

## **A Review of Sustainability Reporting Tools (SRTs) for Communities**

Renard Yung Jhien Siew<sup>\*1</sup>

<sup>1</sup>Centre for Energy and Environmental Markets, University of New South Wales, Australia

\*Corresponding E-mail: [rensiew10@gmail.com](mailto:rensiew10@gmail.com)

Received 7-10-2014; Revised 29-10-2014; Accepted 13-11-2014

---

### **Abstract**

Sustainability reporting tools (SRTs) for Communities is part of a new paradigm to aid local governments and councils in their decision making process. These integrative tools have evolved from prior versions of SRTs that focus purely on a single building performance to consider the sustainability performance of communities. This paper provides a review of mainstream SRTs for Communities, in particular: BREEAM for Communities; LEED for Neighborhood Development; CASBEE for Urban Development; Green Star for Communities; Sustainability Tool for Assessing and Rating (STAR); EcoCity; and HQE2R. A critique of these tools is provided to better understand some of the existing limitations including the lack of clarity in the size of development that these SRTs are capable of assessing; lack of published reasoning behind the allocated scores or weightings for the criteria selected; inadequate account of the different sources of uncertainty; the adoption of a static perspective; and the lack of acknowledgement of possible interaction or correlation between criteria. This review will be of interest to practitioners, academics and developers who are concerned about ways to improve the sustainability of the built environment.

*Keywords: Sustainability reporting tools (SRTs), urban community, rating, urban sustainability, neighborhood, assessment, triple bottom line*

---

### **1.0 Introduction**

The definition of sustainable development provided by the Brundtland Report (1987) [1]: ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’ is perhaps the most cited definition among leading scholars. This concept encompasses a cleaner environment with efficient use of resources and a more inclusive society with shared benefits of increased prosperity. In the built environment, the development of sustainable communities has been a key topic of discussion across global conferences. There is clearly an increased acknowledgement by practitioners, local governments and policy makers that urban sustainability is critical and deserves much attention as it has a huge impact on the livelihoods of surrounding communities and their future generations.

Berardi (2013) [2] claims that communities are nowadays considered an appropriate scale to measure the sustainability of the built environment citing that ‘over 50% of the world’s population live in urban areas and that this figure is expected to rise to 70% by 2050; in Europe, 75% of the population lives in urban areas, and by 2020, the number is expected to reach 80%’.

To guide stakeholders in making informed plans and decisions, sustainability reporting tools (SRTs) have evolved from a primary focus on environmental issues of single buildings such as Green Star, BREEAM and LEED [3] to the assessment of the sustainability of communities. This is, in part, due to the criticism that SRTs for buildings are incapable of addressing the volume of sustainability challenges that are beyond environmental issues [3, 4]. The scaling up of SRTs to a community level is perceived as an effective way of tackling a range of sustainability issues: pollution, biodiversity, social needs, transportation, climate change and energy among others synergistically [4]. Some of the more established SRTs to assess the sustainability of communities include BREEAM for Communities, CASBEE for Urban Development, Green Star for Communities, LEED for neighbourhood Development, Sustainable Tools for Assessing and

Rating (STAR), EcoCity and HQE2R. This paper aims to review and discuss the differences between these tools. A critique will be provided followed by suggestions for improvement.

## 2.0 Background

A search was done on Google, Scopus and Science Direct for articles, reports as well as guidelines with the following combination of key words: ‘sustainability assessment’; ‘communities’; and ‘neighbourhood’. The search was restricted to articles published in all languages within the last five years (2009-2013). The search was restricted to the last five years to avoid redundant data and to select more recent updates on sustainability assessment for communities. The search results revealed that the seven most commonly discussed tools that are used to measure the sustainability or communities/neighbourhood are BREEAM for Communities, CASBEE for Urban Development, Green Star for Communities, Sustainability Tool for Assessing and Rating (STAR); EcoCity; and HQE2R. The nature and characteristics of these tools are discussed in this section.

