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SUSTAINABLE HOUSING PRACTICES IN MALAYSIAN HOUSING DEVELOPMENT: TOWARDS ESTABLISHING SUSTAINABILITY INDEX

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ABSTRACT

This paper presents a study of sustainable rating systems for sustainable housing that have been developed by various countries around the world. The objective of this study is to develop a framework for a rating system for housing development by taking into account local requirements. There are numerous sustainable rating systems for buildings and groups of buildings that have been developed and rating tools like Comprehensive Assessment System for Building Environmental Efficiency (CASBEE), Leadership in Energy and Environmental Design (LEED), British Research Establishment Environmental Assessment Method (BREEAM), Green Building (GB) Tool and Green Star influential in the development of other rating systems. Malaysia has recently launched a rating system for buildings called the Green Building Index (GBI). However, Malaysia has yet to introduce a rating system for measuring sustainable practices in housing development. Hence, this paper reviews some available tools related to the rating of housing developments for the purpose of developing one for Malaysia. Important factors for developing a tool for measuring sustainability practices should include sustainability criteria that relates to the environment, society, economics, site/land use, communication, and transportation. An index for measuring sustainability in housing development will be developed to suit the local context. The formulated index will take into consideration the parameters in sustainable housing developed by various systems around the world. The index, called A Comprehensive Assessment System for Sustainable Housing (CASSH), will be available for further testing.

Keywords: Sustainable housing development; Urban development; Building (housing); Sustainability index; Malaysia

1. INTRODUCTION

Sustainable development is a common and contemporary goal of many urban (re)development policies in various countries (Berke & Conroy, 2002; Chan & Lee, 2006). Development of the housing sector also requires knowledge of urban development policies. Many housing schemes have been developed in Malaysia since housing is a prerequisite for human habitat settlements. In the present context, housing is developing in line with the goals of Habitat Agenda as well as the principles of Agenda 21, a blueprint for sustainable development in the 21st Century adopted by 179 nations (including Malaysia) in Rio de Janeiro in June 1992. Tosics (2004), housing is one of the most important public policies affecting urban development and, as such, it has significant potential to contribute to sustainability.

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Various aspects of housing construction, design, use and demolition can have significant impact on the environment (Huby, 1998). Sustainable development is unattainable without sustainable building and housing. Chougill (1994) explained that sustainable housing may be understood in terms of ecological, economic, technological, cultural, and social sustainability. According to Edwards & Turrent (2000) housing is sustainable if everyone has the opportunity of access to a home that is decent; such housing will promote social cohesion, well-being and self-dependence.

The aim of this research is to develop a guideline for assessing residential developments with the goal of improving the level of sustainable practices in housing development. The formula of the sustainability index in housing development will be based on factors critical to the success of sustainable buildings and housing and the rating systems that apply in Japan, the United States, and the United Kingdom.

Sustainable housing development should measure the area developed according to sustainability criteria, particularly environmental, social, economics, site/land uses, and communication and transportation, and should include the assessment of building forms for housing performance. For example, Japan designed standards and guidelines for sustainable building and urbanization in the Comprehensive Assessment System for Building Environmental Efficiency (CASBEE for an Urban Area+ Building). These system tools refer to CASBEE for Urban Development and CASBEE for building scale. In the United States, a rating system called LEED (Leadership in Energy and Environmental Design) for Neighborhood Development Rating Systems has been developed. This system is used to evaluate the urban development for sustainability, integrating LEED for building scale assessment for sustainable building.

1.1. Statement of Problem

The concept of sustainable housing is still new and unfamiliar to the public in Malaysia. According to Jasan (2004), houses built in the past decade did not meet the essential criteria of sustainability. Problems are detailed as follows:

a) Building design did not take into account energy efficiency and green affordable housing. Building green housing requires specialized designs that specify the purposes of the building installations and requirements regarding building structures and calculations of projected energy use of proposed buildings. To build green houses, we need to employ building professionals with “extensive residential construction experience, drafting experience, building science backgrounds, indoor air quality investigation training, mechanical ventilation training and much more” (Kibert, 2005). Unfortunately, Malaysia lacks expertise in green house building.
b) Sustainability of housing development gives the most emphasis to environmental, economic and social issues. Construction itself creates a variety of environmental problems, such as greenhouse gas emission and environmental pollution, mainly because of ‘the materials used, nature of design, methods of construction, locations and layout, physical structure and the use to which buildings are put’ (Ramachandran, 1990 cited by Joseph, 2000).
c) Furthermore, the development of housing sectors also covers groups of buildings that, as a whole, affect environmental performance. CASBEE for Urban Development has formulated a tool for this purpose, but Malaysia has yet to introduce a tool for rating the sustainable housing development in both urban and suburban areas.

