Lee (2013) uses ten; Hamedani (2013) identifies eight criteria in his comparison; Haapio (2012) and Chandratilake (2013) use seven, though these do not correspond. This makes reviewing their results problematic as studies may not be comparing them on the same terms. The author consider that an agreed standard of comparison could aid research in this area, though it may also hinder innovation and debate.

3.2 **Sustainability Coverage**

A framework's coverage is determined by what themes or criteria are included, and to what level of detail. Through comparison, research seeks to judge if a framework's coverage is sufficiently broad and deep, and comparable to other frameworks and general concepts of sustainability.

i) Themes and criteria

There are themes that are covered in the majority of frameworks at a building and neighbourhood level (Lee 2013): site selection, indoor environment, energy and resources, water, materials (though site selection is not directly covered in BREEAM Communities and is considered a different part of the lifecycle) (personal communication, Buchanan, C., 15th March 2014). However, there are also significant differences (Sharifi & Murayama 2013b). Due to the difficultly in comparing analysis methods of authors (as mentioned above) a number of examples are shown below in Tables 2 and 3, covering building-scale and neighbourhood-scale tools respectively. Comparing these two tables shows that neighbourhood-scale tools seem to have a wider coverage than building-scale frameworks, including more social and economic issues.

It is generally considered that there is good consensus on the scope of both building and neighbourhood frameworks (Sharifi & Murayama 2013a; Lee 2013). As one might expect, in a study of building level frameworks, Lee (2013) found a high correlation between the coverage by a framework and the number of (sub)criteria in that framework.

System	Weightage (%)						
	Site (1)	Energy (2)	Water (3)	Materials (4)	IEQ (5)	O & M (6)	Other
BREEAM	15%	25%	05%	10%	15%	15%	15%
CASBEE	15%	20%	02%	13%	20%	15%	15%
Green globes	11.5%	36%	10%	10%	20%		12.5%
LEED	20%	25%	07%	19%	22%		07%

Table 2 Comparison of Building-level rating systems using WBDG principles (Chandratilake 2013 Table 1)

Despite this consensus, most literature considers the coverage lacking in various aspects. Interviews of construction professionals by Goh found 'mixed responses' on the 'sufficiency of scope' of building level assessments (Goh & Rowlinson 2013). And none of the building level frameworks assess social and economic aspects (Lee 2013; Goh & Rowlinson 2013; Schweber 2013).This has led to criticism of these frameworks for: ignoring the holistic, systemic nature of sustainability and focusing on 'eco-technical' solutions (technical fixes to environmental problems) (Conte & Monno 2012); and contributing to the gap between 'UK policy discourse which... encompasses issues of social sustainability and governance; and... indicators and policy mechanisms, which tend to privilege environmental dimensions' (Lovell, 2008; Russell & Thomson, 2009; Rydin, 2007b via Schweber 2013, p. 135).

Motivated by these criticisms, many studies point out missing criteria that would improve the coverage of frameworks, if included. Some of the more common or interesting ideas identified by the author are summarised in the paragraphs below to inform potential future research.

Sharifi and Murayama (2013b) specify the differences between neighbourhood frameworks (LEED-ND, BREEAM Communities, and CASBEE-UD) based on exemplary case studies and suggest where they could learn from each other. For instance, they suggest some additional items that BREEAM Communities could include: local food production, connectivity, from LEED-ND; consideration of noise, odour, and vibration pollution, hazard and earthquake protection, and inclusion of a local administrative office in the neighbourhood from CASBEE-UD.

Aranoff et al. (2014) undertook an unusual study applying LEED-ND criteria covering 'liveability' to a non-certified area, well known by local inhabitants as 'liveable'. A survey asked residents to describe the most important aspects of the neighbourhood contributing to that assessment of 'liveability', and those were compared to LEED-ND criteria. The framework covered criteria such as 'Location and Accessibility' but not some of the less tangible aspects, such as 'atmosphere', 'diversity', or 'small-town feel'.

Other examples include the lack of explicit embodied energy indicators in assessments (Saghafi and Hosseini via Zuo and Zhao 2014), while Mateus and Bragança (via Zuo & Zhao 2014) suggest that awareness of sustainability issues should be a measured criterion. Haapio (2012) favours the inclusions of criteria addressing 'urban sprawl'.

It is important to remember that non-mandatory criteria supplied by the framework will not necessarily be assigned a representative amount of credits, or even implemented at all.

ii) Mandatory Criteria

Mandatory criteria are seen as important 'to ensure that the minimum sustainability requirements are met' (Sharifi & Murayama 2013a) and (Garde 2009). However, there is a balance to achieve in terms of flexibility and coverage. All frameworks studied, with the exception of DGNB-NSQ (Hamedani & Huber 2012) and CASBEE-UD (Sharifi & Murayama 2013a), include mandatory criteria. However, only BREEAM Communities has any economic criteria as mandatory (ibid.). This deficiency could lead to a skewing of coverage away from economic issues.

Percentage distribution of the frequency of indicators falling under each main theme.