### 2.1 BREEAM for Communities

One of the main features of the BREEAM for Communities tool is that it allows developers, local authorities and master planning professionals to integrate sustainable design features into the master planning stage. This tool is aligned with the current UK planning process addressing all core planning principles found within the national planning policy. There are three progressive steps involved in this tool, each comprising of a list of criteria to be addressed. All criteria listed under Step 1 are mandatory and must be addressed by users of this tool while criteria listed under steps 2 (except for consultation and engagement) and 3 are not. The list of criteria relevant to each step and relevant scores in parentheses are highlighted in Table 1 [5].

**Table 1:** Criteria for BREEAM Communities [5]

Steps	Criterion	Scores available
Step 1: Establishing the principle of development	Consultation plan (1); economic impact (2); demographic needs and priorities (1); flood risk assessment (2); noise pollution (3); energy strategy (11); existing buildings and infrastructure (2); water strategy (1); ecology strategy (1); land use (3); transport assessment (2)	29
Step 2: Determining the layout of the development	Consultation and engagement (2); design review (2); housing provision (2); delivery of services facilities and amenities (7); public realm (2); microclimate (3); utilities (3); adapting to climate change (3); ‘green’ infrastructure (4); local parking (1); flood risk management (3); water pollution (3); enhancement of ecological value (3); landscape (5); safe and appealing streets (4); cycling network (1); access to public transport (4)	52
Step 3: Designing the details	Community management of facilities (3); local vernacular (2); inclusive design (3); light pollution (3); training and skills (3); sustainable buildings (6); low impact materials (6); resource efficiency (4); transport carbon emissions (1); rainwater harvesting (3); cycling facilities (2); public transport facilities (2)	38
Innovation	Any innovation within the design, planning and construction industry that are currently not addressed by BREEAM Communities	7

The percentage of each criterion score achieved out of the total available scores is multiplied by a fixed criterion weighting. The sum of all weighted percentages is mapped to one of the six BREEAM awards as shown in Table 2 [3].

## 2.2 CASBEE for Urban Development

The Japan Sustainable Building Consortium (JSBC) introduced the Comprehensive Assessment System for Building Environmental Efficiency- for Urban Development (CASBEE-UD) in 2006 to assess sustainability in neighbourhood developments [4]. This tool utilises a unique methodology where the environmental quality (Q) within the site boundary is divided by the environmental load (L) beyond the site boundary to calculate the neighbourhood's environmental efficiency. It considers six categories namely natural environment, service functions for the designated area, contribution to the local community, environmental impact on microclimates, façade and landscape, social infrastructure, and management of the local environment. Each of these categories are composed of criteria which in turn are divided into more specific subcriteria [6]. According to Sharifi and Murayama (2014) [4], scores of subcriteria are added up to give the total score of the higher level criteria. This is repeated until final scores for both environmental quality (Q) and environmental load (L) are obtained, following which the Building Environmental Efficiency of urban Development (BEE-UD) is calculated based on Equation 1:

$$BEE - UD = \frac{25X(Q - 1)}{25X(5 - L)} \quad (1)$$

The final BEE-UD score is mapped to a CASBEE award as shown in Table 2 (please refer Page 42).

## 2.3 Green Star for Communities

The Green Star for Communities tool was developed in 2012 by the Green Building Council of Australia (GBCA) in consultation with various industry stakeholders but only released in March 2014. A total of 100 points is distributed across 36 subcriteria with the possibility of getting another 10 bonus points through the innovation criterion. The breakdown of the criteria is depicted in Table 3. In a similar fashion to previous tools such as Green Star (Design and As-Built) which specifically rates the sustainability potential of buildings [3], the cumulative scores from each criterion is mapped to a Green Star award as described in Table 2. The Green Star Communities tool only certifies community projects that have achieved at least 4 Green Stars. A re-certification every five years is required to ensure that commitments made during the design and planning stages are delivered.

