공학박사학위논문

# Developing Design Guidelines Framework for Sustainable High-Rise Apartment Buildings in Ho Chi Minh City

호치민 시의 지속가능한 고층 아파트 설계지침의 기준체계에 관한 연구

**2016년 2월**

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# Abstract


# Developing Design Guidelines Framework for Sustainable High-Rise Apartment Buildings in Ho Chi Minh City



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Global warming and climate change have been a globally topical issues clearly threatening the survival of human race. The emerging term 'sustainable development' was first proclaimed in the 1987 World Commission on Environment and Development for tackling the foreseen environmental risks. Of all sectors, the building sector is the largest contributor to greenhouse gas emissions, the principal factor in global warming. Despite the great impacts of building sector upon global warming, however, the building sector offers the highest potential for reducing significantly greenhouse gases emissions.

Vietnam today is struggling with environmental, social and economic issues inherent in the ongoing process of industrialization and modernization. Ho Chi Minh City, Vietnam's most populous city and economic capital, has been in the progress of upgrading and transforming urban housing from low-rise townhouses to high-rise apartment buildings. Although developing high-rise apartment

buildings has become an increasing tendency, guidelines for embarking designing sustainable high-rise apartment buildings are currently deficient.

This research aims at creating a design guidelines framework working as a foundation for drawing up design guidelines for sustainable high-rise apartment buildings in Ho Chi Minh City. A completed design guidelines framework includes two parts: format and content. The guidelines format framework is embarked upon an investigation of the compositional structures of 34 high-quality guidelines and in-depth analysis of format of five typical design guidelines. The research on guidelines content framework is carried out in three steps, including Step-1, Step-2, and Step-3, which proceeds collecting strategies from Vietnamese vernacular houses, contemporary houses and prominent worldwide guidelines. Case study and comparative analysis are the principal methods used in this research.

Step-1 comprehensively analyzes Vietnamese vernacular houses through ten case studies to define the inherent strategies in Vietnamese vernacular houses. The analysis conducted in Step-1 results in 40 strategies involved in eight categories.

Step-2 proceeds on the basis of the vernacular houses' inherent strategies gained in the Step-1 for expanding further strategies by analyzing systematically positive strategies and negative issues of the contemporary houses in Ho Chi Minh City. Ten major cases of high-rise apartment buildings and five secondary cases of townhouses are selected for carrying out the case studies. This steps finally draws 72 strategies involved in nine categories.

Step-3 again expands further the strategies achieved in Step-2 by analyzing the prevalent sustainable building design guidelines and assessment methods to supplement and update the cutting-edge strategies for designing high-rise apartment buildings in Ho Chi Minh City. Nine design guidelines are selected for

analysis together with the reference of seven typical assessment methods. This step finally reaches 104 strategies involved in nine categories.

As a result, the proposed framework applicable to design guidelines for high-rise apartment building in Ho Chi Minh City is established from the two elements, the provision of the format component and final 104 strategies as the content component. The framework created functions as the basis for any design guidelines involved in sustainable high-rise apartment buildings in Ho Chi Minh City.

**Keywords: sustainable housing, sustainable design, design guidelines, high-rise apartment building, Ho Chi Minh City, Vietnam**

**Student Number: 2011-30781**

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# Abbreviations

| | |
|---|---|
| ASEAN | Association of Southeast Asian Nations |
| BCA | Building and Construction Authority |
| BERDE | Building for Ecologically Responsive Design Excellence |
| BPC Guidelines | Hugh L. Carey Battery Park City Authority Residential Environmental Guidelines |
| BRE | Building Research Establishment |
| BREEAM | Building Research Establishment Environmental Assessment Methodology |
| CASBEE | Comprehensive Assessment System for Built Environment Efficiency |
| CSH | Code for Sustainable Homes |
| DGNB | German Sustainable Building Council (in German) |
| EHTR Guidelines | Eco-Housing Guidelines for Tropical Regions |
| GBI | Green Building Index |
| GHG | Greenhouse Gas |
| GWP | Global Warming Potential |
| HAB | High-Rise Apartment Building(s) |
| HCMC | Ho Chi Minh City |
| HVAC | Heating, Ventilation, and Air Conditioning |
| LCA | Life Cycle Assessment |
| LCC | Life Cycle Costing |
| LEED | Leadership in Energy and Environmental Design |
| MOST | Ministry Of Science and Technology |
| NAHB | National Association of Home Builders |
| ODP | Ozone-Depleting Potential |
| O&M | Operation and Maintenance |
| TBL | Triple Bottom Line |
| UNEP | United Nations Environment Programme |
| UN-Habitat | United Nations Human Settlements Programme |
| UK | United Kingdom |
| US | United States |
| USGBC | U.S Green Building Council |
| USSR | The Union of Soviet Socialist Republics |
| VGBC | Vietnam Green Building Council |
| VGGS | Vietnam National Green Growth Strategy |
| VOC | Volatile Organic Compound |
| WCED | World Commission on Environment and Development |

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# Chapter One: Introduction

## 1.1 Problem Statements

Since the Industrial Revolution in the eighteen century, urbanization process has made great changes in the distribution of the world's population. Economic growth accelerates this process and leads to an incredible alteration in human habitation. The urbanization process has intensively created a reverse distribution of the global rural-urban population. It is estimated that by 2050 two-thirds of the world's population will settle in urban areas, a totally reverse tendency with the situation in 1950 when the same number of residents inhabited in the rural settlement.[1] The urbanization process on one side brings in development and civilization, however, on the other side potentially causes environmental stresses. Expansion of new urban areas leads to narrowing the farmland area and disrupting the ecosystem processes. Constructing buildings in cities consume a lot of natural resources, directly using land and water resources, generating considerable solid wastes to soil and water, emitting greenhouse gasses into the atmosphere, and indirectly exploiting raw materials through industrial production.

Greenhouse gas derived from human activities is challenging the long-lasting living on earth. The greenhouse gas has become the primary reason causing the global warming and climate change, which are responsible for the increasingly severe weather events such as tsunami, storm, flooding, and forest fire. The global warming is believed to contribute to the polar ice melt and sea level rise.

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[1] Nations United et al., *World Urbanization Prospects : The 2014 Revision* (2014), 7.