Theme	Criteria	Percentage of the frequency of indicators falling under each theme and criteria													
		LEED-ND		ECC		BREEAM		CASBEE-UD		HQE²R		Ecocity		SCR	
Resources and environment	Water	14	33	11	33	3	23	13	41	7	26	3	26	4	17
	Energy	9		4		6		9		7		15		6	
	Materials, ecosystem, biodiversity, resources conservation, etc.	10		18		14		19		12		8		8	
Transportation		9		12		19		10		7		15		8	
Social	Affordable housing	2	9	1	15	2	11	0	6	2	45	3	15	4	26
	Inclusive communities	0		3		3		0		5		3		2	
	Safety, community well-being, community outreach, heritage, social networks, etc.	7		11		6		6		38		9		20	
Economic	Local jobs and economy, finances, investments, employment, business	2		2		8		0		5		6		15	
Location, site selection		11		14		5		3		2		6		4	
Pattern and design	Mixed use	2	31	1	23	2	32	0	40	2	15	3	32	4	25
	Green infrastructure, compact development, access, urban planning and design standards, etc.	29		22		30		40		13		29		21	
Innovation	Accredited professionals	2	5	0	1	0	2	0	0	0	0	0	0	0	5
	Innovation	3		1		2		0		0		0		5	

Table 3 Comparison of Neighbourhood–level Coverage (Sharifi and Murayama, 2013a Table 3)

Some mandatory criteria have been criticised as restricting certain projects from certification that would otherwise be sustainable (Spinks 2013).The author found no research identifying whether the mandatory criteria specified in frameworks did indeed represent core sustainability criteria, or were suitable for different local environments.

iii) Local Issues

In general, frameworks have strong linkages to their original national contexts and are not flexible to settings outside these (Haapio 2012; Chandratilake & Dias 2013). They, therefore, are not necessarily transferable to other environments (Garde 2009). Despite this, only HQE2R, Ecocity (Sharifi & Murayama 2013a), and BREEAM Communities have dedicated processes for addressing local issues that may alter the framework's technical content (such as criteria value or inclusion, or indicator difficulty), and, thus, alter the boundaries within which a development can progress if it wishes to achieve certification. HQE2R sets all indicator weightings via consultation with local stakeholders. BREEAM Communities uses an 'International Bespoke' process to assess the applicability of the framework to international projects (outside the UK) and negotiate changes based on local legislation, culture, climate, etc.

Some frameworks address this issue in other ways, for example, by offering slight modifications for different areas, awarding a small number of credits for addressing local issues (LEED-ND), or requiring consultation with local stakeholders (BREEAM Communities). It should be noted, though many studies mention that BREEAM Communities uses regional weightings, these were not included in the 2012 issue.

Perhaps due to this inflexibility it is generally seen as desirable that unique frameworks are developed for each national/regional context (Conte & Monno 2012). This is beginning to happen with BREEAM Communities (as it did with BREEAM) with some countries releasing their own fixed versions (for instance BREEAM ES Urbanismo), as well as other frameworks specific to particular regions, like those mentioned in the introduction.

Stakeholder engagement is important in understanding local variation on an inter- or intra-national scale. LEED-ND has no requirement to hold meetings with local communities or public officials, or to gather stakeholders together; Earthcraft Communities (Carter 2008) and BREEAM Communities both have this requirement, with the former requiring a pre-planning meeting with a variety of stakeholders and including a theme dedicated to 'community engagement', and the latter demanding similar meetings with a requirement that their conclusions are integrated into the design.

3.3 **Indicators and Weightings**

Once the scope of a framework is decided, indicators determine the achievability and standard of that coverage for certification. If frameworks and certified developments are to be compared then these indicators must be transparent in design and comparable in application. If a framework is to achieve its aims of enhancing sustainability, they must also be sufficiently stringent and be awarded an appropriate amount of credits.

i) Indicators

There has been a wealth of research into sustainability indicators. Böhringer & Jochem (2007) and Singh et al. (2009) review indicators generally and Boyko et al. (2012) and Shen et al. (2011) review them in the urban context. Sharifi (2013a, p. 76) describes what indicators should achieve: 'Indicators used for sustainability assessment must be integrating (covering multiple issues and considering linkages among them) (Maclaren, 1996), forward looking (intergenerational equity), distributional (intragenerational equity), developed with input from multiple stakeholders (procedural equity) (Haughton and Hunter, 2003; Maclaren, 1996), and context-specific.'

Every framework studied uses indicators in broadly the same way: as targets for which credits are awarded. There are some differences in their structure, however. CASBEE-UD uses benchmarks representing a standard of practice to aim for, giving fewer/more credits for under/over achieving, instead of setting minimum standards.

There are differences in the level of performance of the indicators used, leading Chandratilake (2013 p. 23) to note (when comparing two building level frameworks) that: 'the best rating (i.e.

"excellent") in BREEAM is probably better than the best (i.e. "platinum") one in LEED.' This corroborates findings by Lee (Lee & Burnett 2008) that BREEAM had the strictest indicators assessing the reduction of energy use in building level assessments.

Degree of emphasis on major themes in the seven selected NSA tools.

