

# 10 Criteria of Sustainable Housing: A Literature Review

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## ABSTRACT

This paper reviews studies on sustainable housing criteria based on their implementation. This paper proposes studies on sustainable housing criteria from previous researchers. The analysis of this study was developed by reviewing several studies about sustainable housing criteria in general. Sustainable development has become an important concept to help humans achieve their needs wisely. This concept can be achieved through a decision-making process that integrates and recognizes the existence of environmental, economic, and social problems. The adaptation of the sustainable development concept within the scope of architecture creates an understanding of the existence of sustainable architecture. Sustainable architecture has begun to apply the concept of sustainable development from the small case to the large scale buildings. It can be implemented through the logical use of technology in buildings, energy-saving, creating and using efficient construction, renovation, operation, maintenance, and demolition models, as well as minimizing the negative impact of buildings on the environment. Above all, it is important to keep in mind that the biggest challenges to sustainable development can start from the housing to the larger space. This paper may help readers to identify how sustainable practices on the scale of housing are developed and applied all the implementations through 10 criteria of sustainable housing based on environmental, economic, and social aspects from the previous journals. These 10 criteria also can be used to create a parameter or assessment of sustainable housing as an outline by adjusting the implementation to the prevailing needs in further study.

**Keywords:** *Sustainable architecture, sustainable housing, sustainable housing criteria, sustainability aspects, sustainable housing implementation.*

## 1. INTRODUCTION

In the WCED report "Our Common Future" (1987) the concept of sustainability can be defined as a development carried out to meet current needs, without reducing the ability of future generations to meet their own needs both in social, economic, and environmental aspects [1]. Sustainable development is an effort to ensure that the activities carried out now will be sustainable in the future and not have a negative impact on the environment [2]. The ultimate goal of sustainable development can only be achieved through a decision making process by integrating and recognizing economic, environmental, and social problems [3]. In its development, the adaptation of the concept of sustainable development in the world of architecture is often known as sustainable architecture, environmentally friendly architecture, and green architecture which broadly aims to create a better life for humanity [4]. The sustainable architecture has begun to apply the concept of sustainable development in every kind of building, even from the smallest case unto the larger building scales. It also can be applied through a very simple implementation until the hi-technology systems by logical use of technology as well as minimizing the

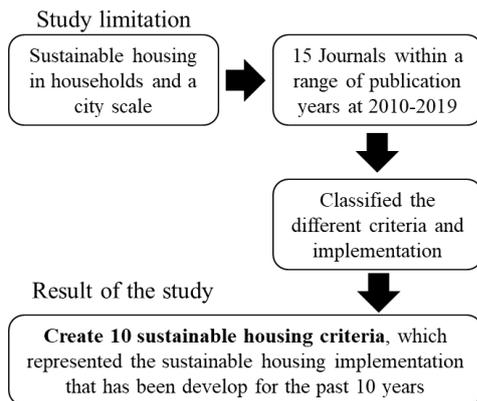
negative impact of buildings on the environment. Sustainable in architecture that contains the social, economic and environmental aspects shows a higher concern on the environmental aspects and the almost total absence of the social and economic aspects in references [5]. This real condition about the sustainability aspects that applied will obstruct the sustainability itself, because to maintain sustainability these three aspects must be in a balanced relationship [6], [7], in order to fulfilled the improvement on human living standards and maintain our ecological systems sustained effectively [8].

Human intention to implement the sustainable architecture on buildings can start from the smallest case, such a house. The highest sustainable architecture implementation in every kind of architecture building can only be achieved if the adaptation of the concept "sustainable development" produce buildings that work together and do not conflict with nature [9]. In fact this sustainable living environment can only be achieved if any environmental issues and problems with the development are given equal emphasis in housing development [8], and followed by the Government and the construction leaders that lead the housing industry towards energy efficiency and develop sustainable practices that represent the social, economy and environmental aspects [10].