The emerging term ‘sustainable development’, first proclaimed by the 1987 World Commission on Environment and Development (WCED), has caught widespread concerns in the global discourses, becoming the global tendency responding to the foreseen environmental risks. The well-known Brundtland Commission, report of 1987 WCED, issued a ‘manifesto’ to affirm a commitment to a confrontation with those challenging the sustainability and to ensure that the development ‘meets the needs of the present without compromising the ability of future generations to meet their own needs.’[2] Sequent World Commissions accelerated the agreements for mandatory commitments among nations, particularly regarding carbon dioxide emissions. Each country, depending on its status, makes a proper engagement on the amount of carbon dioxide emitted and designs a particular national program with specific targets to fulfill that obligation. As a result, the matters of greenhouse gas, global warming, and climate change have become a critical subject through series of environmental debates in international affairs and global dialogs. There are many strategies mapped out for gradually transforming the development toward sustainability. The universal strategy is promoting the use of alternative/renewable energy to take place of fossil-fuel-originated energy, which is the primary source of greenhouse gas emissions. The term of energy-saving technology has also been an efficient strategy to minimize the energy consumption of human activities.

In Southeast Asia region, the Association of Southeast Asian Nations (ASEAN), an immensely influential organization in politics and economy of the

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[2] Gro Brundtland, "Our Common Future: The World Commission on Environment and Development," (Oxford: Oxford University Press, 1987), 8.

ten Southeast Asian countries including Vietnam, offers concrete commitments on sustainability in the 1997 ASEAN Summit hold in Kuala Lumpur through the proclamation of ASEAN Vision 2020. The documents reaffirmed the long-term sustainable development framework:

> "We envision a clean and green ASEAN with fully established mechanisms for sustainable development to ensure the protection of the region's environment, the sustainability of its natural resources, and the high quality of life of its peoples."[3]

For the built environment, ASEAN Vision 2020 takes into consideration of environment-related issues including energy security, efficient utilization of natural resources, water conservation, and issues associated with climate change.[4]

Building sector has been a primary factor consuming natural resources and contributing to emissions. Buildings consume about 40% of global energy, 25% of global water, and 40% of global resources. Building sector is the largest contributor to emissions when emitting roughly one-third of global GHG emissions. Despite the large effect on global warming, building sector offers the highest potential for reducing significantly GHG emissions, at least decreasing energy consumption by 30 to 80% using available technologies.[5] Thus, building industry evidently becomes a principal concern in the sustainable development debates. The emerging terms 'sustainable building,' 'green building,' 'ecological building,' have been familiar to specialists, professors, policy-makers, and managers. The 'sustainable building' used to focus on the efficiency of energy consumption, natural resources

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[3] ASEAN, "Asean Vision 2020," accessed September 15, 2014, http://www.asean.org/news/item/asean-vision-2020.

[4] Faridah Shafii, Zainab Arman Ali, and Mohamed Zahry Othman, "Achieving Sustainable Construction in the Developing Countries of Southeast Asia," (2006): C-33.

[5] "Why Buildings," accessed October 5, 2015, http://www.unep.org/sbci/AboutSBCI/Background.asp.

conservation, emissions reduction and indoor environment quality. The strategies of sustainable building design often include efficient use of natural resources, waste constraint, energy-saving, indoor quality management, ecological encouragement, life cycle costing consideration, reduction of the transportation needs, and natural lighting and ventilation.

A variety of assessment methods has been introduced to qualify the building performance for exploiting the potentials of the GHG emissions reduction and energy saving. This trend offers a prospect of a market for promoting green building in built environment. Globally, the vanguard assessment methods such as BREEAM, LEED, SBTools, and CASBEE have spread broad knowledge of green building in practices of designing, constructing, operating and maintenance activities. Regionally, countries in Southeast Asia region have made significant steps to foster the green building market. They have developed individual assessment methods based on the reference of the prevalent assessment methods combined with the consideration of local conditions. Some typical assessment methods are Singapore's Green Mark, Malaysia's Green Building Index (GBI), Thai's Rating of Energy and Environmental Sustainability (TREES), Philippines' Building for Ecologically Responsive Design Excellence (BERDE), and Vietnam's LOTUS systems.

Vietnam government has profoundly proclaimed that sustainable development is a crucial future of the country. Vietnam early affirmed the sustainable development at the 1992 Rio Earth Summit and again concretized that affirmation at the 2002 Johannesburg Earth Summit through launching the National Agenda 21. The Agenda 21 of Vietnam was introduced in the Decision No. 153/2004/QD-TTg, namely, ‘The Strategic Orientation for Sustainable Development in Vietnam.’ The subsequent Decision No. 432/QD-TTg specified the framework of the Vietnam Agenda 21 to strategies for sustainable development in the period of 2011-2020.

Regarding building sector, construction industry is one of the sectors that consumes energy most in Vietnam, approximately 36% of total national energy consumption,[6] which raises the tendency of energy efficient buildings. Green architecture was the intensively highlighted in the Eighth Congress of Vietnamese Architects in 2010 with prominent statements of Prof. Dr. Nguyen Viet-Chau: ‘Ecological architecture is the only direction for orienting Vietnam architecture in the twenty-first century. We cannot drift away and lag behind on the general path of the world’s architecture.’[7] Vietnam Association of Architects (VAA) declared the “Vietnam’s Green Architecture Manifesto” on 27 April 2011, which stated that:

> “Green Architecture is the way to create a sustainable living-environment for people. This is direction of development of Vietnam architecture for the objects of quality of today living without compromising the future living, all for the everlasting growth of the country”.[8]

VAA has committed to promote the public awareness of green architecture, facilitate studies, development and dissemination of the criteria for green architecture in accordance with the conditions of Vietnam.[9] Aside with that,

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[6] According to Wendy Werner, Director of Trade and Competition in Asia - Pacific

[7] Anh Dao Tran, "Phát Triển Nhà Ở Cao Tầng Thành Phố Hồ Chí Minh Theo Hướng Xanh - Hiện Đại - Bản Sắc,"[Development of high-rise housing in Ho Chi Minh City towards green - modernity - identity], Vietnam Union of Science and Technology Associations, accessed October 15, 2014, http://118.70.241.18/english3/news/?41939/Phat-trien-nha-o-cao-tang-Thanh-pho-Ho-Chi-Minh-theo-huong-xanh---hien-dai---ban-sac.htm.

[8] Translated from the original contents in Vietnamese.