Theme	Criteria	Percentage of the maximum points achievable for each main theme and its sub-themes													
		LEED-ND		ECC		BREEAM		CASBEE-UD		HQE²R		Ecocity		SCR	
Resources and environment	Water	9	18	9	33	4	23	13	41	7	26	3	26	5	15
	Energy	6		11		6		9		7		15		5	
	Materials, ecosystem, biodiversity, resources conservation, etc.	3		13		13		19		12		8		5	
Transportation		5		8		17		10		7		15		8	
Social	Affordable housing	6	11	4	12	1	11	0	6	2	45	3	15	13	30
	Inclusive communities	0		5		3		0		5		3		2	
	Safety, community well-being, community outreach, heritage, social networks, etc.	5		3		7		6		38		9		15	
Economic	Local jobs and economy, finances, investments, employment, business	3		2		7		0		5		6		25	
Location, site selection		18		12		5		3		2		6		1	
Pattern and design	Mixed use	4	36	11	31	2	31	0	40	2	15	3	32	1	12
	Green infrastructure, compact development, access, urban planning and design standards, etc.	27		20		29		40		13		29		11	
Innovation	Accredited professionals	1	9	0	2	0	6	0	0	0	0	0	0	0	9
	Innovation	8		2		6		0		0		0		9	

Table 4 Criteria Weighting (Sharifi and Murayama, 2013a Table 4)

ii) Weighting

There are various ways weightings are applied, if they are applied at all. They can be applied to individual indicators, groups of indicators (criteria), and/or themes. For instance, BREEAM Communities weights each theme (and sub-theme), criteria and indicator differently: the theme 'land use and ecology (LE)' is worth 12.6% of the total score, criterion 'LE02 – Land use' has an overall weighting of 2.1% (i.e., it is worth 16.7% of the LE theme), and each credit available for achieving indicators within that criterion is worth 0.7% of the total (or 33% of the LE02 criterion) (BRE 2012). DGNB-NSQ, however, weights only criteria and indicators, with each theme weighted equally at 22.5% (with the exception of 'process quality, which is worth 10%) (Hamedani & Huber 2012).

If weights are applied, there is no consensus on how or why and whether credits should be given in proportion to the environmental, social, and economic consequences of failing to apply a measure, or the cost of implementation (Lee, 2013). A disconnect between weighting and cost of implementation has been blamed for some criteria generally not being taken up (Garde 2009). It is suggested that LEED-ND and BREEAM Communities base weightings on their impact on sustainability (Hamedani & Huber 2012). However, generally, studies have found a lack of agreement in weighting of criteria in neighbourhood frameworks (Hamedani & Huber 2012; Sharifi & Murayama 2013a; Berardi 2013; Haapio 2012; Kyrkou & Karthaus 2011). A summary of weightings is shown in Table 4. In contrast, Lee (2013 p. 409) found when comparing building level schemes (BREEAM, LEED, BEAM Plus, CASBEE, and ESBG) that 'consensus is considered moderately reached on weights and ranks of weights'.

Studies showed that few frameworks apply weights to all themes equally, leading to a 'lack of balance' (Sharifi & Murayama 2013a) between each of the three pillars of sustainability. As with the Themes and Criteria, there seems to be a bias towards the environmental, with BREEAM Communities, for example, paying it most attention compared to LEED-ND and DGNB-NSQ (Hamedani & Huber 2012), and away from, in particular, economic sustainability, with only low scores available.

Though environmental factors are in general rated the highest, this is not always the case within or between frameworks. For instance, within building level frameworks, though energy is the highest rated theme, water use is the least. Environmental factors are also less favoured in neighbourhood

frameworks (BREEAM Communities and LEED-ND) than building level assessments (Berardi 2013).

Site location and selection is heavily weighted in LEED-ND compared to other frameworks (Berardi 2013; Haapio 2012; Garde 2009). Garde (2009 p. 431) notes, with a survey of 73 LEED-ND certified projects, that it was 'relatively easy to get well-located projects certified', and suggested, along with others (Sharifi & Murayama 2013b), that project location is too heavily favoured, leading to other aspects being ignored. It is not covered directly in BREEAM Communities.

iii) Weighting Analysis

There are a limited number of studies looking at the reasons for weightings and criteria choice within frameworks (and the differences between them), though some papers propose hypothetical explanations. For example, it is suggested (Kyrkou, 2011; Carter, 2008) that the difference in weightings between LEED-ND and BREEAM Communities is due to the different principles the two schemes are based on, with LEED-ND looking to 'new urbanism' with a strong focus on site selection and connectivity, while BREEAM Communities 'tends to address more environmental concerns' (p. 207). This reflects differing understandings of sustainability from the BRE and USGBC. Lee (2013) discusses the inclusion of peak electricity use in ESGB and BEAM + (building level frameworks from China and Hong Kong respectively) and attributes this to more severe power production problems in China and Hong Kong than in Europe or the US, whose frameworks do not include these criteria.

A notable exception is a study of building level frameworks by Chandratilake and Dias (2013) which examined whether the weightings assigned to different criteria were based on any physical or structural phenomena in the country in which they had been developed. These authors plotted the weightings assigned to the criteria ‘Energy Efficiency’, ‘Water Efficiency’, and ‘Site’ in the assessment framework against a number of national environmental indicators: primary energy use, water scarcity, and population density respectively. Figure 1 shows these plots. The authors suggest that the relationship between weightings and national indicators varies by country; that in the case of water scarcity, where there appears to be a correlation between weightings and indicators, countries with similar water scarcities could apply the water criterion from a variety of other national frameworks to their own buildings; that where there appears to be no correlation, other indicators or factors seem to be influencing the decision about weightings. This research is at an early stage but has the potential to provide greater transparency to frameworks and uncover motives behind weightings. It could also provide a stronger basis for comparison and legitimacy of weightings, as well as for the inter-regional applicability of a framework. For instance, the first graph in Figure 1 suggests that CASBEE-UD (from Japan), may not be applicable for use in the UAE, but Green Star (Australia) has potential to be used in the USA or NZ. The other figures are less convincing, however.