**1.1. Research Limitation**

This journal is about to discuss about sustainable architecture implementation in a scale of housing, as the smallest scale and also the most energy consumer and contributor in climate change [11]. To review the implementation that could be applied in housing scale, these journals discuss all the simple things to the hi-technology implementation from previous journals. This journal will provide some previous studies about sustainable housing that provide criteria's and implementation in a housing and residential scale or even a city scale. The selected journals are within a range of publication years at 2010-2019 that discusses the distribution of sustainability in the context of households and housing on a city scale. The journal will discuss sustainability in housing at least within 2 aspects from the 3 aspects known as: social, economic and environmental. This study will look at the relevance and sort each application applications and implementation in 10 different criterions that represent all the previous journals. As shown in Diagram 1 - Study limitation diagram, there are two results that the author expects from this study.

**Diagram 1 - Study limitation diagram**

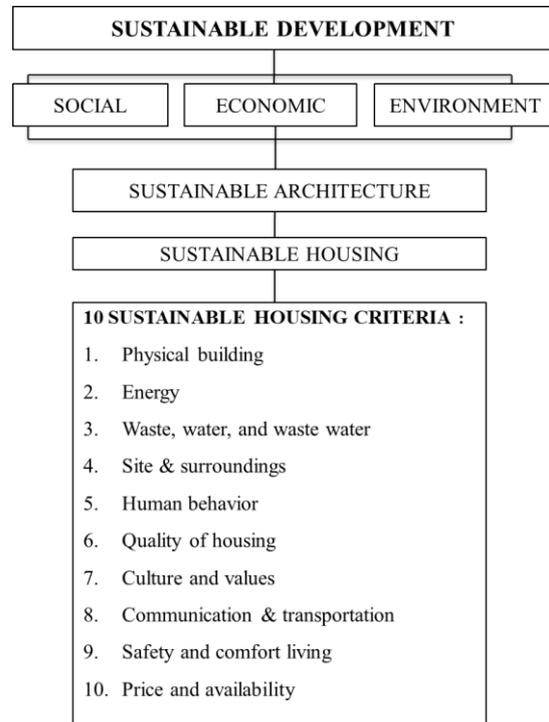


**1.2. Paper Structure**

The rest of the paper is organized as follows. Section 2 will explain the background used in this paper to discuss sustainable housing criteria in terms of sustainable aspects. This section will provide the whole picture of sustainable architecture in short, to discuss sustainable housing specifically in this journal. Section 3 will examine the journals that already chosen, and divide them into criteria, and application in terms of sustainability aspects. All the criteria and application that shows in every journal will be classified as 10 categories that will represent the sustainable housing aspects. For the last section 4, the author will conclude the paper and presents the result for future research. This can be a reference to how sustainable practices on the scale of housing are developed and applied through 10 criteria of sustainable housing based on the environmental, economic, and social aspects.

From the limitation that has mentioned before, this study purpose is to create 10 sustainable housing criteria to support the sustainable development from sustainable architecture.

**Diagram 2 – Purpose of the Study**



**2. BACKGROUND**

Development is considered important because it is able to create jobs for human as needs and increase the country's growth and development, but on the other hand this sector consumes a lot of energy and contributes the most to Earth's pollution [12]. In fact the buildings where we live, work and play protect us from the extreme conditions of nature, can also affect our health and the environment [13].

As sustainable development, sustainable architecture also aims to produce mutual support between social, economic, and environmental aspects with availability of adequate public health services, peace creation, gender equality, human rights, availability of decent work, quality education facilities, law enforcement, proper production, while preserving the environment [14]. There are many ways to achieve sustainability: by an effort to carry out development that does not require extensive regeneration [15], using an appropriate technology in buildings logically [9], energy savings [16], create and using healthier and more resource-efficient in construction, renovation, operation, maintenance, and demolition models [12]. Reducing the negative impact of buildings on the environment, and minimize climate change while reducing pollution and improving air quality and

population health [17], is also an effort to achieve the sustainability aspects. The biggest challenge of sustainable development remains a global awareness from the household into the meeting room regarding the importance of overcoming the challenges of the Industrial Revolution which: unlimited human and environmental exploitation [18]. It was observed that there was a higher attention to environmental impacts and lack of social and economic references so that analysis on different tools from various countries is very useful for a more integrated approach that will include other social, economic and significant parameters and significant parameters [5] even in the scope of a sustainable house. As mentioned in previous research that residential and houses is a major energy consumer and contributor to climate change [11], so it is important to see how the implementation of sustainable housing to balance human behavior which also contributes to various environmental issues [19]. In order to support the sustainable housing practice, the analysis on different tools from various countries is very useful for a more integrated approach that would incorporate social, economic and other significant parameters [5].