[9] "Tôn Vinh Các Tài Năng Kiến Trúc,"[Honoring the Architectural Talents], accessed October 21, 2014,

Vietnam Green Building Council (VGBC) was firstly established to develop a green building rating tool designed for Vietnam condition. As a result, Vietnamese green building rating tool, LOTUS, were launched initially in 2011 with LOTUS-NR (non-residence version) and LOTUS-R (residence version) in two years later.[10]

Despite the macro commitments, the particular actions, however, have evidenced much inertia indeed. Vietnam is struggling with environmental, social and economic issues inherent in the process of industrialization and modernization. The urbanization process has intensively taken place in most of the large cities in Vietnam since the 1990s, accompanying with that process, several noteworthy questions of housing have been progressively rising. The demands for accommodation from emerging middle class and immigrants are forcing existing settlements to its limitation, which drives the major cities confronted with issues of overpopulation. The administrators of large cities such as Hanoi and Ho Chi Minh City (HCMC) are suffering intricate questions on responding the massive needs of settlement as well as social and environmental problems caused by uncontrollable habitat expansion.

High-rise dwellings are determined as the only solution for solving the questions of housing demands in HCMC in the coming decades. Recent official proclamation intensively insists that developing apartment housing must be the principal priority for all new residential projects developed in the major cities of

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http://www.baoxaydung.com.vn/news/vn/quy-hoach-kien-truc/ton-vinh-cac-tai-nang-kien-truc.html.

[10] "LOTUS Green Building Rating & Classification System," Vietnam Green Building Council, accessed October 15, 2014, http://www.vgbc.org.vn/index.php/pages/lotus-rating-tool.

Hanoi and HCMC. It particularly targets that the ratios of apartment buildings in new residential projects in HCMC must reach 80% in 2015 and 90% in 2020 respectively.[11] These policies have gradually been actualizing. HCMC today has been in the progress of upgrading and transforming urban housing from low-rise townhouses to high-rise apartment buildings (HAB). It is expected that high-rise residences reserve land for infrastructures, public facilities, and green spaces, as well as facilitate municipal management and public transportation development.

HCMC has remarkably increased the high-rise residential projects since 2000. The HAB projects are scattered in historic and new urban areas. This tendency has gradually formed a modern living style and cityscape.[12] However, most of built and ongoing apartment projects were profoundly carried out in the profit-oriented driven rather than the ecological and communal establishment.[13] Although sustainable high-rise residence has become a majority in the prospective period, the relative supports for HAB design are insufficient. The demand for guidance in designing sustainable HAB in HCMC is thus critical.

Besides, Vietnam building codes and standards have evidenced varied drawbacks and inadequacies in practices. The standards are fragmented and hard to apply to the actual practical activities. Also, shortage of guidance for practitioners

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[11] "Phê Duyệt Chiến Lược Phát Triển Bền Vững Việt Nam Giai Đoạn 2011-2020," [Approval of the strategy for sustainable development of Vietnam in the period 2011-2020], Prime Minister Decision No. 432/QD-TTg, (Hanoi: 2012). "Approval of National Housing Development Strategy to 2020 and Vision to 2030 [in Vietnamese]," Prime Minister Decision No. 2127/QD-TTg, (Hanoi: 2011).

[12] Tran, "Phát Triển Nhà Ở Cao Tầng Thành Phố Hồ Chí Minh Theo Hướng Xanh - Hiện Đại - Bản Sắc".

[13] "Gỡ vướng trong phát triển nhà ở tại TP Hồ Chí Minh," [Disentanglement of housing development in Ho Chi Minh City], accessed October 15, 2014, http://cand.com.vn/dia-oc/Go-vuong-trong-phat-trien-nha-o-tai-TP-Ho-Chi-Minh-372833/.

limits the applicability of the standards. In addition, Vietnam building codes and standards are not timely updated to consistent with the universal tendency, particularly those associated with sustainable design. Furthermore, national building codes and standards are often used for all the city and provinces without considering local unique history, culture, climate and developmental level. As a result, the standards have not caught the adequate attention from either governmental departments or private enterprises yet. Standards or codes are often regarded as mandatory documentaries for officially certification purpose rather than guidance for the real quality of buildings. Therefore, the gaps of the design guidelines for professionals, owners, and developers are remained in the building activities, specifically sustainable buildings. Although there are diverse design guidelines in developed countries, those guidelines are impossible to be applied to Vietnamese context due to the discrepancies in technology, climatic conditions, and social and cultural context.

The above arguments have specified the context of HCMC with the tendency sustainability enhancement, high-rise housing priority, and limitation in the application of codes and standards. By this reason, it is essential to develop a design guidelines framework for sustainable HAB in HCMC. This research aims at producing a design guidelines framework for sustainable HAB in HCMC with intention that this framework will become a core for creating various design guidelines.

## 1.2 Aims and objectives, research questions

### 1.2.1 Research Aims and Objectives

This research aims at developing design guidelines framework for sustainable HAB in HCMC. To achieve this aim, the seven specific objectives are specified.

(1) To understand the scope of sustainable residential buildings

(2) To examine the critical problems of HCMC

(3) To investigate strategies inherent in Vietnamese vernacular houses

(4) To examine the contemporary HAB in HCMC in terms of positive strategies and negative issues

(5) To explore strategies in design guidelines for sustainable HAB in HCMC

(6) To explore the format element of sustainable design guidelines

(7) To propose framework applicable to design guidelines for sustainable HAB in HCMC.

### 1.2.2 Research Questions

This dissertation focuses on answering the five essential questions:

(1) What is a sustainable building? What is the scope of designing sustainable residential buildings?

(2) What are the critical problems of HCMC?

(3) What are the Vietnamese vernacular houses inherent characteristics? How are they applied to the contemporary HAB in HCMC?

(4) What strategies are required for designing sustainable HAB in HCMC?

(5) How are sustainable design guidelines composed?

Table 1-1 indicates the connection of the research questions and the research objectives:

Table 1-1 Research questions and objectives

<table>
<tr><th>Research questions</th><th>Research Objectives</th></tr>
<tr><td>(1) What is a sustainable building? What is the scope of designing sustainable residential buildings?</td><td>(1) To understand the scope of sustainable residential buildings</td></tr>
<tr><td>(2) What are the critical problems of HCMC?</td><td>(2) To examine the critical problems of HCMC</td></tr>
<tr><td>(3) What are the Vietnamese vernacular houses inherent characteristics? How are they applied to the contemporary HAB in HCMC?</td><td rowspan="2">(3) To investigate strategies inherent in Vietnamese vernacular houses<br>(4) To examine the contemporary HAB in HCMC in terms of positive strategies and negative issues<br>(5) To explore strategies in design guidelines for sustainable HAB in HCMC</td></tr>
<tr><td>(4) What strategies are required for designing sustainable HAB in HCMC?</td></tr>
<tr><td>(5) How are sustainable design guidelines composed?</td><td>(6) To explore the format element of sustainable design guidelines<br>(7) To propose framework applicable to design guidelines for sustainable HAB in HCMC.</td></tr>
</table>

## 1.3 Research Methodology

### 1.3.1 Case study

The criteria and strategies of sustainability applying to a particular building typology and region should not just indicate the general sustainable terms but also respond to the specific regional issues, designing and constructing techniques and living context. The framework applicable to design guidelines for sustainable HAB in HCMC, therefore, must be associated with the context of the municipal problems, construction industry and current living activities in HCMC. Thus, local context related analysis should be attached to the process of study by using the appropriate methods. This research encourages the involvement of the local conditions by paying attention to analyzing the inherent characteristics and the alteration of HCMC residential buildings.