Energy Efficiency Criteria Weightings plotted against national annual per capita CO2 emissions	**Water Efficiency Criteria Weightings plotted against percentage of land classified as water scarce**	**Site Criteria Weightings plotted against population density**

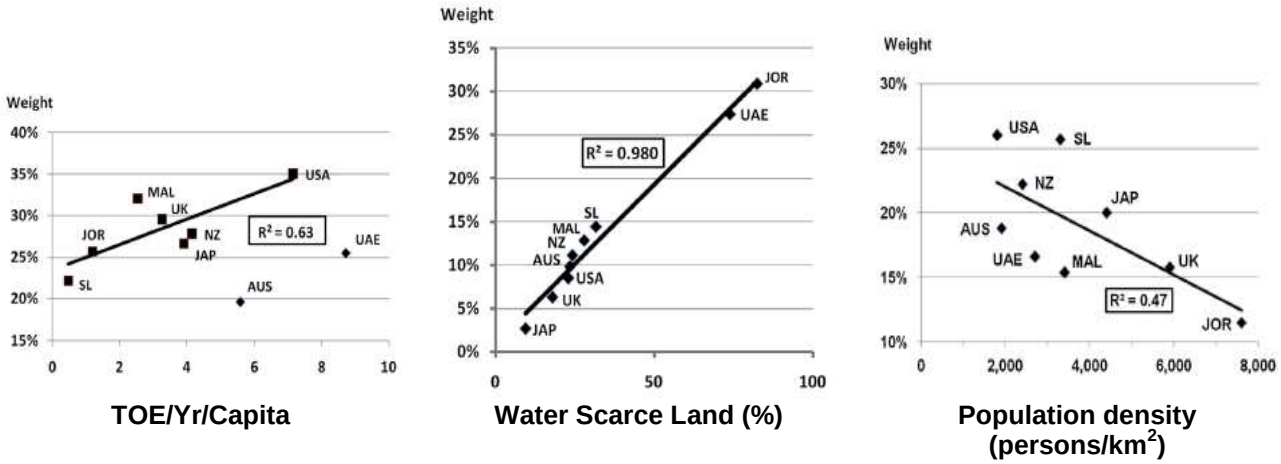

Figure 1Plots of weighting applied to different criteria against existing environmental indicators for different countries (Chandratilake & Dias 2013)

4. Framework Analysis and Real-World Application

As well as describing and analysing 'what a framework is' research has also looked at the impact of frameworks on stakeholders and developments: how frameworks are used, by whom, and how effective they are. This section will review these types of studies.

It is significant that the author found very little literature on how development stakeholders use and are affected by frameworks. For instance, whether the use of frameworks leads to more engaging, liveable, or likable urban spaces, or whether the frameworks lead to processes that are more participatory than traditional property development processes.

4.1 Certification and Rating

One of the key ways that frameworks interact with stakeholders is through certification and ratings.

i) Process

Broadly the same rating and certification process is followed in all cases (Hamedani & Huber 2012; Lee & Burnett 2008): credits are given for completed indicators, and certificates are awarded for receiving a certain percentage of credits. Work has been done on comparing the differences, and also analysing the theoretical effectiveness of various systems (Lee, 2013).

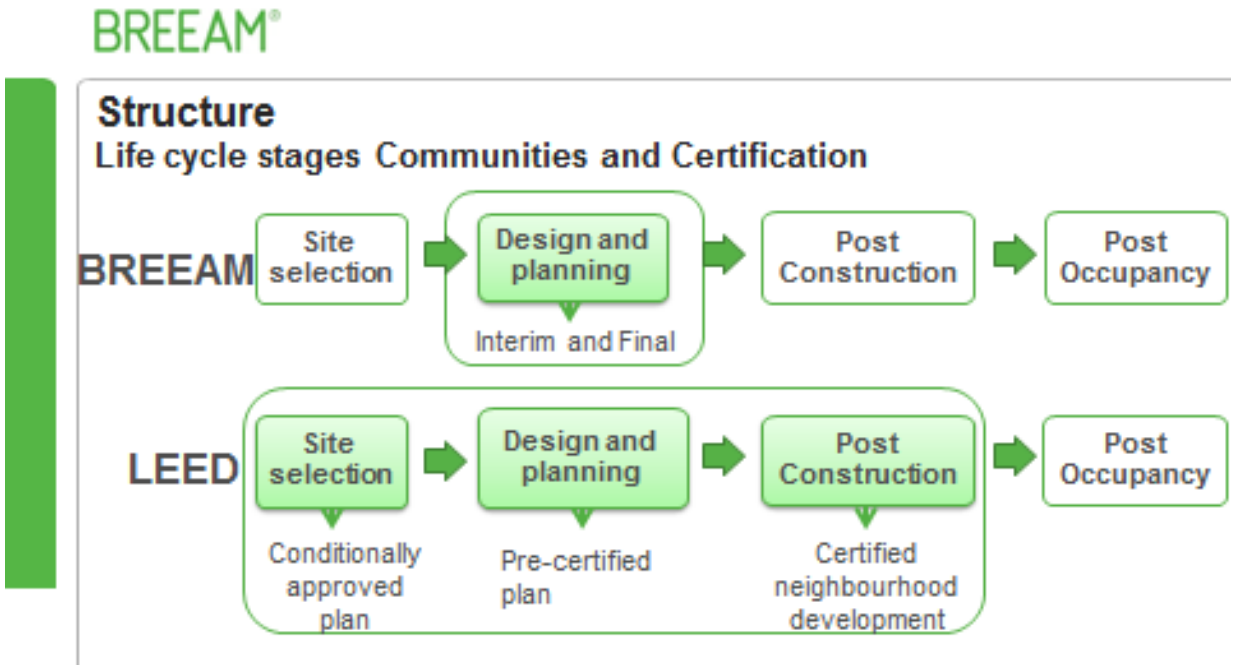

Figure 2 Life Cycle Stages of BREEAM Communities and LEED-ND (BRE personal communication)