### 3. SUSTAINABLE HOUSING CRITERIA

Sustainable housing is an important thing to support human health, sustainability, and safety [20], while sustainable housing practices need to integrate the three aspects: environment, social, and economic together [21], [22]. There is a lot of things that human can start living a sustainable housing by its own, even from the smallest implementation with the affordability cost [23]. As one example, a previous study already had a concern on affordable material of housing need some improvement [24], especially for people who have a low-income household who need a sustainable housing affordability [25]–[28]. This practices also depend on the Government, architects, developer, community residents, and the construction leaders to create the sustainable housing that implies the criteria and implementation mentioned before [10], [29]–[31], with integration of land use, social, economic and environmental consideration [8], [32].

In order to maintain the continuance of sustainability housing programs, the programs need to always evaluate the economic viability, socio-cultural acceptability, technical feasibility, and environmental compatibility [33]. With the aim of increasing the level of sustainability potential in residential research, this study will discuss sustainability implementation on housing or a residential scale that can be applied. The criteria of sustainability in housing will be examined based on the application that has discussed in previous journals related to sustainability in housing. This journal will categorize all the implementation or application that showed in every journal to 10 sustainable housing criteria. This 10 criterion will be represented by the alphabetical codes in table 2 (10 Sustainable housing criteria) at the end of the sentence to show the most represented aspects from 10 sustainable

housing criteria. The 10 criteria in this study will describe as follow:

(a) Physical buildings: the goal of sustainable housing is to ensure minimal negative effects of buildings and their operations, which impact human well-being and environmental conditions through better design in terms of position, construction, function, maintenance and the entire building life cycle [34].

(b) Energy use: the implementation of saving energy in housing need to be improve [35], known that housing consumes a lot of energy and contributes the most to the pollution of the Earth [12].

(c) Waste, water and wastewater (WWW): water features and their management is one of the principles of a green architecture. [13], and a waste management in a housing scale reduced the illegal dumping and increased the volume of recovered material to lower the costs to city and county council [36].

(d) Sites and Surroundings: The green environment is a critical factor in housing that contributes to physical and mental health, and also support the quality of life and thus their sustainable happiness [37].

(e) Human behavior: this aspects are important because almost all the development happens because of human act, and the lack of knowledge about human behaviors, attitudes and values is an important problem to architects and planners that will support the sustainable housing implementation [38].

(f) Quality of housing: this quality of housing is related to the users standard of living, the house need to meet the needs, have a self-support financial system, building management, circular economy , and also a good area for employment opportunities [8], [32].

(g) Social culture and values: implementing the sustainable housing practices also need to consider the influence of culture and the prevailing context, as a potential aspects to improve the implementation of the sustainable housing criteria [39].

(h) Communication and transportation: sustainable houses need to support the long distance communication and facilitate the mobilization of the people with the environmental friendly transportation [21], [40]

(i) Safety and comfort: to reach the safety and comfort in sustainable housing, we need to supply the social infrastructure required for sustainable communities. Adequate staffing of community services, management and maintenance of sustainable housing, and a good community also contribute to the sustainable development in the context of housing [41], [42].

(h) Price and availability: sustainable housing need to be available for people in every economy situation, even the low income households [25]–[28]. These methods help the author to categorize all the implementation that has been discussed by 10 previous journals.

The main table of this study Table 2 (previous journals of sustainable housing) will provide the information of the 15 previous journals about the main discussion, criteria, implementation, applications, and also the sustainable aspects code and criteria code that will be needed to inform the reader.