This research adopts case study research strategy in studying the Vietnamese vernacular houses and contemporary houses in HCMC for withdrawing the strategies for the framework. Case study is the main research strategy used in analyzing the Vietnamese vernacular houses and HCMC contemporary houses. Wang and Groat (2013) indicates that the nature of the case study is the studying the setting or phenomenon engaged with the actual context. The case study does not approach the phenomenon separately but rather in association with the complex dynamics inseparable with the case.[14] In terms of sustainability, the 'environment' or 'context' is critical, to which the building responds.

[14] David Wang and Linda N. Groat, *Architectural Research Methods,* Second Edition ed. (Hoboken: Wiley, 2013), 421.

The using case study strategies catches the question and researcher's purpose with no limitation. The case study can serve the explanatory, descriptive and exploratory purpose.[15] One of the key factors of case study is its incorporation of multiple sources of evidence.[16]

The purpose of case study is finding the diverse strategies of housing responding with surrounding environment as well as issues of the present situation. The appropriate number of cases are conducted to offer reliable findings. Single case study is far too narrow to examine the diverse strategies. Multi-case studies, thus, are preferred since it works on many houses and reflect more comprehensive and realistic perspective.

The detailed case study in each chapter is deeply discussed in respective part.

### 1.3.2 Data collection

#### 1.3.2.1 Secondary Data

Secondary data is mostly used for documentary analysis. The data derives from various relevant sources, including books, electrical books, narratives, reports, guidelines, journals, magazines, archival data, and websites. Some of particular secondary data are as follows:

- Governmental documents: ordinances, regulations, guidelines, building codes and standards, and latest census and housing data.
- Green building assessment systems: the relevant green building assessment

[15] Ibid., 423.

[16] Ibid., 428.

systems in Vietnam and foreign countries are available in publishing website.

- Guidelines: most of the published guidelines used for investigation are available in electrical versions, which can be downloaded from websites.
- Drawings and images: planning and design drawings, relevant images are available in archival data, extracted from websites, or from author.

#### 1.3.2.2 Field observation

Field observation is conducted supporting the case study research in Vietnamese vernacular houses and HCMC contemporary houses. In some housing cases, sites visits were carried out to observe the conditions of the houses if possible. For vernacular cases, sites surveys are conducted in merely remaining houses for exploring detailed elements responding to climate and the surrounding environment, occupant's life and activities, village environment where the houses are located. For contemporary houses in HCMC, specifically HAB, only cases are possible to access are visited. The investigations pay attention to the internal and external conditions of the buildings, quality of living environment, infrastructure and connected public traffic systems, landscaping and open space, nearby community services and facilities, everyday life and activities in residential areas.

### 1.3.3 Data Analysis

The combination of quantitative and qualitative analysis are primarily attached to the arguments in this research. The quantitative analysis is conducted for data that are measurable or countable. The qualitative analysis is adopted for data that enable to quantitatively evaluate. Besides, comparative analysis is often used in the combination of the two analyzes.

## 1.4 Organization of Thesis

The organization of thesis is composed into seven chapters (Figure 1-1):

<u>Chapter One: Introduction</u>

This chapter introduces all fundamental information associated with the research implementation. The aims, objectives, research questions and limitations are clearly defined to figure out a clear path of the research contents. The research scope and methods draw the particular targets of implementation to fulfill the aims and objectives.

<u>Chapter Two: Scope of Sustainable Residential Buildings and Context of Ho Chi Minh City</u>

This chapter falls into two parts, reviewing the scope of sustainable residential buildings and arguing the context of HCMC. First part approaches all the relative concepts of sustainable development and scope of sustainable residential buildings. The three fundamental dimensions of the sustainability are specially interpreted to understand the key principles of sustainable development holistically. Design criteria for sustainable residential building are reviewed to build brief reference source including topic areas and design criteria. Topic areas are reviewed through literature review. The design criteria result from analysis of seven selected assessment methods. This reference source then directs the investigation of strategies inherent in vernacular houses and finding the issues in HAB, which leads to the list of strategies in Chapter Three, Four, and Five.

Second part intentionally investigates the context of HCMC and argues the priorities of choosing strategies for sustainable HAB in HCMC. The context of

HCMC is reviewed holistically, from climate, environment, socio-economic to high-rise housing issues. The issues of HCMC then support the arguments for priorities of choosing strategies for sustainable HAB in HCMC, which supports selecting and filtering the strategies in Chapter Four and Five. Besides, the literature review figures out the academic background of Vietnam, especially influential Vietnamese scholars and their most updated studies in the associated terms.

Chapter Three: Step-1: Defining Inherent Strategies in Vietnamese Vernacular Houses

This chapter is intended to define the inherent strategies in Vietnamese vernacular house in light of sustainability. This chapter proceeds the first step of a three-step process, Step-1, to find out strategies used in Vietnamese vernacular houses. The main scope of Step-1 is to study the Vietnamese vernacular settlement morphologies, searching for particular strategies inherent in the way the houses responding to the surrounding environment and satisfying the social and cultural context. Case study method is used with ten case models of vernacular houses, including eight cases of the rural house and two cases of the urban house.

Step-1 brings about 40 strategies inherent in vernacular houses involved in eight categories, which are the foundation for further expansion of strategies in Step-2 in Chapter Four and Step-3 in Chapter Five.

Chapter Four: Step-2: First Expansion of Strategies through Contemporary House Analysis

This chapter proceeds the second step, Step-2, of the three-step process. The subject of this step is the contemporary houses in HCMC, more specifically, the

HAB in HCMC. Step-2 inherits the result of the Step-1 and proceeds the argument on HAB and supplemental townhouses in HCMC to draw a list of strategies that engages with the current issues of the city. The debate of this Chapter firstly argues the HCMC urban housing classification for understanding the current habitation and discusses the transformation from low-rise to high-rise housing. The argument proceeds with the discussion on the research methods and case study models for clarifying the methods used, the methods of data analysis, the reasons for choosing case study models. Ten major case study models of HAB and five secondary case study models of townhouse in HCMC are used for investigation. The cases analysis and findings are subsequently conducted in all topic areas and strategies obtained from Step-1. Finally, a new list of strategies is summarized as the result of the Chapter Four. This result is strenngthened with the second expansion of strategies in Chapter Five.