1.2. Objectives

The objectives of this paper are:

1. To develop a framework for a comprehensive assessment system for sustainable housing,
2. To identify factors affecting sustainability performance in Housing Development, and
3. To formulate a Comprehensive Assessment System for Sustainable Housing (CASSH) for Malaysia.

2. METHODOLOGY

The sustainability criteria comprised multiple variables to be evaluated as leverage for achieving housing sustainability in the develop area. The criteria can be categorized in six categories namely; Environment, Social, Economics, Building Forms (Housing), Site or Land usage, and Communication & Transportation. The design indicators consist of 30 measurement criteria which are important in urban design or neighborhood development plus building performance considerations highlighted in many green assessment systems. Through the literature review, a total of 131 short listed considerations can be incorporated in the model of the assessment after verification through a pilot study for reliability and validity, to suit the local context.

The formulation of the indices is proposed by multiplying the score indicating the performance of the designated area of each sustainable criterion with the defined weightage of each of the same indicator as well. The weightage coefficients between the assessment criteria will be determined by using the Analytic Hierarchy Process (AHP) to determine the weightage of each criterion as is adopted by the CASBEE. The AHP method is based on the principles of decomposition, comparative judgments, hierarchical composition which conceive as synthesis of priorities (Saaty, 1994 cited by Forman & Selly, 2002). Software of Expert Choice will also be used to facilitate the calculation of weights for the sustainability criteria and the element indicators, plus the consistency ratios of the matrices (Chan & Lee, 2007) with the development of hierarchical structure of goal, objectives and alternatives (Forman & Selly, 2002).

3. EXISTING SUSTAINABILITY ASSESSMENT SYSTEMS

Recently, Malaysia published its own first edition (version 1.0) of the Green Building Index (GBI) Assessment Criteria for Non-Residential which measures new building construction since April 2009. The outline for key components of the Green Building Index (GBI) for Residential purpose is yet to be published. The intention of the GBI for Residential is to assess the building and its external area. This system is similar to that of the BREEAM for EcoHomes in the U.K., the LEED for Homes in the U.S., the CASBEE for Homes (detached houses) in Japan, Green Star for Multi-Unit Residential in Australia, and Green Mark for Residential Building in Singapore.

3.1. Available Assessment Tools for Building

Several systems for evaluating environmental performance of buildings are currently being developed. The growth and use of environmental performance assessment methods for new construction have contributed to sustainability practices in various stages of building performance. Assessment tools have been developed with different evaluation criteria based on conditions to suit the characteristics of the countries for which the tools are designed. Table 1 identifies some of the rating tools employed by various countries. This paper focuses on BREEAM (UK), GB Tool (International), LEED (USA), CASBEE (Japan) and HQE® or recognized as High Quality Environmental standard (France). Key issues identified by the most widely used assessment tools are site, indoor environment, energy, material resources and water (Table 2).