**Table 2 - previous journals of sustainable housing**

Author	Details	Criteria	Implementation and Applications
Construction Management and Economics  [43]	Sustainable housing for low-income communities: Lessons for south Africa in local and other developing world cases	Minimize resource consumption	Passive thermal design, low embodied energy materials (a), energy efficient system (b), water efficient systems, water efficient landscaping, water harvesting (c), durable materials, economical design (a)
		Maximize resource reuse	Design for disassembly, Reuse waste materials, Reuse old building (a), Grey water systems (c)
		Renewable/ recycled	Renewable energy (b), Renewable materials, Recyclable materials/design for recycling, Use of recycled materials, Recycle construction waste & other (a)
		Protect natural environment	Environmentally friendly materials (a), environmentally management system/EIAs (f), suitable sanitation system (c) (i), mixed use/high density layout, design with nature (natural vegetation) (d), produce minimal waste (c), replant vegetation , restore natural systems (d)
		Create a healthy environment	Nontoxic products/safe appliances, natural (i), permeable materials & ventilation (a), appropriate site & position, green & open space, flexibility (d),
		Pursue quality in the built environment	Compact & efficient layout (f), social infrastructure & mixed usage (d), functional & appropriate to needs (f), aesthetically pleasing (g), durable materials & structure (a), humane building contributing to overall well-being (f)
International Journal Of Technology  [5]	CASSH (Comprehensive Assessment System For Sustainable Housing)	Environmental	Energy efficiency (b), water conservation, waste management (c) materials/resources, pollution matters (a) and surrounding ecosystem (d).
		Social	Community/ neighborhoods health/wellbeing security/ safety joint program home offices (i).
		Economics	Market and social life (d) (f) (i).
		Building Forms	Eco construction, indoor environments design history, cultural preservation economics GBI (a).
		Site / Land Uses	Landscape, soil preservation (d).
		Communication & Transportation	Internet networking and telecommunication, transport facilities, transportation accessibility and networking, pedestrian, roadways and bikeways (h).
Sustainable Development And Environmental Protection  [33]	Framework for evaluating the sustainability of public housing programmers in developing countries	Environmental & Technological Dimensions	An architectural solution to energy consumption issues as ventilation, lighting, building morphology (b), quality of housing environment, quality of neighborhoods environment, housing density/building type (i),type of building/ construction materials, construction techniques (a), locational appropriateness to reduce dependency on the car (d), storm water discharge system, waste management system, main sources of power and water supply (c), open spaces and green areas, landscaping elements (d), noise level (i).
		Economic Dimension	Housing affordability (j), job creation, cost of living (f) adaptability of housing units for future needs (j)
		Social Dimension	Access to social infrastructure, recreational/ sporting facilities, places of work and worship (d), security and safety issues (i), level of social mix

			in housing environment (g), quality of internal spaces of housing units, privacy in dwelling units (i), the contribution of public housing to the aesthetics of urban landscape and morphology (d).
		Cultural Dimension	The architectural design of housing in relation to cultural values of residents, natural way of life, a reflection of the unique historical and cultural characteristic (g).
8th International Conference on Environmental Engineering, ICEE 2011 [25]	Criteria for sustainable housing affordability	Prices, Interest and availability	Housing affordability suitable the household income (f), a sufficient range of affordable housing within a balanced housing market (j).
		Safety	Low crime and safe residential environment (i).
		Employment	The availability of employment opportunities (f).
		Public transport services:	Access to good transport services (h) to make a good place to live and to create a thriving community (i), transportation costs directly impact on housing affordability (j), a transit-rich environment can have a positive effect on a household's disposable income (f).
		School	The availability of a good education for an individual's future (d).
		Shops	Shopping facilities as a thriving community and attractiveness (d).
		Health Services	The availability of health services (d), a good place to live and for creating sustainable communities (i).
		Child Area	Access to child care facilities (d) may ultimately affect a parents' ability to go out to work if such services are inaccessible (f).
		Leisure Facilities	Both adults and children can spend their free time in leisure facilities (d) and participate in activities that support a healthy lifestyle (i).
		Open green public space	To relax and interact (d), encourage community cohesion (i).
		Quality of Housing	Affordable housing also needs to meet certain quality standards (j).
		Energy efficiency	Improvements to energy efficiency (b).
		Waste facilities	Waste management and facilities (c).
RSPCB Occasional [40]	Sustainable Housing: Balancing Environment with Urban Growth in India	Green Infrastructure	purification of air and water (c), pollution control, mitigation of floods and droughts, re-generation of soil fertility, moderation of temperature extremes, carbon sequestration (i) climate change mitigation and enhancing the landscape quality (d).
		Wastewater Treatment, Recycling And Appropriate Use	Wastewater reused and contamination checked of soil water, land and water resources to face the scarcity and using waste water to partly fulfill the water requirements of per-urban farmers (c).
		Waste Management	Managing solid waste (c).
		Green Transportation	Good quality and affordable mass transportation system, road infrastructure, fuel quality and traffic planning (h)
		Affordable Housing	Affordable housing to the poor , avoid the development of slums (j).
		Energy	Combine energy with other interventions, renewal or fossil fuel-based energy sources, shift energy sources, and improve energy efficiency (b).
		Recovery of Full Costs , and Reinvestment in Urban Services	Recover the costs of services by proper functioning and maintenance, organization of economic activities financial, economic and market instruments need to be aligned to provide incentives (f) enhance energy efficiency (b), encourage recycling and reuse (c), greening the urban economy.