Chapter Five: Step-3: Second Expansion of Strategies through Analysis of Selected Guidelines

This chapter proceeds with Step-3, the second expansion of strategies attained in Step-1 and Step-2 through comparatively analyzing the selected guidelines for updating the cutting-edge strategies. Nine selected sustainable design guidelines are involved in sustainable building, housing, HAB, and buildings in the tropical zone. The comparative analysis also includes seven assessment methods described in Section 2.3.3 as the supplemental reference.

The Step-3 finalizes the most potential strategies for HAB in HCMC. The result of this chapter contributes the content element of design guidelines framework in Chapter Six.

Chapter Six: Constructing Proposed Framework Applicable to Design Guidelines

The major work of this chapter is to construct the proposed framework applicable to design guidelines. Constructing complete design guidelines framework requires the two key elements: the guidelines format and guidelines content. After the Chapter Three, Four and Five, the three-step process has resulted in a list of strategies applicable to HAB in HCMC, which would contribute the content of the design guidelines framework. Since the content element has been built, this chapter firstly focuses on building the format element before combining the two elements to become a complete proposed framework. Therefore, the first part works on the sustainable design guidelines format by analyzing comparatively the structures of a collection of 34 available design guidelines in sustainable building and implementing the in-depth analysis of five selected design guidelines. The result of analysis offers a perspective on available guidelines' format, which supports the suggestion of the format for the proposed design guidelines. Finally, the suggestion of design guidelines framework proceeds with a discussion of validation issues.

Chapter Seven: Conclusion

This chapter summarizes major findings of the research and points out its limitations and recommendations.

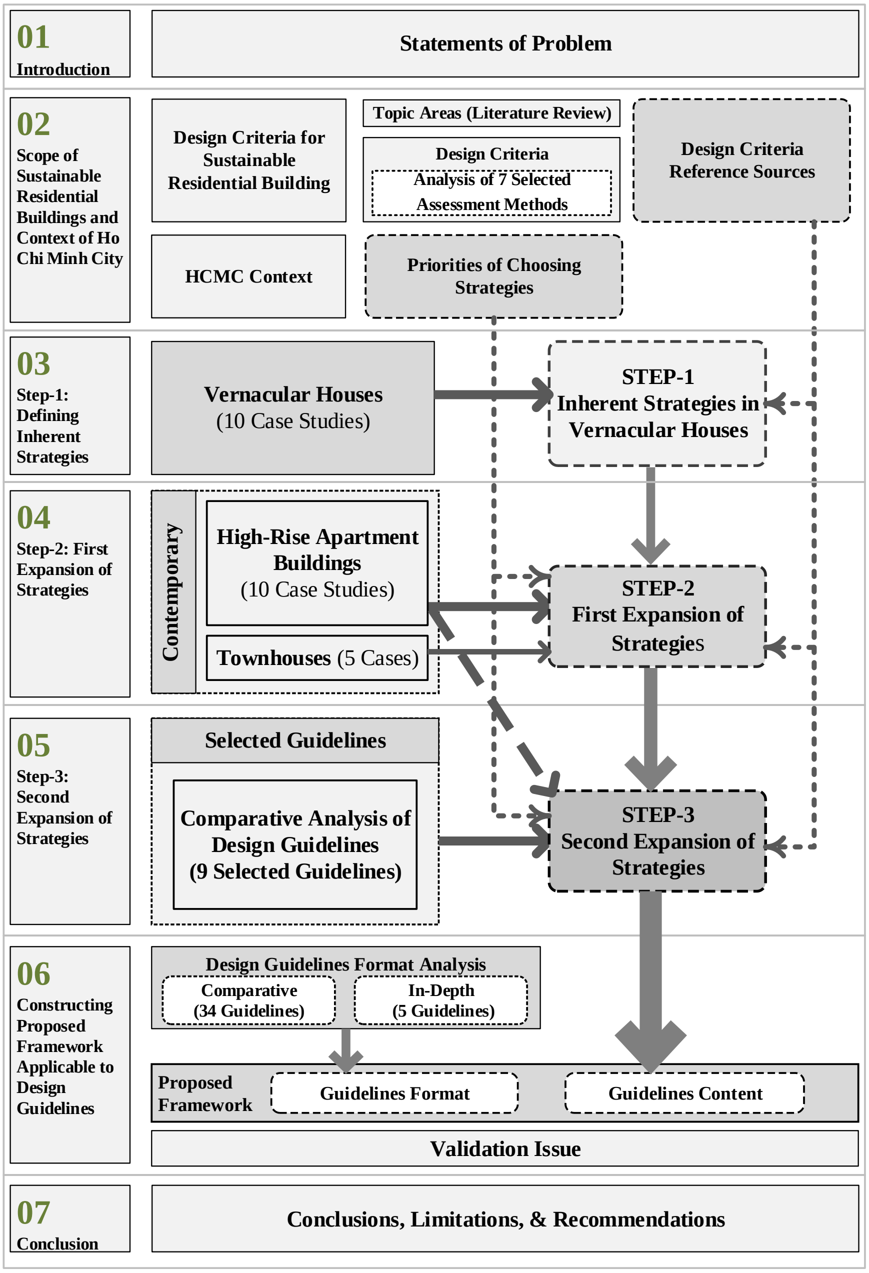


Figure 1-1 Research Organization Layout

## 1.5 Research Limitation

Since the scope of sustainability is greatly broad covering environmental, social and economic aspects, this research highly focuses on a critical portion that is originated from the inherent strategies of vernacular houses. Accordingly, the strategies associated with highly ‘active’ methods are loosely glued with the arguments of this study, for instance, the strategies related to the mechanical and electrical (M&E) technologies. However, the technologies enhancing the ‘passive’ methods tend to be the objectives of this research. Likewise, the efficient management, financial and economic issues are out of the concentration of this dissertation.

In addition, this research aims at building a framework applicable to the design process, which involves those related to pre-construction stage. The process of construction and post-construction are out of the scope of this study.

# Chapter Two: Scope of Sustainable Residential Buildings and Context of Ho Chi Minh City



This chapter falls into two parts, reviewing the scope of sustainable residential buildings and arguing the context of HCMC. First part approaches all the relative concepts of sustainable development and scope of sustainable residential buildings. Design criteria for sustainable residential building are reviewed to build brief reference source including topic areas and design criteria. Second part investigates the context of HCMC and argues the priorities of choosing strategies. The context of HCMC is reviewed holistically, from climate, environment, socio-economic to high-rise housing issues. The issues of HCMC then support the arguments for priorities of choosing strategies for sustainable HAB in HCMC. Besides, the literature review figures out the academic background of Vietnam.