Table 1 The various sustainable building assessment tools around the world

No.	Tool name	Country	Year	No.	Tool name	Country	Year
1	BREEAM	UK	1990	26	EarthCraft House	US	1999
2	GB Tool	International	1998	27	Built Green Alberta	US	2001
3	LEED	US	1998	28	Green Communities Minnesota	US	2005
4	CASBEE	Japan	2004	29	GreenStar	US	2007
5	HQE	France	1996	30	AccuRATE	Australia	2007
6	VERDE	Spain	n/a	31	ARE Scorecard	Australia	2003
7	Green Star	Australia	n/a	32	BASIX	Australia	2004
8	Green Mark	Singapore	2005	33	EnviroDevelopment Docklands ESD	Australia	2006
9	Green Building Index	Malaysia	2009	34	Guide	Australia	2005
10	BEPAC	Canada	1993	35	First Rate	Australia	2008
11	Green Globes	US	2004	36	SDS	Australia	1999
12	GEM	UK	2003	37	PassivHaus	Germany	1991
13	Go Green	Canada	2004	38	The Code for Sustainable Homes	UK	2006
14	HQAL	Japan	2001	39	BEAT	Denmark	2001
15	NABERS	Australia	n/a	40	EcoCalculator	Canada	2007
16	HK-BEAM	Hong Kong	1996	41	BEES	US	2007
17	EEWH	Taiwan	1999	42	Living Building Challege	US	2007
18	Green Star SA	South Africa	2008	43	LiderA	Portugal	2005
19	LEED-India	India	2008	44	LEED-Brazil	Brazil	2008
20	Green Star NZ	New Zealand	2007	45	GOBAS	China	2008
21	FGBC	Florida, US	2002	46	DGNB	Germany	2008
22	NAHB	US	2005	47	TeriGriha	India	2008
23	DDC	US	1999	48	Protocollo Itaca	Italy	2004
24	Austin Green Building Program	US	1992	49	Leed Mexico	Mexico,US	n/a
25	Colorado Built Green Housing	US	1995	50	AQUA	Brazil	n/a

Table 2 Primary issues of concern identified in each building assessment tool

Assessment Tools	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
BREEAM	X		X	X	X	X	X								
GBTool	X	X	X	X	X			X	X				X		X
LEED	X	X	X	X	X									X	
CASBEE	X	X	X	X	X					X		X			
HQE	X	X	X	X	X		X			X	X		X		
GBI	X	X	X	X	X	X	X				X				

Notes: 1.Site, 2. Indoor Environment, 3. Energy, 4. Material Resources, 5. Water, 6. Transport, 7. Health, 8. Social, 9. Economy, 10. Comfort, 11. Management, 12. Services, 13. Long term performance, 14. Design aesthetics, 15. Functionality.

Elementary sustainable urban assessment tools include measurements of economic and social sustainability in the development of the designated area (housing sector), with different evaluation criteria based on each country's local conditions. Key assessment systems are noted in Table 3.

Primary issues of concern have been identified in each sustainable urban/neighborhood development assessment tool by some of the initiative countries (Table 4).

Table 3 Assessment Tools for Sustainable Urban/ Neighborhood Development in Various Countries

No.	System Name	Country	Year
1	CASBEE for Urban Development	Japan	2007
2	LEED for neighborhood Development	US	2008
3	RHSI (Rural Housing Sustainability Index)	Ireland	2004
4	FGBC-Green Development	Florida, US	2009
5	DDC-Sustainable Urban Site Design	New York, US	2008
6	ACI - Adriatic Common Indicators	Greece, Italy, Slovenia, Other	2004
7	ACTEUR - Analyse Concerté des Transformations et des Equilibres URbains	France	2004
8	Baden-Württemberg-Indicators in the framework of the Local Agenda 21	Germany	2004
9	Catania - State of the Environment Report	Italy	2004
10	Cercle Indicateurs (CI)	Swiss	2004
11	CEROI - Cities Environmental Reporting on the Internet Indicator Database	Czech Republic, Finland, Others	2004
12	Cities21® Assessing Mutual Progress Toward Sustainable Development	Czech Republic, Finland, Latvia, Poland, Others14	2004
13	Core Indicator System of the cities Basel and Zürich	Basle, Zurich	2004
14	Czech Republic - Environmental indicator	Czech Republic	2004
15	Czech Republic - Transport Yearbook 2002	Czech Republic	2004
16	Denmark National Strategy for Sustainable Development	Denmark	2004
17	Nature Balance	The Netherlands	2004
18	EcoBUDGET	Germany, Greece, Italy, Sweden, United Kingdom	2004
19	Ecosistema Urbano	Italy	2004
20	EEA - Core set of environmental indicators	Europe	2004
21	EEA - Environmental Indicators	Europe	2004
22	The Integrated Regional Framework for the North East	England	2004
23	Environment Explorer Amsterdam	The Netherlands	2004
24	Trends and Indicators for Monitoring the EU Thematic Strategy on Sustainable (TISSUE)	Finland, the Netherlands, UK, France, Italy, Switzerland, Czech Republic	2004
25	SUDEN (Sustainable Urban Development European Network)	France, Italy, Denmark, Romania, Belgium, Poland	2004
26	Indicators for Sustainable Development in Scotland	Scotland	2004
27	Indicators For The Sustainable Development In The Mediterranean Region – ISD	Mediterranean area	2004
28	Quality of Life indicators	United Kingdom	2004