Tools rate development life cycles differently (Haapio, 2008). For example, the USGBC and the BRE have different tools for life-cycle stages (e.g., New Construction for new builds, In-Use for post-occupation, and Refurbishment), whereas others assess the whole development process in one tool (Lee 2013).

Developments are also certified in different ways and cover different phases. LEED-ND, for example, uses a three-phase certification, while BREEAM uses one phase and does not certify post-construction (see figure 2 left). Some advocate a one-phase certification at project completion to ensure certified buildings deliver anticipated performance (Lee, 2013) and that two-phase certifications risk a disconnect between performance and design-phase predictions (Environmental

Building News website, 2008). Though Lee (2013) points out that a two-phase system is more flexible and still results in the actual performance being assessed.

Some authors suggest that most (building) tools fail to take into account the life-cycle of a development and multiple post-occupancy certification phases are needed to truly assess the sustainability of a development (Goh & Rowlinson 2013). This is currently not practised by any frameworks studied.

ii) Rating Scale and Standard

All frameworks use hierarchical rating scales: awarding increasingly better certificates to developments that obtain larger percentages of credits. There are three types of rating scales: linear (as used by BREEAM and ESGB), concave non-linear (adopted by LEED, CASBEE, and BEAM Plus), and convex non-linear (Lee 2013). Convex scales mean that as credit scores become higher and harder to achieve, the gap between certification levels decreases. Lee (2013) argues that a convex scale is preferable because it would better encourage developers to aim for better performance. The author finds it interesting that no frameworks seem to adopt this method.

There are differences in the minimum standard for certification. Both BREEAM Communities and LEED-ND have mandatory criteria, while there are none in DGNB (Hamedani, 2012). Also the lowest certification level in BREEAM Communities is 30%, while for LEED-ND this is 40%, and DGNB-NSQ, 50%. BREEAM Communities framework awards its highest certificate at 85%, while it is 80% for LEED-ND and DGNB-NSQ (ibid). It would seem that BREEAM Communities allows certification for a wider range of developments, but there is no literature on the subject.

4.2 **Stakeholders: Who are they? How and why are they using frameworks (or not)?**

It has been recognised since the early 1970s (Craven (1969), Kaiser and Weiss (1970), and Drewett (1973) via Healey, 1991) that the process of development is both social and a physical. Understanding those social processes, and the actors involved, is important in understanding sustainable development in the context of frameworks (Rydin, 2010). There has been only limited research on this topic, however, perhaps because it is 'very difficult, if not impossible to distinguish the real users of the tools' (Haapio & Viitaniemi 2008 p. 476).

i) Private Sector Actors

The primary users of frameworks are construction and development professionals and property developers. There are many reasons for their use of frameworks; a review by Carter (2008) identifies research showing that sale price premiums, reducing costs of development, company stakeholder and customer demands, anticipation of regulation, and increasing competitiveness are factors. Marketing or publicity also seem to be a common reason (Garde 2009). Indeed, Sharifi (2013 p. 83) is concerned that frameworks might ‘just be used by those… seeking market appeal’. This publicity is not just sought by developers promoting their developments, but also by design/construction professionals trying to attract clients or employees (Spinks 2013). Construction professionals have also stated that frameworks are useful to ‘defend design decisions’ (Schweber 2013), though not always successfully (Spinks 2013). Research into other types of voluntary environmental standards suggests they may also be used by organisations trying to gain recognition for ‘green’ decisions already made (Darnall & Sides 2008).

Generally, frameworks are seen as positive within the construction industry (Garde 2009; Schweber 2013). In a recent survey of the UK property development sector, 64% of respondents described BREEAM as an essential tool (Schweber 2013). This is in line with findings from Retzlaff (2009) that 70% of municipalities that incorporated LEED into their policies reported a positive overall reaction. Though this was qualified with the observation that this may be because the ‘requirement [for LEED] is so narrowly applied’ (p. 73), for example, in many cases only to public buildings of a certain size.

However, this is not an opinion universally held (Garde 2009 p. 428), with some interviewees declaring that 'the costs greatly overshadow the benefits'. Spinks (2013) also found that isolated working occurs, leading to missed opportunities for integrated or synergistic solutions were lost.

ii) Policy and Governance Actors

Frameworks are often used by governments (local and national) in 'raising public awareness, promoting achievements of standards over and above the minimum regulatory requirements and in maintaining dialogue with the private sector' (Lee 2013 p. 403).