**Table 3:** Green Star Communities criteria [7]

Criterion	Subcriterion
Governance	Accredited professional (1); corporate responsibility (4); sustainability awareness (3); engagement (6); operational governance (2); adaptation and resilience (4); environmental management (1)
Design	Site and context analysis (2); site planning and layout (4); urban design (4);
Liveability	Access to amenities (2); community development (4); healthy and active living (5); access to fresh food (2); safe places (2); culture, heritage and identity (3)
Economic prosperity	Employment and economic resilience (2); education and skills development (2); return on investment (2); community investment (4); affordability (4); incentive programs (2); digital economy (2); peak electricity demand (2);
Environment	Site sensitivity (2); ecological enhancement(2); heat island effect(1); light pollution(1); greenhouse gas emissions (6); 'green' buildings (4); potable water consumption(4); stormwater (3); materials(3); waste management (2); transport(3)
Innovation	10 points available demonstration of innovation

**Table 2:** Mapping scores to award

SRTs for Communities		Levels of award						
		Unclassified	Pass	Good	Very good	Excellent	Outstanding	
BREEAM for communities	< 25%	≥ 25%	≥ 40%	≥ 55%	≥ 70%	≥ 85%		
		Poor	Fairly good	Good	Very good	Excellent		
CASBEE for Urban Development		BEE < 0.5	BEE= 0.5-1.0	BEE= 1.0-1.5	BEE= 1.5-3.0	BEE ≥ 3		
	1 Green Star	2 Green Stars	3 Green Stars	4 Green Stars	5 Green Stars	6 Green Stars		
Green Star for Communities	<20 points	≥20 points	≥30 points	≥45 points	≥60 points	≥ 75 points		
			Certified	Silver	Gold	Platinum		
LEED for Neighborhood Development			40-49 points	50-59 points	60-79 points	80-100 points		
			Reporting STAR	3-STAR	4-STAR	5-STAR		
Sustainable Tools for Assessing and Rating (STAR)			<200	200-399	400-599	600+		
		Bad	Medium	Good	Very good	Best score		
Eco-City		E	D	C	B	A		
HQE <sup>2</sup> R	-3	-2	0	1	2	3		

## 2.4 LEED for Neighbourhood Development

The LEED for Neighbourhood Development tool integrates principles of ‘green’ buildings, New Urbanism and smart growth into neighbourhood design. This tool was initially developed by the U.S. Green Building Council (USGBC) in collaboration with the Congress of New Urbanism (CNU) and the Natural Resources Defense Council (NRDC). The six main criteria are further divided into sub-criteria as shown in Table 4. Some criteria are prerequisites while others carry points if requirements are met.

**Table 4:** LEED Neighbourhood Development criteria [8]

Criterion	Subcriterion
Smart location and linkage- encourages communities to consider location, transportation alternatives, and preservation of sensitive lands	Smart location (pre); preferred locations (10); brownfield development (2); housing and jobs proximity (3); imperilled species and ecological communities (pre), wetland and water body conservation (pre), site design for habitat or wetland and water body conservation (1); agricultural land conservation (pre), floodplain avoidance (pre), steep slope protection (1), restoration of habitat or wetlands and water bodies (1); long term conservation management of habitat or wetlands and water bodies (1); locations with reduced automobile dependence (7); bicycle network and storage (1)
Connected neighbourhoods - focuses on vibrant, equitable communities that are healthy	Compact development (6); walkable streets (12); connected and open community (pre); reduced parking footprint (1); tree-lined and shaded trees (2); transportation demand management (2); mixed used neighbourhood centres (4); access to civic and public spaces (1); access to recreation facilities (1); mixed income diverse communities (7); community outreach and involvement (2); local food production (1); neighbourhood schools (1); street network (2); transit facilities (1); visitability and universal design (1)
‘Green’ infrastructure and buildings – promotes the design and construction of buildings that reduces energy and water use while promoting more sustainable use of materials,, reuse of existing and historic structures, and other sustainable best practices.	Certified ‘green’ building (5); building energy efficiency (2); building water efficiency (1); water-efficient landscaping (1); existing building reuse(1); historic resource preservation and adaptive use(1); construction activity pollution prevention (pre); stormwater management (4); light pollution reduction (1); heat island reduction (1); solar –orientation (1); on-site renewable energy sources (3); district heating and cooling (2); infrastructure energy efficiency (1); solid waste management infrastructure (1); wastewater management (2); recycled content in infrastructure (1); minimised site disturbance in design and construction (1)
Innovation and design process- recognises innovative practices that go beyond the existing criteria in the tool	Innovation and exemplary performance (5); LEED accredited professional (1)
Regional priority- encourages projects to focus on meeting criteria that have a significance to the local environment	Regional priority credit (4)