Table 4 Primary issues of concern identified in each assessment tool for sustainable urban area

Assessment Tools	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CASBEE	X		X	X	X	X	X	X		X	X	X	X	X	X
LEED	X		X	X	X	X	X	X	X		X	X	X	X	X
RHSI	X	X	X	X	X	X		X	X			X			
FSBC	X	X	X	X	X	X	X	X			X	X	X		X
DCC	X		X	X	X	X	X	X	X		X	X	X	X	X
SURPAM	X	X	X	X	X	X	X	X	X			X			X

Notes: 1.Site, 2. Indoor Environment, 3. Energy, 4. Material Resources, 5. Water, 6. Transport, 7. Health, 8.Social, 9. Economy, 10. Comfort, 11. Management, 12. Services, 13. Long term performance, 14. Design aesthetics, 15. Functionality.

4. ESTABLISHING A RATING SYSTEM FOR HOUSING DEVELOPMENT IN MALAYSIA

Since 2009, Malaysia had established a rating system in order to achieve sustainable development in building with incorporating criteria of green architecture. The rating system is

known as the “Green building Index (GBI)” which developed by Persatuan Arkitek Malaysia (PAM), which is the Architect Association of Malaysia and Association of Consulting Engineers of Malaysia (ACEM).

According to Tony Arnel, the chairman of World Building Council, the major greenhouse gases (GHGs) emissions were contributed by building sector. Simultaneously, this statement do consonant with the citation of Organization for Economic Cooperation and Development (OECD) that said buildings account for 25-40% of total energy consumption (UNEP, 2007). Tackling over the root cause contributed by building characteristics might prevail over the matter of global warming as building has a significant impact to reduce the GHGs (Herbert, 2009).

In conjunction with the environment conservation, the GBI association had taken the initiative to establish two distinguished rating system tools that differentiated the non-residential and residential type of buildings. The design specification of these rating tools was established based on the Malaysia tropical climate and geographical identities, which is hot and humid for the whole year, and to protect the sake of environmental, cultural and social developments in Malaysia context (GBI, 2009).

The establishment of GBI’s rating system tools incorporated six key assessment criteria in the rating tools in order to measure the sustainability of the building sector that being developed. The standardized sustainable criteria embraced energy savings, water savings, a healthier indoor environment, better connectivity to public transport and the adoption of recycling and greenery for their projects and reduce the impact on the environment (GBI, 2009).

Notwithstanding the GBI association had established the building rating tools for measuring the sustainable of non-residential and residential development, however, these rating system tools are yet to cover the whole building surrounding development elements in the designated area. According to CASBEE for Urban Development, the Japanese rating system explicitly explained that the measurement should cover the group of building in the designated area. The assessment of environmental can be extensive when comprises multiple buildings and other elements on a single, large-scale site under a unified design concept (CASBEE-UD, 2007). Synchronically, the important of measurement concerning the building surrounding area in the hypothetical boundary emphasized in LEED for Neighborhood Development (LEED-ND) as well. The LEED-ND advocated including the assessment criteria of “enhance the overall health, natural environment, and quality of social communities’ life” in order to achieve the sustainable development in particular designated area.

The proposed assessment model for housing sustainability index will be addressed as Malaysia’s Comprehensive Assessment System for Sustainable Housing (CASSH). It comprises three major levels, that is, the outcome, design measurement indicators, and sustainability criteria level. The schematic diagram is as shown below in the theoretical framework in Figure 1. The goal level describes the ultimate achievement of the model. It attempts to generate the most sustainable housing development for an area either undergoing new development or renovation. The proposed assessment model try to evaluate an area of development as a whole, plus evaluates the environmental performance of individual buildings within the designated area as well. The framework requires the assessment method that integrates the neighborhood of group of buildings constructed in the designated area and also consider the assessment of the interior environment performance of the building (housing) itself.