## 2.1 The Debates of Sustainable Development

The Industrial Revolution in late 18th and early 19th centuries has brought in the major social and economic changes in human society by developing new machinery, new sources of power, and new ways of manufacturing products. Conversely, it also opened a period of environmental problems through its side effects of natural resources degradation and environmental pollution, threatening the quality of living and the survival of humanity on earth in the long run. The dark sides of the economic development were early mentioned in the Rachel Carson's 1962 book *Silent Spring*, pointing out massively environmental degradation from the common products such as poisons, insecticides, weed killers and others.[17] The influential 1972 book of the Club of Rome, *The Limits to Growth*, raised arguments presenting that pollution, environmental degradation, and natural resource depletion were vitally threatening the lasting living on earth and that economic growth was the main cause of this environmental destruction. The book cautions that if people kept on the directions of population growth, food production, resource use, and pollution the planet would be endured to an exhausted state over the next 100 years.[18]

The energy crisis in 1973 and the rising awareness on environmental protection led to an emerging 'green' movement in the 1970s. The movement highlighted the needs to diversify the sources of energy to diminish the dependence

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[17] Eddy Krygiel and Brad Nies, *Green BIM : Successful Sustainable Design with Building Information Modeling*, Sybex Serious Skills (Indianapolis, Ind.: Wiley Pub., 2008), 5.

[18] Donella H Meadow et al., *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind*, Potomac Associates Book (New York: Universe Books, 1972).

on fossil fuels originated energy, especially using renewable energy. This trend has driven architects, environmentalists, ecologists to rethink about the wisdom of building techniques and encourage them to seek creative approaches to energy-efficient buildings.[19]

The global community has early addressed the most crucial issues of the environment in current economic development. The 1972 Stockholm Conference on the Human Environment declared 26 principles concerning the environment and development.[20] The 1987 World Commission on Environment and Development (WCED), commonly known as Brundtland Commission, firstly introduced the concept of "sustainable development" with the definition that "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[21] The debates proceeded with 1992 Earth Summit on Environment and Development in Rio de Janeiro, where the well-known Agenda 21 was published with the basic contents providing detailed action plans for the sustainable development of 21st-century globalization. The discussion was then prolonged with the 2009 Copenhagen Climate Change Conference (Copenhagen Summit) with a confirmation that climate change is the greatest challenge of the world today. Table 2-1 summarizes some key events that play a significant role in expansion knowledge of sustainable development.

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[19] Sam Kubba, *Handbook of Green Building Design and Construction LEED, Breeam, and Green Globes* (Waltham, MA: Butterworth-Heinemann,, 2012), 7.

[20] John Baylis, Steve Smith, and Patricia Owens, *The Globalization of World Politics: An Introduction to International Relations* (Oxford University Press, 2013), 454-55.

[21] Brundtland, "Our Common Future: The World Commission on Environment and Development," 8.

Table 2-1 World's key events for sustainability[22]

| Year | Event | Issues of Debates |
|---|---|---|
| 1962 | Rachel Carson's *Silent Spring* book was released | Raising a look at the massive scale of environmental degradation from various common products such as poisons, insecticides, weed killers and others |
| 1972 | Club of Rome's *The Limits to Growth* was published | Present pollution, environmental degradation, and natural resource depletion were vitally threatening the lasting living on earth and that economic growth was the main cause of this environmental destruction. |
| 1973 | Energy crises: Eruption of OPEC oil crisis | Highlighting the need for diversified sources of energy and encouraging corporate and government investment in solar, wind, water, and geothermal sources of power / Promoting saving energy technology |
| 1987 | The United Nations World Commission on Environment and Development | Proposing the term "sustainable development" with definition "Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs" |
| 1992 | Earth Summit in Rio de Janeiro | Providing the Agenda 21 as a blueprint for achieving global sustainability |
| 1996 | Kyoto Summit | The Kyoto Protocol was ratified to set particular targets of emission reduction. |
| 1998 | John Elkington's *Cannibals with Forks* was released | The emerging Triple Bottom Line concept in sustainability |
| 2009 | Copenhagen Climate Change Conference | Climate change is the greatest challenge of the world today. |

### 2.1.1 Agenda 21

The 1992 Earth Summit held in Rio de Janiero, Brazil has been the most preferred conference thanks to its well-known published proceedings, *Agenda 21* providing a comprehensive sketch in the possible scope of sustainable development. The Agenda 21 is a complex document with 40 discrete sections approaching various concerned areas constructed based on the fundamental premise that "the First World must subsidize development in the Third World in order to redress past

[22] Kubba, *Handbook of Green Building Design and Construction LEED, Breeam, and Green Globes*, 7-13.

inequities and reverse the destructive cycle of resource depletion."[23] The Agenda 21 report includes 120 programs outlines and 1000 proposals that cover six principal subjects, including the quality of life and earth, efficient use of earth's natural resources, the protection of our global commons, the management of human settlements, chemicals and the management of waste, and sustainable economic growth (Table 2-2).[24]

Table 2-2 Six principal subjects of the Agenda 21[25]

| No. | Primary Theme | Strategy |
|---|---|---|
| 1 | The quality of life and earth | Alleviating poverty, changing patterns of consumption, improving standards of health, and reducing population growth |
| 2 | Efficient use of natural resources | Decentralized policies, identifying ecosystems as units to be managed uniformly, developing new technologies to reduce the degradation and depletion, increase productivities and efficiency |
| 3 | The protection of our global commons | The atmosphere, lands, and the oceans are belonging to everyone, and it is necessary to increase the international cooperation among nations. |
| 4 | The management of human settlements | The need of adequate environmental infrastructure and changes in construction industry |
| 5 | Chemicals and the management of waste | Cost required to correct existing problems and implement new programs is solved by both, discussion of international trade policies in connection with environmental damage, technology transfer, and the economic policies necessary to support sustainable development. |
| 6 | Sustainable economic growth | |

Regarding built environment and construction industry, the Agenda 21, to a certain extent, requires changes in designing and constructing activities. Among the six issues, the fourth is the most direct relation to architects and urban planners. It highlights the needs to prevent the ecology from the inevitable impacts of built activities. Aside from that, the first, second, fifth, and sixth issues indirectly

[23] James Steele, *Sustainable Architecture : Principles, Paradigms, and Case Studies* (New York: McGraw-Hill, 1997), 8.