*pre = prerequisite*

Unlike the other residential LEED tool, LEED for Neighbourhood Development comprises the following three stages of certification:

**Table 5:** Three stages in the LEED Neighbourhood Development tool [8]

<b>Stages</b>	<b>Description</b>
Stage 1- Conditionally approved plan	This stage provides the conditional approval for a LEED Neighbourhood Development plan before the completion of entitlements of the public review process. Completing this stage is envisioned to help the project garner support from the community and local government.
Stage 2-Pre-certified plan	Pre-certifies a LEED Neighbourhood Development plan and is applicable to either fully entitled projects or projects under construction. Completing this stage might help projects secure financing or attract tenants.
Stage 3- Certified Neighbourhood Development	Once the project is completed, it can apply for the certification process which recognises that the project has achieved all prerequisites and met certain level of sustainability performance.

The LEED Neighbourhood Development award is determined based on the aggregated scores for each criterion shown in Table 2.

## 2.5 Sustainable Tools for Assessing and Rating (STAR) Communities

STAR Communities was developed between 2008 and 2012 by a joint steering committee and technical advisory group [9]. The purpose of STAR Communities is to provide a common tool for local governments to inform the progress on sustainability initiatives using a set of performance-based criteria. This tool includes seven criteria, where each criterion is further divided into 5-7 subcriterion (total up to 44 subcriteria- see Table 6). Scores are given to neighbourhood communities for successfully meeting the requirements of each subcriterion. The aggregated subcriteria scores are then mapped to a STAR Communities award as shown in Table 2.

**Table 6:** STAR Communities criteria [9]

<b>Criterion</b>	<b>Subcriterion</b>
Built environment	Ambient noise and light (5); community water systems (15); compact and complete communities (20); housing affordability (15); infill and redevelopment (10); public spaces (15); transportation choices (20)
Climate and energy	Climate adaptation (15); greenhouse gas mitigation (20); greening the energy supply (15); industrial sector resource efficiency (10); resource efficient buildings (15); resource efficient infrastructure (10); waste minimisation (15)
Economy and jobs	Business retention and development (20); green market development (15); local economy (15); quality jobs and living wages (20); targeted industry development (15); workforce readiness (15)
Education, arts and community	Arts and culture (15); community cohesion (15); educational opportunity and attainment (20); historic preservation (10); social and cultural diversity (10)
Equity and empowerment	Civic engagement (15); civil and human rights (10); environmental justice (15); equitable services and access (20); human services (20); poverty prevention and alleviation (20)
Health and safety	Active living (15); community health and health system (20); emergency prevention and response (15); food access and nutrition (15); indoor air quality (5); natural and human hazards (15); safe communities (15)
Natural systems	'Green' infrastructure (20); invasive species (10); natural resource protection (20); outdoor air quality (15); water in the environment (20); working lands (15)

## 2.6 EcoCity

The European Commission in its 5th framework program initiated the EcoCity project which aims to develop a common concept and design model settlements across seven countries (Austria, Finland, Germany, Hungary, Slovak Republic, Italy and Spain). The developed tool focuses on main criteria such as: urban structure; transport; energy flows; material flows; socio-economic issues; and processes [10]. It uses relative benchmarks in its evaluation, that is the measured value of a criterion is compared against the given benchmark criterion value to derive its score between A (best) and E (worst). If the criterion meets the benchmark value, a score of D- normal practice is given [10]. The five award levels for EcoCity are detailed in Table 2.

## 2.7 HQE2R

The HQE2R project led by Charlot-Valdieu and funded by the European Commission aims to provide decision making tools for municipalities and their local partners focussing on the needs of residents and users of neighbourhoods [11]. The five main criteria identified under this project are: to preserve and enhance heritage and conserve resources; to improve the quality of the local environment; to ensure diversity; to improve integration; and to reinforce social life. These criteria are further divided into a total of 21 subcriteria detailed in Table 7. Each criterion is measured based on a -3 to +3 scale.