21 US states (as well as a number of smaller municipal bodies) have adopted the LEED framework in some way in their policies (Retzlaff 2009). In looking at the factors explaining the adoption of LEED in the US, Cidell (Cidell & Cope 2013 p. 1) found that there was a strong relationship between the number of registered LEED-certified (or to be certified) buildings and the presence of a policy that 'requires or incentivises such certification'. Illinois's Green Neighborhood Grant Act, which offers grants of 1.5% of LEED-ND certified project costs, is an example of one such incentive scheme (Garde 2009). Cidell also found that 'larger cities with a younger population, those whose mayors have signed climate protection agreements, and those whose neighbours are also producing green buildings are more likely' (p. 17) to have LEED-certified buildings, and that these results were not correlated to 'local electoral politics or wealth', and 'local champions' were important.

LEED-ND is also being used to evaluate grant applications to the Department of Housing and Urban Development (HUD) (Benfield, 2013). BREEAM Communities is less widely used in government, but has been requested by Bristol Council and Eastleigh Council for large projects.

Schindler (2010) notes the trend of municipalities adopting LEED policies but worries about the legitimacy of applying frameworks created by private institutions. She suggests further transparency or using the tools as a basis for local frameworks created with community involvement.

iii) Barriers to uptake

There is relatively little research on this area with regards to frameworks specifically, though barriers may be similar to those generally associated with sustainable buildings. A selection of papers identify economics, process, a lack of knowledge and understanding, and policy and regulatory standards as potential obstacles (James 2012; Häkkinen & Belloni 2011; Lowe & Oreszczyn 2008; Shen et al. 2011)

Hoffman and Henn (p. 391) state, '[for the adoption of green building practices and LEED certification], obstacles faced by the green building movement are no longer primarily technological and economic. Instead, they are social and psychological.' This is supported by studies showing that stakeholder involvement (Lam et al. 2010) and socio-political context (Zhao & Lam 2012) are significant in adoption of green specifications and LEED respectively.

Retzlaff (2009) studied the obstacles to building frameworks in government, finding that, where they were perceived to exist (which was 70% of the time), key obstacles were a lack of staff expertise and increased cost.

Transparency

As touched upon above, there have been criticisms of the frameworks and GBC for a lack of transparency. The transparency of frameworks is vital to their legitimacy as standards and tools for stakeholder engagement.

LEED-ND is more transparent than BREEAM Communities (Kyrkou & Karthaus 2011); credit scores for LEED and LEED-ND projects are available online via the USGBC website, whereas BREEAM Communities has 'no published data available for non-assessors'. This could be a symptom of the way the two schemes are marketed: the BRE makes its money by training accredited assessors, therefore the money paid by the assessors to the BRE must lead to some value added, for example, access to resources. By contrast, the US-GBC makes its money through LEED by registration fees, hence it makes sense to give as much information away for free to encourage up-take, and thus more project registrations. The lack of transparency in BREEAM Communities: 'has two important implications: the first is that it is not possible for anyone external to the Communities process to know how a particular scheme has been assessed and therefore on what basis it achieves the rating that it achieves; the second is that the standard has little wider educational potential beyond the simple rating of individual systems.' (Kyrkou, 2011 p. 209). Despite the USGBC's relative transparency, Berardi (2013) still considers most frameworks lacking in this area in relation to the reasons behind the choice of criteria.

4.3 **How do frameworks affect their users, and the design and development process?**

One outcome of frameworks, indeed, any new tool, is that they have an impact on working practices, and the people who use them. However, research on the effects of frameworks on their users, the development process, and the wider social/institutional environment, such as planning, are relatively scarce.

i) Effect on Users

A study by Schweber (2013) stands out and looks into the 'effect of BREEAM New Construction on clients and construction professionals'. While it is not unreasonable to surmise that the findings may apply to other frameworks as well, more research needs to be done in this area.

Schweber uses a theoretical framework based on Foucault's theory of governmentality, and data from interviews and case studies to assess the following: 'What aspects are rendered visible in the course of an assessment? What type of knowledge and techniques are mobilised in the conduct of a BREEAM assessment? What effect does involvement have on the identities of a project team etc?'. The first of these questions has been partly answered in the Indicators and Weightings Section. Environmental concerns are more visible overall; frameworks favour elements of sustainability over others based on their regional context and founding principles.

The effect on workload is discussed, with the majority of team members commenting on the additional work, with indicators that demanded 'beyond standard practice' (p. 138) giving significant issues. 'Project managers reported spending approximately 20% of their time on BREEAM-related activities'. In addition, due to limited assessor funds, interviewees reported that often the task of chasing up work was 'down to whoever cared the most'. Schweber attributes this partly to a 'weak technique of government', noting that BREEAM credits are often not team members sole tasks and the 'moral sanction' for incompletion or delay is 'relatively weak' – teams that performed well were applauded, but those that did not were not 'condemned as being poor or unethical', but less seriously seen as 'dropping the ball'.

The extent to which BREEAM is able to promote sustainable development as a norm is discussed. Schweber suggests that it does not necessarily change people's behaviour but acts as a marker for professionals to advertise their sustainable credentials, and allows them to 'defend [sustainable] design decisions' against being engineered out at a later phase. Similarly, she suggests that due to its complexity it 'does little to educate external stakeholders' about sustainable building practices. This is supported by Kyrkou and Karthaus (2011). However, interview data from Goh suggests that 'understanding and knowledge of construction stakeholders on sustainability issues have been increased in the process of applying rating systems', despite this complexity (Goh & Rowlinson 2013 p. 1367). Schweber (p. 140) does, however, recognise that 'it does seem reasonable to say that it is an important element in the landscape contributing to the on-going inflection of internalised

standards of good practise', as well as being a tool that can bring people together to talk about sustainability that would otherwise not have done so.