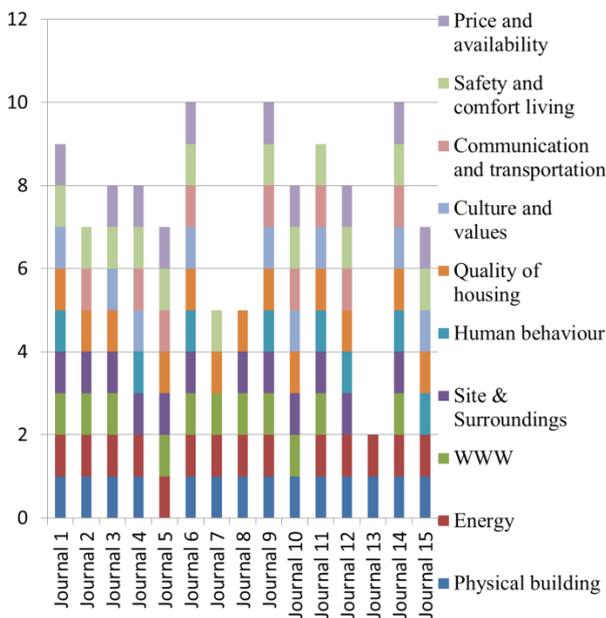
<p>Sustainable Housing for Sustainable Cities [22]</p>	<p>Sustainable a Policy Framework for Developing Countries Cities</p>	<p>Sustainable houses design build and manage</p> <p>Healthy, safe and secure (i), durable, resilient to sustain potential natural disasters and climatic impacts (d), affordable for the whole spectrum of income levels (j), using ecological low-energy (b) and affordable building materials and technology (a), connected to decent, safe and affordable energy (b), water, sanitation and recycling facilities (c), using energy and water most efficiently and equipped with certain on-site renewable energy generation and water recycling capabilities (b) (c), not polluting the environment and protected from external pollution (e), suitably located in terms of jobs (f), shops, health-and child-care, education and other services, properly integrated into (h), and enhancing, the social (d), cultural and economic fabric of the local neighborhood and the wider urban areas (g), properly run and maintained, timely renovated and retrofitted (f)</p>
<p>Journal of Cleaner Production [35]</p>	<p>Energy-efficient design for sustainable housing development</p>	<p>Architectural</p> <p>Application of passive solar (a), Use energy efficiency and renewable energy sources (b), Use wooden logs to provide structure and insulation , Optimization building orientation and configuration, Application of green roof technology, Optimization building envelope thermal performance , Insulation (roofs, windows, floors, walls and exterior doors), Application of natural, Ventilation, Ample ventilation for pollutant and thermal control (a)</p> <p>Mechanical</p> <p>Cooling and heating system (environmental friendly materials for HVAC system) (a) (b), Application of ground source heat pump, Application of efficient water heating, Application of solar water heater, Insulation tank and pipes, Demand tank less water heater, Application of thermostats (b) (c)</p> <p>Electrical</p> <p>Making clean electricity (application of solar system technology), Application of lighting choices to save energy (b), Application of lighting product, Application of artificial lighting, Use off efficient type of lighting (lighting output and color) (i), Integrative use of natural lighting (day lighting) with electric lighting system (b) (f)</p>
<p>Architectural Engineering Technology [24]</p>	<p>Sustainable Housing and Building Materials for Low-income Households</p>	<p>Construction</p> <p>Using a comprehensive passive solar design, using strategic shading of trees and plants in tropical climates, local construction materials, Insulating walls and roofing, natural ventilation, using small-scale solar panels, installing reflective window film, overhanging roofs bin verandas and painting outside walls with reflective paint and color (a).</p> <p>Location</p> <p>Building orientation: using passive solar energy and insulation of ‘back’ at north orientation, ventilating and insulating as well as backward sun-orientation of houses in tropical climates, solar panels and collectors on roofs later, designing adequately-sized housing plots (not too big or too small) (a), designing individual sanitation solutions that are environmentally acceptable, using septic tanks or a collective sewer solution for urban situations (c), designing for tree-lined streets in order to lower environmental temperatures, designing for neighborhoods parks, playing grounds and footpaths, building homes around collective courtyards to stimulate community interaction, designing city gardens for leisure and growing vegetables (d). · designing houses with space for commerce and workshops and connections to main roads (f).</p> <p>Behavior</p> <p>Using day lighting and energy-saving bulbs, insulating houses (a) cooking with gas instead of wood, using solar cookers (b), using water-saving measures in showers and toilet (c).</p>
<p>MATEC Web of Conferences</p>	<p>Investigation of Sustainable Housing Criteria</p>	<p>Inexpensive</p> <p>The housing and accommodation should have been constructed, administered, and upheld at a judicious cost (j).</p> <p>Socially And Ecologically Suitable</p> <p>Support services and facilities (d) the type, size, and terms of accommodation should aid comprehensive ecological, social, and economic sustainability policy goals (a) (j) (i).</p>