**Table 7: HQE<sup>2</sup>R criteria [11]**

<b>Criterion</b>	<b>Subcriterion</b>
To preserve and enhance heritage and conserve resources	To reduce energy consumption and improve energy management; to improve water resource management and quality; to avoid land consumption and improve land management; to reduce the consumption of materials and improve their management; to preserve and enhance the built and natural heritage
To improve the quality of the local environment	To preserve and enhance the landscape and visual comfort; to improve housing and building quality; to improve cleanliness hygiene and health; to improve safety and risk management; to improve air quality; to reduce noise pollution; to minimise waste
To ensure diversity	To ensure the diversity of population; to ensure the diversity of functions; to ensure the diversity of housing supply
To improve integration	To improve the levels of education and job qualification; to improve access for all residents to employment, to services and to facilities; to improve the attractiveness of the neighbourhood by creating living and meeting place for all inhabitants of the city; to avoid unwanted mobility and to improve environmentally sound mobility
To reinforce social life	To reinforce local governance; to improve social networks and social capital

## 3.0 Comparison between SRTs for Communities

In contrast to SRTs for buildings and infrastructure [3], SRTs for communities have done well in terms of their coverage of sustainability issues encompassing economic, environmental and social dimensions as can be observed from Table A1 (Appendix A). It was particularly encouraging to note that all mainstream SRTs for communities have placed emphasis on the social needs of the communities calling for higher engagement levels with this group of stakeholder. There is also acknowledgement of the existence of 'green' buildings/ infrastructure. This is notable since the World Economic Forum [12] identifies the building sector as an area that

needs to be addressed, accounting as it does for 40% of the world's energy use, 40% of carbon output and consuming one-fifth of available water [13]. Even though there appears to be more consistency in the themes and criteria selected in SRTs for Communities, yet, Table 8 shows that these different tools still have varying emphasis on the selected criteria. On the other hand, every criterion for EcoCity and HQE2R are measured on a predefined scale. No aggregation of scores is done for both of these tools.

**Table 8:** Different emphasis across selected criteria (available points for the criterion out of total points in percentage)

<b>Criterion</b>	<b>BREEAM for Communities (%)</b>	<b>Green Star for Communities (%)</b>	<b>LEED for Neighbourhood Development (%)</b>	<b>STAR (%)</b>
Climate and energy	11.1	6	4	14.3
Design and layout/Consultation plan	4.76	10	13	12.1
Transportation	7.14	3	3	2.86
Demographic needs/community/ social	15.87	18	42	14.3
Ecology and biodiversity	0.79	4	3	11.4
Noise pollution	2.38	0	0	0.71
Water strategy	5.55	4	8	0.71
Land use	6.35	0	2	1.43
Economic impact/ Business growth	15.9	20	0	14.3
'Green' buildings/ infrastructure	7.9	4	8	5
Innovation	5.55	10	5	0
Others	30.95	21	12	22.9

Of all the SRTs for Communities analysed, only Green Star has made an attempt to interlock with the Global Reporting Initiative (GRI), allocating points under its governance criterion for any demonstration of reporting in line with the GRI. The GRI is a globally accepted guideline for corporate sustainability reporting [3, 13].

A majority of the mainstream SRTs have started the process of engaging councils by publishing reasons behind the selection of the criteria although this can be done better by

providing a more thorough justification behind the selection of criteria weightings and allocated scores [7].

#### **4.0 Critique of SRTs for Communities**

There are a few limitations with SRTs for Communities. First, a large majority of these mainstream tools do not clearly define the dimension or size of development that can be assessed with the exception of CASBEE-UD: where the minimum standard of assessment is defined as consisting of a group of buildings on two or three adjoining plots while the maximum standard of assessment is defined as consisting of a combination of tens, hundreds, or thousands of building plots and non-built land such as roads and parks [4]. This is problematic especially since some of these tools have started to introduce benchmarking in determining criteria scores such as EcoCity. It would be questionable as to whether the benchmarks selected are valid if the size of development assessed differs significantly.

Second, there is a lack of published reasoning behind the allocated scores or weightings for the criteria selected. Without such information, users may find it difficult to understand the rationale as to why certain criteria are weighted more heavily than others. This leads to heavy speculations or accusations of these tools being a misrepresentation of what should constitute appropriate sustainability assessment. Berardi (2013) [2] argues that SRTs for Communities misrepresents economic sustainability as low importance is given to the ability of a community to promote business and economic opportunities. As well, Berardi (2013) [2] adds that other important economic criteria such as 'industrial vitality, the amount of economic exchanges and financial viability in the community are ignored'.