Spinks (2013) found BREEAM failed to prevent isolated working, leading to missed opportunities for integrated or synergistic solutions were lost, while others believe frameworks to constrain innovation (Conte & Monno 2012).

ii) Effect on the Development Process

This section addresses the question of where frameworks act within the development process, and how much effect frameworks have.

Site Selection and Land Use Planning

Talen (2013) uses LEED-ND over a large area (Phoenix) to find suitable locations for development. She argues that is it more efficient applied at scale, leading to cost reductions and suggests that planning authorities can use this method to 'incentivize more sustainable development' (p. 20), which has been the tactic used by at least three US cities (Benfield, 2013). Though this approach may be more applicable to LEED-ND than other frameworks due to its higher focus on site location, similar approaches should be investigated for use with other tools. It has been suggested (Benfield, 2013) that neighbourhood frameworks could be used as 'informal tools for assessment and planning' by various stakeholder groups.

It is not envisaged, on the other hand, that BREEAM Communities would be used in the same role due to differences in the UK planning system (Batcup, F., 2014 personal correspondence)

Planning Process

As discussed above, many public organisations have incorporated frameworks into their planning requirements. However, how this has impacted the process of planning has not been investigated.

Design Process

Hudson (2002) considers BREEAM's effect on the design process 'significant'. However, Garde (2009) found, based on a survey of 11 respondents, that 'it appears the rating system had very little influence on the planning and design of the projects... because many developers were already designing and buildings projects "with sustainability in mind"' (p. 428). Similarly, other studies have found that frameworks are mainly used for 'flagship' projects (Spinks 2013).

More specifically, Schweber finds that 'some [criteria] were made more visible (people would not have included them otherwise) by BREEAM and had added value', whereas 'some were seen as not necessary but "introduced [into the design anyway] solely in order to get another credit"' (Schweber 2013 p. 137).

4.4 **Implementation**

It is important that frameworks help to produce more sustainable developments, and there is evidence to suggest that, overall, frameworks and other third party assessed environmental certification schemes do improve sustainability performance (Lam et al. 2010; Darnall & Sides 2008). However, most research has focused on the post-construction performance of individual criteria, with a significant portion looking at reduction of carbon emissions and energy use. Again, there has been very little research with respect to neighbourhood level schemes.

The research generally compares certified to non-certified buildings (or sustainability ideals) on various indicators to analyse the benefit (or lack thereof) of designing to frameworks, or looks to explain the factors behind that variation.

It is of note that some authors suggest that significant benefits of certified buildings are 'more psychologically oriented' (Kato et al via Zuo and Zhao 2014), which suggests research needs to

extend beyond a simple comparison of building metrics. Likewise, no frameworks address the problem of unsustainable lifestyles directly, even though personal consumption accounts for 30% to 45% of total emissions (Säynäjoki, E. et al., 2014).

i) Factors Affecting Performance

A certified development may not perform better than a conventional development for a number of reasons: features or processes may not work as intended (Abdalla et al. 2011), users may interact with a development unexpectedly, framework specifications may not be higher than good practice (Schweber 2013), developers and design teams may pursue different criteria to those being compared (Sharifi & Murayama 2013a).

Features not working as intended

Abdalla (2011) compared the rating given to 6 BREEAM Communities projects with the final built form (though actual criteria score was not used due to a lack of information). Between 2 and 18% of sub-categories 'mentioned' (not necessarily awarded credits) in assessments did not work satisfactorily, though what that actually means is not defined.

Criteria Choice

Developers and designers, due to a lack of resources, have been shown to focus on criteria that are highly weighted (Sharifi & Murayama 2013b) or cheap to implement (Garde 2009; Spinks 2013). This leads to some areas of sustainability which are covered in theory generally not being covered in practice, and could be a reason for lower performance in some areas compared to non-certified buildings. There seems to be a link, particularly within ‘indoor environmental quality’ (IEQ) and ‘inclusive communities’ criteria.

ii) The Effectiveness of Criteria

The actual performance of certified developments appears mixed, with as many studies finding significant benefit as those finding none (or even detriment to sustainability).

Microclimate/IEQ

Studies by Huizenga et al. showed that 'sustainable' buildings (those that won awards for their greenness) and LEED certified buildings performed better in building and workspace satisfaction, indoor air quality, cleaning and maintenance, and thermal comfort but not lighting and acoustics, which, interestingly, tend to be criteria not attempted by developers (Sharifi & Murayama 2013b). However, there was not a clear relationship between each individual indicator score and the performance. Conversely, Altomonte & Schiavon (2013) found there to be no statistical difference in IEQ between LEED and non-certified buildings.

Carbon and Energy

A number of studies (Lee & Burnett 2008; Turner & Frankel 2008 via Zuo & Zhao 2014; Jo, Golden & Shin 2009 via Zuo & Zhao 2014) find that certified buildings (LEED and BEAM Plus) use less energy than non-certified buildings. For example, Suh (2014) found an average reduction to life-cycle energy use and carbon emissions of 14%. Other studies, however, (Scofield 2013; Newsham et al., via Zuo & Zhao 2014) that though Gold certified LEED office buildings had lower energy consumption than similar buildings, Silver and Certified LEED rated office buildings had a higher energy use. However, they also found that all LEED certified buildings scored better in the Energy Star assessment. Scofield suggests this could be because LEED buildings have more 'productivity', for example, 'having longer building hours, higher occupancy density, or housing larger numbers of personal computers' (these all affects the energy star ratings). Another explanation could be the ‘rebound effect’ (Berkhout et al. 2000).