[24] Ibid., 7-8.

[25] Referring the summary of Agenda 21 from ibid., 9-18.

required a comprehensive approach ranging from social aspects of quality of human health, the ecological problems like efficient use of natural resources and management of waste, to the sustainable economic growth.

In particular, the noted strategies for planners, architects, and builders are summarized in Table 2-3.

Table 2-3 Strategies for planners, architects, and builders in Agenda 21[26]

| **Recommendations from Agenda 21** | |
|---|---|
| 1 | The use of local materials and indigenous building sources |
| 2 | Incentives to promote the continuation of traditional techniques, with regional resources and self-help strategies |
| 3 | Recognition of the toll that natural disasters take on developing countries, due to unregulated construction and use of inadequate materials and the need for improvements both in use and manufacture of materials and in construction techniques, as well as training programs |
| 4 | Regulation of energy-efficient design principles |
| 5 | Standards that would discourage construction in ecologically inappropriate areas |
| 6 | The use of labor-intensive rather than energy-intensive construction techniques |
| 7 | The restructuring of credit institutions to allow the poor to buy building materials and services |
| 8 | International information exchange on all aspects of construction related to the environment, among architects and contractors, particularly about nonrenewable resources |
| 9 | Exploration of methods to encourage and facilitate the recycling and reuse of building materials especially those requiring intensive energy consumption in their manufacture |
| 10 | Financial penalties to discourage the use of materials that damage the environment |
| 11 | Decentralization of the construction industry, through the encouragement of smaller firms |
| 12 | The use of "clean technologies" |

### 2.1.2 The Kyoto Protocol

After the success of the Agenda 21, the subsequent 1996 Kyoto summit was planned to concretize the achieved agreements into the specific measures that could potentially be applied to all nations. The Kyoto Protocol was ratified to set

[26] Ibid., 13-16.

particular targets of emission reduction, according to which the participating countries committed to adjusting the average greenhouse gas emissions over in the period 2008-2012 returning the rate of 1990. The industrial countries were the subjects mainly affected by this protocol. To achieve this commitment, they need to progress in three area: reducing energy consumption, switching fossil energy to renewable sources and enhancing carbon capture and storage.[27]

[27] Dominique Gauzin-Mueller, *Sustainable Architecture and Urbanism: Concepts, Technologies, Examples* (Springer Science & Business Media, 2002), 14.

"In 2000, representatives from 180 countries met in The Hague to resolve the details of the Kyoto Protocol, which set the cut C02 emissions and other greenhouse gases in the 38 countries of the now. The conference ended in failure, among other things due to disagreements between Europe and the United States on the question of carbon sinks (see p. 15). A new round of talks, entitled "Rio + 10", will be held in Johannesburg in 2002."

## 2.2 Perspective on Sustainable Building Design

### 2.2.1 Three Dimensions of Sustainability

In his well-known book published in 1998, *Cannibals with Forks: The Triple Bottom Line of 21st Century*, John Elkington, co-founder of business consultancy SustainAbility, first mentioned the so-called concept 'Triple Bottom Line' (TBL) to prefer to the concept of sustainable development. The author indicates the three aspects of people, planet and profit to explain the sustainable development in the economy. Further developed, the TBL involves three interdependent bottom lines including social, economic and environmental. The three bottom lines are inconstant flux rather than stable since there is fluctuation among the three sides.[28]

The concept of sustainable development is largely acknowledged to be an intersection of the environmental, social and economic dimensions, which is often indicated by the intersection of three circles as Figure 2-1. The three dimensions are interrelated and interdependent to form the comprehensive approach of an issue.[29] Regarding built environment, sustainable design is a three-dimensional thinking of problem-solving. The strategies for sustainable design in planning,

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[28] "SustainAbility is developing the concept of the "triple bottom line" ofsustainable development. Society depends on the economy — and the economy dependsonthe global ecosystem, whose health represents the ultimate bottom line".

"The three bottom lines are not stable; they are inconstant flux, due to social,political, economic and environmental pressures, cycles and conflicts. So the sustainability challenge is tougher than any of the other challenges in isolation".

See John Elkington, *Cannibals with Forks : The Triple Bottom Line of 21st Century Business*, Conscientious Commerce (Gabriola Island, BC ; Stony Creek, CT: New Society Publishers, 1998), 71-74.

[29] ISO, "ISO/DIS 15392, Sustainability in Building Construction – General Principles," *International Organization for Standardization* (2006): 5.

design and construction should be studied in a local situation and diverse contexts in order to achieve large effects of sustainability in a global scale.

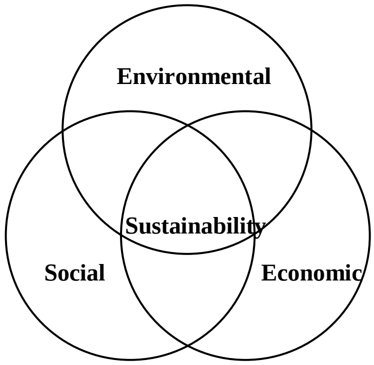


Figure 2-1 Three Dimensions of Sustainability

## 2.2.2 Fundamental Concepts of Sustainable Building Design

### 2.2.2.1 Systems Thinking

Systems thinking, also known as ‘whole system thinking,’ ‘total system approach,’ ‘whole building assessment,’ is an important concept in practicing the sustainability in built environment. The concept pays attention to approaching the building design and construction processes as whole rather than individual parts. The study of system and sustainability is early described in the influential book The Limits to Growth[30], according to which, the system is a complex entity formed from a multiple of elements or parts that interact in numbers of relationships to practice a specific function. The systems seldom exist in isolation and most of the systems are indeed systems within the system. The boundaries of a system are

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[30] Meadow et al., *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind.*

relatively defined relying on the scale of the system consideration. For example, the building, as a system, is made up of many interlinking internal systems, building parts, which interact with external systems, natural environment with daylight, climate, and raining. The concept of system thinking highlights the approaching an object as a system with full of mutual interactions and relationships. The theory of systems have a wide applicability in multidisciplinary fields such as computer science, business, psychology, and ecology.[31]

The system distinguishes into open and closed system when considering about the working of a system. Open system is a system in which materials and resources are continually imported from outside the system, used in certain process and then finally released back to outside in a few form of waste.[32] The realistic examples of open systems are a majority of human-made systems. Conversely, nature shows different things. There are no open systems in nature but closed systems, in which waste of something is always become food for something else. In a ideal closed system, no wastes created, output or previous process will be the input of subsequent process and non-stop over time. The resources and materials in the closed system always go somewhere rather than go "away" like in the open system.