Third, these tools do not sufficiently account for the different sources of uncertainty (see Table B1, Appendix B). From the analysis in Table B1, BREEAM Communities acknowledges uncertainty in criteria weighting depending on geographical locations. Other tools ignore uncertainty in criteria weighting and scores. Green Star for Communities has removed the process of applying weightings to criteria altogether, that is, the number of scores available for a criterion simply reflects on the weighting for that criterion (i.e. one point for the energy criterion is equivalent to one point for the transport criterion). This is potentially problematic as there is a tendency for a criterion which has the higher the number of subcriteria to be weighted more heavily. According to Siew (2014b) [14] there are four different types of uncertainty (conceptual, contextual, mathematical and input data) which should be acknowledged. Some of the criteria selected by these tools are non-deterministic and uncertainty in measurements may arise because of variations in the perception of users [14]. Ignoring the need to account for uncertainty is not scientific as prior studies have established that doing so alters the resultant ranking of alternatives [3, 15]. As well, it would be difficult to establish benchmarks without truly understanding the potential of measurement errors. There is a possibility of uncertainty propagating due to the nature of most SRTs for Communities where criteria or subcriteria scores are added and mapped to an award (see Section 2).

Fourth, it is argued that SRTs for Communities are not a true reflection of the state of sustainability because they adopt a static perspective; that is measurements are only realized at the beginning of the community development process [2] and not on a continuous basis. This static perspective prevents the analysis of trends which may potentially convey useful information about the sustainability performance of a community.

In addition, because of this static perspective, most SRTs are limited in that they only incorporate stakeholders' views at the start of the project and not on a long term basis.

Fifth, there is hardly any acknowledgement of interaction or correlation between criteria measured. The inclusion of interacting criteria might lead to 'double-counting' [16, 17] hence skewing the end result. This is certainly a problem when using a weighted sum or weighted average, because models of this form assume that all criteria are independent, which is rarely the

case in practice. For example, two HQE2R subcriteria: preserving and enhancing the landscape and visual comfort; and improving the attractiveness of the neighbourhood may be highly dependent on each other.

## 5.0 Opportunities

Given the limitations highlighted, there are various opportunities to improve the current state of SRTs for communities as depicted in Table 9.

**Table 9:** Opportunities to address limitations in current SRTs for communities

No.	Limitations	Opportunities
1	Lack of clarity on the size of development assessed/benchmarks established	<ul style="list-style-type: none"> <li>• Include both absolute and relative measurements as benchmarks. This will involve a number of iterations based on in -depth case studies of existing projects.</li> <li>• Include size of development that was used to establish benchmarks and propose recommended size of development that should be assessed with SRTs</li> </ul>
2	Lack of published reasoning behind the allocation of scores and weightings	<ul style="list-style-type: none"> <li>• SRT developers need to provide justification on why certain criteria are weighted more heavily than others; this is especially important so that users are able to better comprehend the rationale behind the allocation of scores</li> </ul>
3	Do not sufficiently account for sources of uncertainty	<ul style="list-style-type: none"> <li>• SRT developers need to encourage the acknowledgement of uncertainty in criteria measurements where appropriate</li> </ul>
4	Static perspective	<ul style="list-style-type: none"> <li>• Rather than having a static measurement at the beginning of the project, it might be worthwhile considering a half-yearly assessment of sustainability performance. This might require some tweaking of the criteria proposed to ensure that the criterion is not merely a checklist (input criteria) but rather a performance measure (output criteria)</li> </ul>
5	The negligence of correlation between criteria	<ul style="list-style-type: none"> <li>• Applying the ‘Choquet integral’ [18,19] which is an alternative aggregation method accounting for criteria interaction or</li> <li>• Adopt a criteria breakdown structure to minimise criteria overlapping each other.</li> </ul>

## 6.0 Conclusion

This paper has presented and discussed existing SRTs for communities. Seven mainstream SRTs which include BREEAM Communities, CASBEE for Urban Development, Green Star for Communities, LEED for neighbourhood Development, Sustainable Tools for Assessing and Rating (STAR), EcoCity and HQE2R have been considered. This paper has provided a critique of these tools and highlighted a few limitations such as lack of clarity in the size of development that these tools are capable of assessing; lack of published reasoning behind the allocated scores or weightings for the criteria selected; do not sufficiently account for sources of uncertainty; the adoption of a static perspective; and the lack of acknowledgement of possible interaction or correlation between criteria. These issues need to be addressed to ensure the precision of sustainability measures.