Inclusive Communities

'Inclusive communities' refers to criteria aimed at making a development accessible to all groups in society. In a study of three exemplary case-studies, Sharifi and Murayama (2013b) found that neither the BREEAM Communities nor LEED-ND developments included affordable or social housing, suggesting the frameworks are not successful in creating inclusive communities. This study investigated the 2008 version of BREEAM Communities but, in the 2012 version, affordable housing targets based on discussions with local stakeholders are mandatory. This supports the findings from Garde (2009) that affordable housing was only 'somewhat-utilized' or 'least-utilized', describing the lack of provision in certified projects as 'a great concern'.

4.5 **Economics and Value**

The costs of implementation and the effect of sustainable building on land and rental value has been moderately studied for building level developments, though often general sustainability or energy efficiency is analysed instead of a particular framework.

In some municipalities or project types, frameworks are required by law and are effectively environmental legislation (for instance, BREEAM is required in the UK for public buildings, and as mentioned above LEED is increasing required in US municipalities). Regulatory stringency has been shown to have a negative effect upon profits, though firms that embrace and integrate the legislation 'have a greater probability of… offsetting the cost of regulation or accruing a net gain' (Darnall 2009, p. 1).

i) Implementation/Running Cost

Ross et al (Via Zuo & Zhao 2014) found that it costs 10% more to refurbish a pre-existing, non-certified building to LEED standards, though it achieves savings through running costs. This agrees with findings that GBCA 5 and 6 star buildings cost 4% and 10% more to build, respectively (Zuo & Zhao 2014).

ii) Value

Eichholtz et al. (2009) found that buildings with an Energy Star rating had a rental price 3% higher, and sold for 16% higher, than 'an otherwise identical building'. This is in line with research done by the Australian Green Property Investment Index and the Building Better Returns Report (Green Building Council Australia, 2013). However, Eichholtz's findings for LEED rated buildings were not statistically significant (though they suggested a higher premium), and Lutzkendorf and Lorenz (2011) found sustainability metrics had a 'very limited effect on property valuation'. Fuerst and McAllister (2011) found that BREEAM ratings had no effect on value.

It has also been found that relatively higher premiums were paid for 'green buildings' in places where 'the economic premium for location is lower' (Eichholtz et al. 2009).

Dixon et al. (2009) 'found that while BREEAM provides a useful market signal for occupiers already committed to sustainability, for other groups location, cost, and availability continue to take precedence (Schweber 2013 p. 132)'. While some industries use green buildings more than others (such as finance and energy firms), possibly because of the image they are trying to send out.

5. **Conclusions for Further research**

Frameworks are entering a new phase with the introduction of neighbourhood level tools. These new frameworks have been less well studied than their building level counterparts. Approximately half of the research has been done comparing and critiquing the frameworks' sustainability coverage and details. There is less of a consensus amongst frameworks at neighbourhood level as to what criteria to include compared to building level frameworks. Despite this, it is generally thought that frameworks provide a more holistic approach to sustainable development, covering the three pillars, though they have been accused of favouring the environmental aspects. They

have also been criticised for a lack of coverage generally. Other literature focuses on the interaction between a framework and the development process and actors: how frameworks affect their users, and the design and development process. The evidence that they influence the sustainability of individual projects is mixed, though it is thought they have pushed the standards of sustainability generally. Likewise it is uncertain whether they promote sustainability as a value amongst users. However, they are also useful for those committed to sustainability to show their credentials and defend their decisions.

Finally, research has shown that certification does increase rental and sale value of properties, but this effect is more significant for those users more inherently interested in sustainability, or promoting their 'green' image. It is yet to be seen whether the increased uptake of these tools by governments may go some way to normalising these projects away from 'high-end' developments.

This study has shown the potential for further research into this area, some example questions are suggested below:

- There is a lack of research on the effect of frameworks on the development process, focusing on the details of the framework itself. Furthermore, what little there has been focuses on the design stage. Leading on from this, how do frameworks work in the wider planning context? And what is their ability to provide sustainable development at a regional scale?
- Increased cost and 'silo' working are often seen as symptoms of a framework being used incorrectly, either too late in the process to incorporate holistic cost-saving strategies or without regard for synergistic solutions). What, then, can be done to not only increase their uptake, but the correct use? How do perceptions and outcomes of a framework vary with the point at which it is introduced into a project or programme?
- There are concerns that frameworks only deal with 'high end' developments. How do certified buildings compare to the current housing stock? And what are the barriers to their wider use?
- There is research on the environmental 'pillar' but less so on what that actually means socially and economically, and its implementation. Do frameworks in general fully represent sustainability?
- Most frameworks are compiled using experts and not local knowledge or values. How can these be better incorporated? Do the mandatory criteria represent the core sustainability criteria, and are they suitable for different local environments?
- There is a need for more up to date research as new versions are released; specifically most authors seem to have used the previous version of BREEAM Communities. What are the implications of more recent versions?

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