[34]		Accessible And Flexible	Travel liberally within and across the development, access buildings (d), houses should be adaptable enough to the varying needs (f).
		Resource Efficient	Renewable energy sources should be utilized optimally (c), infrastructure, land, and energy should be utilized effectually (b), well-located in terms of conveyance, services, and facilities (d), design as well as house position to manage negative wind impacts and maximize the advantages of daylight, sunlight, and solar paybacks (a).
		Safe, Secure, And Healthy	The housing should be a safe and healthy place to stay (i). Cyclists and pedestrians should find easy and safe to travel within and across the locality (h).
		Long-Lasting	The finest construction methods, service lifespan of around sixty years without the requirement for uncharacteristic repairs or replacements (a).
		Architecturally Proper	The places where accommodations are located, a pleasing environment (d), the design should be comprehended and respond to its context, enhance the vicinity (i), high regard for its cultural legacy (g), the way they are designed and constructed (a), and the manner in which they interlace with the socio-cultural, environmental and economic structures of communities (e).
Planning Malaysia [44]	Sustainable housing affordability in Sabah	Sustainable housing affordability 26 factors	Housing price (j), housing type, housing finishes, housing design (a), position of the unit in layout plan (f), size of built-up area, size of land area (a), age of the unit (a), topography (d), property interest, near to commercial area, near to hospitals, near to post office, near to recreation area (f), public space (d), near to transportation (h) , near to education (d), near to workplace (f), environmental quality, security (i), traffic congestion, density, view, exterior condition, availability of waste management (c), safety level (i), theme or concept (g)
Energy Procedia [45]	Sustainability assessment of family house from Building environmental assessment system (BEAS)	Site Selection And Project Planning	Selection of location near the commercial cultural facilities area, and avoiding vulnerable things such as floods (d). Possibility of connection to engineering networks of renewable energy sources (b) and building orientation concern to maximize the passive solar design (a). Adapting the local cultural values (g), the availability of green spaces (d), and transport infrastructure (h).
		Building Construction	Using local materials and recycled materials. Substitutes concrete, concerning radioactivity of building materials and life cycle of materials (a), and awareness of global warming potential (e).
		Indoor Environment	Maintaining thermal comfort during the heating season and cool season, using natural ventilation and mechanical ventilation. Building exterior to isolate noise, the use of lighting elements, and the use of shading and blinds. The use of materials that blocking pollutants transferred from the garage to the house (a) (i).
		Energy Performance	Operation energy for heating, domestic hot water, mechanical ventilation, lighting, and cooling. Active systems for renewable energy such as solar system/heat pump, photovoltaic technology, heat recuperation. (b).
		Water Management	Water management surface runoff, reduction, and regulation of water flow, water supply for drinking, and grey water system (c).
		Waste Management	Waste disposal management measures to minimize waste from building operations and minimize emissions resulting from air pollution. (c).
International Journal of Sustainable	Critical Success Factors (CSFs) for achieving	Economic factors	Adequate funding and provision (j), provision of infrastructure services (d), appropriate construction technology (a), economic design, efficient use of resources (f), good governance and political will (i), efficient management, effective legal and policy frameworks (f).