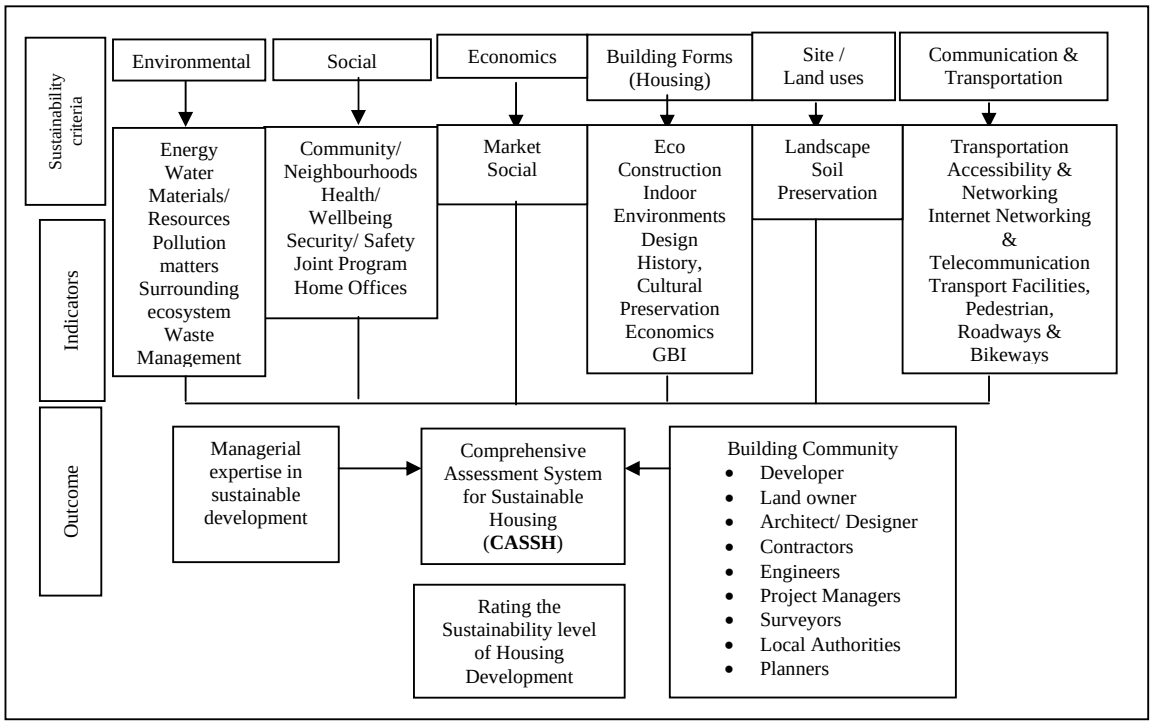

Figure 1 Conceptual frameworks for Comprehensive Assessment System for Sustainable Housing (CASSH)

4.1. Establishing of the Assessment Model

Indices are widely used in performance evaluation and have proven useful in locating weaknesses in overall design systems (Bell & Morse, 1999). The index is generally a number derived from the collection of a broad range of individually generated values or indicators that are used to characterize or evaluate specific aspects of the system (Gray & Carton-Kenny, 2004). The following are some examples of rating systems have been established successfully for measuring the sustainability of housing development in respective countries.

Rating system (1)

Gray & Carton-Kenney (2004) studied the sustainability index for rural housing. The sustainability index comprises 70 indicators categorized by site, design, construction and social. The criteria used in the selection of sustainability indicators included: policy relevance, simplicity, validity, affordable data, reality, adequate scope and openness. For example:

$$RHSI = \sum_{i=1}^{n} q_i w_i \quad (1)$$

where *RHSI* is the rural housing sustainability index, n is the number of indicators, q_i is the score of the *ith* indicators and w_i is the weighting attributed to the *ith* parameter.

Rating system (2)

In CASBEE of Urban Development, both Q_{UD} (environmental quality in urban development) and L_{UD} (outdoor environmental loads in urban development) are evaluated and scored separately. All categories are also compounded using the formula below to generate BEE_{UD}, an indicator for Building Environmental Efficiency in Urban Development:

$$BEE_{UD} = \frac{Q_{UD}}{L_{UD}} = \frac{25 \cdot (SQ_{UD} - 1)}{25 \cdot (5 - SLR_{UD})} \quad (2)$$

where Q_{UD} is environmental quality in urban development and L_{UD} is environmental load in urban development.