There is still much room for research in this area. For example, in –depth case studies focussing on the application of these tools would help further illustrate the limitations of SRTs. This is especially true since Green Star for Communities was just recently released in March 2014

and has not been widely adopted compared to other tools. Sources of uncertainty and how they can be captured by SRTs should also be a main focus of researchers. Acknowledging uncertainty helps project planners to be more transparent in their decision-making process. It may also facilitate better discourse and more accurately capture the sustainability performance of communities [13, 20].

## References

- [1] Brundtland Report, “Our Common Future”, United Nations, New York, viewed on 16/9/2014, [http://conspect.nl/pdf/Our\\_Common\\_Future-Brundtland\\_Report\\_1987.pdf](http://conspect.nl/pdf/Our_Common_Future-Brundtland_Report_1987.pdf), 1987
- [2] U. Berardi, “Sustainability assessment of urban communities through rating systems”, *Environment, Development and Sustainability*, Vol. 15, pp. 1573-1591, 2013
- [3] R. Y. J. Siew, M.C.A. Balatbat and D. G. Carmichael, “A review of building/infrastructure sustainability reporting tools (SRTs)”, *Smart and Sustainable Built Environment*, Vol. 2, No. 2, pp. 106-139, 2013
- [4] A. Sharifi and A. Murayama, “Viability of using global standards for neighbourhood sustainability assessment: insights from a comparative case study”, *Journal of Environmental Planning and Management (in print)*, DOI: 10.1080/09640568.2013.866077, 2014
- [5] BRE, “BREEAM communities manual 2012”, BRE, UK, viewed on 5/9/2014, <[http://www.breeam.org/communitiesmanual/#\\_frontmatter/breeam\\_communities.htm%3FTocPath%3D1](http://www.breeam.org/communitiesmanual/#_frontmatter/breeam_communities.htm%3FTocPath%3D1)>, 2012
- [6] JSBC, “CASBEE urban development”, CASBEE, Japan, viewed on 5/8/2014, <<http://www.ibec.or.jp/CASBEE/english/method2E.htm>>, 2007
- [7] GBCA, “Green Star communities: guide for local government”, Sydney, viewed on 5/9/2014, <[http://www.gbca.org.au/uploads/189/2749/Green\\_Star\\_Communities\\_Guide\\_for\\_Local\\_Government\\_For\\_Web.pdf](http://www.gbca.org.au/uploads/189/2749/Green_Star_Communities_Guide_for_Local_Government_For_Web.pdf)>, 2013
- [8] USGBC, “A citizen’s guide to LEED for neighbourhood development: how to tell if development is smart and green”, USGBC, CNU & NRDC, U. S., viewed on 6/9/2014 <[https://www.nrdc.org/cities/smartgrowth/files/citizens\\_guide\\_LEED-ND.pdf](https://www.nrdc.org/cities/smartgrowth/files/citizens_guide_LEED-ND.pdf)>, 2013
- [9] STAR Communities, “STAR community rating system version 1.1”, STAR Communities, U. S., viewed on 9/8/2014, <https://www.starcommunities.org/uploads/rating-system.pdf>, 2014
- [10] P. Gaffron, G. Huismans and F. Skala, “Ecocity book II: how to make it happen”, EcoCity, Utrecht, Vienna, viewed on 9/5/2014, [http://www.gea21.com/\\_media/proyectos/ecocity/ecocity\\_book\\_2.pdf](http://www.gea21.com/_media/proyectos/ecocity/ecocity_book_2.pdf), 2008
- [11] C. Charlot-Valdieu, P. Outrequin, and C. Robbins, “The HQE2R toolkit for sustainable neighbourhood regeneration and European application overview”, The European Commission, France, viewed on 6/9/2014, <[http://www.eukn.org/France/fr\\_en/E\\_library/Housing/Housing\\_Quality/Sustainable\\_Construction\\_Methods/HQ2ER\\_Sustainable\\_renovation\\_of\\_buildings\\_for\\_sustainable\\_neighbourhoods](http://www.eukn.org/France/fr_en/E_library/Housing/Housing_Quality/Sustainable_Construction_Methods/HQ2ER_Sustainable_renovation_of_buildings_for_sustainable_neighbourhoods)>, 2004
- [12] World Economic Forum, “A profitable and resource efficient future: catalysing retrofit finance and investing in commercial real estate”, World Economic Forum, Geneva, Switzerland, October 2011, viewed on 6 January 2013, <[http://www3.weforum.org/docs/WEF\\_IU\\_CatalysingRetrofitFinanceInvestingCommercialRealEstate\\_Report\\_2011.pdf](http://www3.weforum.org/docs/WEF_IU_CatalysingRetrofitFinanceInvestingCommercialRealEstate_Report_2011.pdf)>, 2011
- [13] R. Y. J. Siew, “Evaluating and enhancing the impact of sustainability reporting tools (SRTs)”, PhD Thesis, School of Civil and Environmental Engineering, University of New South Wales, Sydney, 2014a
- [14] R. Y. J. Siew, “Alternative framework for assessing sustainable building funds: green building fund”, *Building Research & information (in print)*, <<http://dx.doi.org/10.1080/09613218.2014.936170>>, (2014b)