Built Environment [32]	sustainable social housing (SSH)	Environmental Factors	Environmental of appropriate materials (a), appropriate land use and development plan (d), good accessibility and provision of adequate alternative transport modes (h), environmental protection (b) (e)
		Social Factors	Security of lives and properties , community development and social services, promotes social cohesion (i), ensuring welfare and quality life, skills acquisition and job opportunities, promotes equity, quality housing provision, public awareness, stakeholders' participation (f)
Engineering Sciences & Research Tech [17]	Ecological approach to sustainable housing development	Energy	Design, materials, and construction initiatives to reduced energy (b).
		Materials	The process of sourcing, transportation, manufacturing, and construction of materials is vital to reduce the embodied energy used in housing production (a).
Sustainable Cities And Society [21]	A comparative analysis of sustainable building assessment methods	Site And Sustainable Development	Planning and designing the regeneration and influence of the characteristics of the site (g), availability of transport management (h) and external light pollution (d).
		Water	Water quality, water cycle, monitoring use and various water sources (c).
		Materials And Resource Consumption	Material use, recycling, reuse, and concern of environmental impact from materials and resources (a).
		Energy	The reduction, consumption, control, and use of energy in housing (b).
		Indoor Environmental Quality	Environmental ergonomics such as reduction and elimination of pollutants (b), hydrothermal and acoustic comfort, and light quality (i).
		Innovation	Designs, processes, and building strategies promote sustainability movements in the built environment and building (a) (e).
		Social & Economy	Using traditional local materials and techniques that compatible with cultural values (g), and the cost of use and commercial viability (j).
		Service Quality	Spaces efficiency (a), local control of the different systems, and the efficiency (b) of an adequate maintenance and management plan (f).
		Circular Economy	Using reuse building material resources, systems and subsystems (a).
Journal of Cleaner Production [46]	Group self-build housing: A bottom-up approach to environmentally and socially sustainable housing	Energy efficiency	Better understanding of the home energy system, ability to specify higher standards of energy efficiency (b), sharing information and awareness about zero carbon, lifestyle choice (e), shared energy system, stimulate demand for zero carbon/energy efficient homes (b), lower cost frees up funding (f), explore lower impact materials and methods (a)
		Affordability	Economies of scale in construction, access to funding/finance available only (f), lower running costs (j).
		Quality Innovation	Self-builders have a vested interest in quality, prepared to take risks with unproven technologies (a) (b), self-build inspires innovation and creativity (b)
		Sustainable communities	The act of building as a group builds community bonds, homes for local people, resilient, less transient community (i), Supports (adaptation to) sustainable lifestyle, shared energy systems (e), variety – more interesting urban design, empowering, build skills and confidence, supporting local businesses (f)
		Meeting the needs of occupants	Ability to procure a tailored design, increased satisfaction, greater input into specification and materials (a) (g)

This table made to conclude the discussion in every journal only in sentences, the author already compresses every application and implementation that has been shown in the previous study to be more understandable. Every implementation and application has been directed to the realm of more universal discussion because there is some of the previous discussion focused on examining a special case in a country. The sustainability aspects code on the right side of the table was given by authors' interpretations from previous study discussion. Table 2 (previous journals of sustainable housing) also shows that every discussion might name and implement their criteria differently, but most of them contain the same thing in different ways to support sustainable housing. As every journal has more than one criteria that support sustainable housing with more than one implementation, we can also see what kind of criteria that every journal has, and see what is the most often criteria appears and discussed Graphics 1.