Rating system (3)

Chan & Lee (2007) illustrated the assessment mechanism of SURPAM on the basis of Hong Kong's context for evaluating the sustainability level of individual urban renewal projects by assessing the design quality of the projects. The formula for SURPAM is:

$$P_k = {}_jW_j \, x \, Sk_j \quad (3)$$

where P_k is the overall score of an urban renewal project k, W_j is the final weight of criterion j in third level, Sk_j is the score of project k on criterion j, and j is the 17 design criteria.

Proposed Assessment Model for CASSH

In order to address the sophisticated problems of housing sector development, the authors suggested the sustainability level of housing development which is represented by the overall score of using formula of CASSH (Comprehensive Assessment System for Sustainable Housing) model. The calculation method is similar to the CASBEE for Urban Development and SURPAM of Hong Kong measurement. The overall score of the sustainable development area is calculated by using the proposed formula below:

$$CASSH = \sum SC_n \, X \, W_n \quad (4)$$

Where *CASSH* is Comprehensive Assessment System for Sustainable Housing, n is the numeric indicator for each of the sustainability criteria parameter, SC_n is the score of the Sustainability Criteria of each of the n indicator and W_n is the weightage attribute to the n indicator to each Sustainability Criteria.

The calculation of final score of CASSH on a particular project is as listed below:

$$CASSHp = \sum EnxW_{En} + ScxW_{Sc} + EcxW_{Ec} + BxW_B + SxW_S + CTxW_{CT} \quad (5)$$

Where *En* is represent Environmental criteria, *Sc* is represent Society criteria, *Ec* is represent Economics criteria, *B* is represent Building Forms criteria, *S* is represent Site/ Land uses criteria and *CT* is represent Communication & Transportation criteria.

In order to calculate the overall score, it is necessary to define the value of the component of each indicator. The element of criteria and the indicators for CASSH assessment rating system in fact retrieve from the literature review from other established assessment rating systems. The recognition of housing sustainable development assessment criteria will be at the same as the principles as shown in the conceptual framework of CASSH, which means that the elementary of sustainable development of residential area should embraced environmental, social, economic, building form, land utility and the conveniency of transportation and facility. Gibberd (2005) suggested that the social and economic issues are essential to be included in the sustainable development of developing countries. In addition, the CASSH will also take into consideration the health advantages for the whole of residential society. The establishment of CASSH rating system reciprocal the research study of the building forms, climate conditions, economics of the local state, group of society in local community, authorities of those stakeholders in housing development and the system being established.

According to Hikmat & Saba (2009), the uniqueness of each rating system is distinguishable from the aspects of local context, the country cultures, political issues, resources availability, priorities of the stakeholders' expectations, country developing performance and the structural of organization institutions.

5. CONCLUSION

A majority of countries, especially developed countries, have their own established building assessment systems to assess for sustainability. For example BREEAM in the UK now has multiple tools for different building designs, such as Ecohomes, Healthcare, Industrial, Multi-residential, Prisons, Office, Retail and Education Buildings. However, it is also important to evaluate environmental performance for a group of buildings. This means evaluating the surroundings of the designated area; in other words, assessing the buildings' neighborhood. The common district for buildings within a district can raise environmental quality and performance throughout the area. Thus, the Comprehensive Assessment System for Sustainable Housing (CASSH) has been designed to assess a wider scope of housing sector development.

The analysis of the existing assessment tools and design methodologies has shown that there is considerable emphasis on environmental issues. However, in the holistic approach, every aspect of the sustainability parameters must be assessed to ensure a more pragmatic effort in preservation of the environment. The assessment tools are intended to be used as guidelines during the design process and as a more general sustainability assessment rather than as a specific architectural evaluation tool. The evaluation of housing sector development not only includes the surroundings of the building being developed but also should include the assessment of building performance, since the building's performance will have significant impact on environmental issues.

The establishment of CASSH, the housing sustainability index, is an assessment tool to evaluate the designated area identified by CASBEE Urban Development, and the buildings themselves within the hypothetical boundary of the defined area. The formula of sustainability index in housing development will be produced by adapting critical factors to the successful practice system tools developed in Japan, United States and United Kingdom. These indicators for sustainability parameters should be recommended for incorporation into policies on sustainable built environment and should take into account criteria compatible to the local context. The rating system is still in its infancy stage and further study is required to ensure the reliability and viability of this system as a tool for measuring sustainability in housing development.

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