- [15] K.M. Hyde, H. R. Maier and C. B. Colby, "A distance-based uncertainty analysis approach to multi-criteria decision analysis for water resource decision making", *Journal of Environmental Management*, Vol. 77, No. 4, pp. 278-290, 2005
- [16] M. Lenzen, "Double-counting in life cycle calculations", *Journal of Industrial Ecology*, Vol.12, No. 4, pp. 583-599, 2008
- [17] E. Lai, S. Lundie, and N. J. Ashbolt, "Review of multi-criteria decision aid for integrated sustainability assessment of urban water systems", *Urban Water Journal*, Vol. 5, No. 4, pp. 315-327, 2008
- [18] C. Labreuche and M. Grabisch, "The Choquet integral for the aggregation of interval scales in multicriteria decision making", *Fuzzy Sets and Systems*, Vol. 137, No. 1, pp. 11-26, 2003
- [19] P. Meyer, and M. Roubens, "On the use of the Choquet integral with fuzzy numbers in multiple criteria decision support", *Fuzzy Sets and Systems*, Vol. 157, No. 7, pp. 927-938, 2006
- [20] R. Y. J. Siew, M. C. A. Balatbat and D. G. Carmichael, "The relationship between sustainability practices and financial performance of construction companies", *Smart and Sustainable Built Environment*, Vol. 2, No. 1, pp. 6-27, 2013

**Appendix A**

**Table A1:** Comparison of criteria across different SRTs

<b>Criterion</b>	<b>BREEAM Communities</b>	<b>CASBEE for Urban Development</b>	<b>Green Star for Communities</b>	<b>LEED for Neighbourhood Development</b>	<b>Sustainable Tools for Assessing and Rating (STAR) communities</b>	<b>EcoCity</b>	<b>HQE<sup>2</sup>R</b>
'Green' infrastructure/ buildings	X	X	X	X	X	X	X
Innovation	X		X	X		X	
Climate and energy	X	X	X	X	X	X	X
Design and layout/ Consultation plan	X	X	X	X	X	X	X
Transportation	X	X	X	X	X	X	X
Demographic needs/ Community/ Social	X	X	X	X	X	X	X
Ecology and biodiversity	X	X	X	X	X	X	X
Noise pollution	X	X			X	X	X
Water strategy	X	X	X	X	X	X	X
Land use	X	X	X	X	X	X	X
Economic impact/ Business	X		X		X	X	X

**Appendix B**

**Table B1:** Acknowledgement of uncertainty-criteria weighting and scores

SRT for Communities	Acknowledgement of uncertainty	
	Criteria weighting	Criteria scores
BREEAM Communities	Yes- variation depending on geographical locations	No
CASBEE for Urban Development	No	No
Green Star for Communities	No	No
LEED for Neighbourhood Development	No	No
STAR	No	No
EcoCity	No	No
HQE <sup>2</sup> R	No	No