**Graphics 1 – Sustainable housing criteria trend**



From Graphics 1, we can see that 14 journals talk about the physical building and energy as criteria out of 15 journals. Energy and physical building as criteria has become the main concern of sustainability implementation [35] and application to support the sustainability aspects [17], when human behaviour has appeared less frequently in discussions although this criteria is also play a role to support the sustainable housing criteria implementation especially from the social aspects [47][48][49]. This also shows that the journals concern in these two criteria is not much as the others criteria, when in fact that the social-economy is the fundamental obstacle of applying the concept of sustainable development [50]. This may also happen because every country has a different problems and main concern that need to developed from the

sustainability aspects, and all the 10 journals has come from various cities background, characteristics and potentialities [51][52][53][54].

**Table 3 - 10 Sustainable housing criteria**

No	Sustainability Aspects and Limitation	Code
1	Physical building : Materials, construction, building shape, physical building, climate change adaptation consequences without incurring damage, green area, and building durability and etc.	(a)
2	Energy : The energy use of the building, building emission, the using of technology for new energy resources, maintenance etc.	(b)
3	Waste, water and waste water (WWW) : managing solid waste, reusing waste water, using the potential of rain water, etc.	(c)
4	Site & Surroundings: Land use, location, green infrastructure, facilities, shops, health services, children's areas, leisure facilities, green open public spaces, school, etc.	(d)
5	Human behaviour: Not polluting the environment, ecological behavior, pro-environmental behavior.	(e)
6	Quality of housing : House meets the needs, self-support financial system, building management and policy, circular economy, a good area for employment opportunities, etc.	(f)
7	Culture and values, which should apply in housing.	(g)
8	Communication and transportation : The availability of internet networking, pedestrians, bikeways, public transportation services, green transportation, properly integrated, etc.	(h)
9	Safety and comfort living : Healthy place to stay, healthy community, sustainable communities, low crime, safety, acoustic comfort, light quality comfort, noise level, etc.	(i)
10	Price and availability, of the sustainable housing.	(j)

Human rights to achieve a good standard of green environment and sustainability living also need to be considered by other criteria such site and surroundings, communication and transportation, safety and comfort living [41][37]. Human technologies and education has developed in building science through sustainable architecture, and this movement also developing into sustainable housing. From all the previous study we can

conclude that there are 10 sustainable housing criteria that have different implementation at Table 3. Every criterion has their own purpose that can be more expandable by any research and founding, but we can understand that they all are the way to expand the three sustainable aspects: social, economic and environmental which also needed to apply in sustainable housing.

As the table before, we can also see that every application or implementation suggested by each journal mostly has more than one aspects of sustainability that are bound to one another, where we can increasingly be convinced that the principle of sustainability cannot indeed stand-alone [21][22]. The implementation of building energy efficiency in this study is also purpose to reduce the maintenance cost that also represent the economic aspects and a healthy house movement that make a self-initiated communal activities that has purpose to environmental awareness also needs a social aspects as humans and community to actualize the environmental needs.

#### 4. CONCLUSION

From this study, we can conclude that all the implementation and application of every journal can be categorized through these 10 sustainable housing criteria as: physical building, energy, waste, water, and waste water (WWW), site & surroundings, human behaviour, quality of housing, culture and values, communication & transportation, safety and comfort living, and price and availability as the last criteria. From all the 10 criteria, physical building and energy become the most discussed criteria at 93% more than other criteria, while human behaviour become the most rarely criteria discussed specifically at 53% from 15 journals. The entire journal may discuss the sustainability housing concept in a different scope and focus, but all of them simultaneously contained the sustainability aspects. Each implementation that has been discussed in the 15 journals varies greatly, although discussed in different ways; some of them have the same goal to support sustainability.

These 10 sustainable housing criteria can be used to make the parameters or assessment of sustainable housing as an outline, by adjusting the implementation to the prevailing needs. All of the implementation and application in this paper are constructed by previous journals that have standards about sustainable housing which need to concern about the real condition about living in a sustainable house. Although this journal already mention the scope of every criteria in Table 3 - 10 Sustainable housing criteria, all of the implementation from 10 criteria can expand through further needs, it's not limited to.

Further work is needed to explore in more detail which factors are the most important to be considered about sustainable housing based on reality, is it the price or the saving energy or even the maintaining cost that matter the most.

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