The design for sustainability requires a system thinking in creating a thing as a closed system. The possible way is learning from nature, observing and mimicking nature in designing the flow of materials and resources in systems and connecting elements for providing new relationships and functions. The conventional design

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[31] U.S. Green Building Council, *Green Building and LEED Core Concepts Guide*, 2nd ed. (Washington, DC: U.S. Green Building Council, 2011), 19.

[32] Ibid.

and construction process tend to treat the multiple parts as if they are unconnected. In common sense, people tend to treat the construction works, product manufacture or operations of organizations as open systems. The building elements are considered separately without connecting with a larger set of systems, this result in wastes of individuals are unknown. By which, the system uses materials from outside to product, construct and operate and finally discards what remains out of the system. The constant process of consumption and waste is repeated for every period of the life cycle. Conversely, a system thinking approach tends to find out the possibility of make above open system become a closed loop. Under the light of system thinking, materials used in buildings are investigated on a comprehensive level, including its upstream and downstream processes, covering entire impacts created before the material is used and later in operation, dismantling till the end of its life. This approach brings about a holistic perspective of environmental costs and benefits of materials. The system thinking, therefore, should be applied over a building lifetime, ranging from designing, constructing to operating and dismantling the building to ensure the flow of materials working continuously.[33]

Systems thinking is the fundamental approach, the backbone of all the guidelines and manuals responsible for the theme of sustainable building design and construction. Applying this approach enables the building project to establish interaction among the various aspects and cause cost effective fashion over the building's lifetime.

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[33]Ibid., 18.

#### 2.2.2.2 Life Cycle Approach

Life cycle approach highlights the approaching the whole life of a project, product or service rather than a narrow view of a system. Longevity is the dimension for distinguishing sustainable buildings from the conventional ones. A sustainable building is considered in its entire life with the positive effects on surrounding environment while a conventional one is often regarded in a short run. In built environment, a life cycle approach covers all activities from beginning to the end of building existence. The building life cycle begins with initial pre-design decisions of setting goals and program, and proceeds with planning, design, construction, operation, maintenance, refurbishment, and renovation. At the end of the building life, it ends with demolition and further preferable reuse.[34] McDonough and Braungart (2002) offers concepts of ‘cradle to grave’ and ‘cradle to cradle’ to describe the extent of life cycle approach. The ‘cradle to grave’ represents to the linear process of material extraction to their disposal while ‘cradle to cradle’ symbolizes for a closed system, in which no waste created, the output of the previous becoming input of another process.[35]

Life cycle approach helps to find out the environmental and human health concerns. Granite tiles, which are used in a construction building in Vietnam, may consist of raw granite stones mined in Africa, manufactured in China and shipped to Vietnam for purchase. If only focus on energy efficiency of the granite tile when constructing a building, we will miss its environmental effects caused by extracting

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[34] U. S. Green Building Council, *Green Building and LEED Core Concepts* (Washington. D.C.: U.S. Green Building Council, 2011), 26.

[35] William McDonough and Michael Braungart, *Cradle to Cradle : Remaking the Way We Make Things*, 1st ed. (New York: North Point Press, 2002).

from its raw material, manufacturing process and transferring from factory to marketplace and construction site. Therefore, project's energy-saving goals will be uncertainty when merely concentrating on the recycled content proportion of products. This term often known as 'embodied energy.' 'Embodied energy is the total amount of energy used to harvest or extract, manufacture, transport, install, and use a product across its life cycle.'[36]

When approaching the concept of life cycle thinking in environmental regards, Life Cycle Assessment (LCA) is often used, and in cost regards, Life Cycle Costing (LCC) is preferred. LCC indicates the total cost of a building over the life of its use, which covers all the process of design, construction, operation, and maintenance. There are two groups of costs cover the whole life of a building project, direct capital, and direct operation. The direct capital costs involve expenses linked with original design and construction of the building. The direct operating costs cover expenses needed for operating and maintaining a building over its whole life, which includes the payments for energy use, water use, insurance, maintenance, waste, property taxes, and so on.[37] Thus, the cost of a building is not only the cost of initial investment but also the long-term operating costs of the facility. Using green materials and technology would help pay back the prior investment quickly through energy efficient strategies such as lower electricity costs while increasing productivity. Figure 2-2 shows a comparison of LCC between a conventional and sustainable building. Over the whole life, the cost of sustainable building is far lower than a conventional building despite the higher

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[36]Council, *Green Building and LEED Core Concepts*, 26.

[3737] Kubba, *Handbook of Green Building Design and Construction LEED, Breeam, and Green Globes*, 503.

initial cost of the sustainable one. This results from the lower operating costs of sustainable building over the building life, especially the energy and maintenance costs.

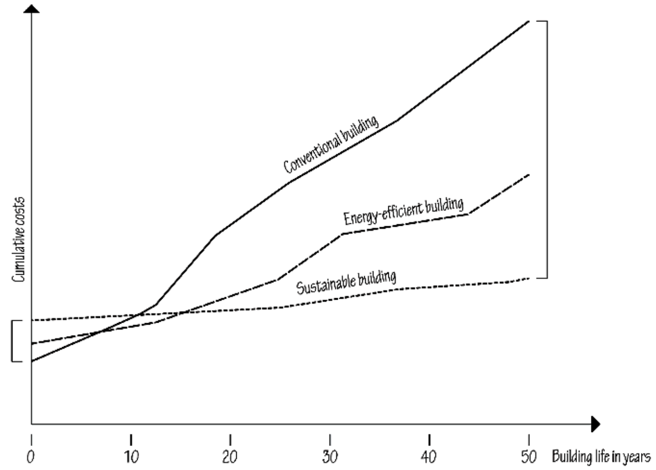


Figure 2-2 Cost of buildings over the whole life[38]

### 2.2.2.3 Integrated Process

The principle of integrated process, also known as integrated design, is based on the previous principles of system thinking and life cycle. Integrated process plays a key role in an interdisciplinary method for design and operation of sustainable buildings. The integrated process can apply to all phases of the building project, from design, construction to operations and reuse or deconstruction.[39]

The integrated process provides a new way of treating with resources and materials and helps practitioners to consider and make decisions in a whole

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[38] Francis D. K. Ching and Ian M. Shapiro, *Green Building Illustrated* (2014), 23.

[39] U.S. Green Building Council, *Green Building and LEED Core Concepts Guide*, 28.

perspective. The integrated process requires a closely collaborative coordination among participants from interdisciplinary fields, which is completely different from a conventional process. In the conventional process, building design professionals, such as architects, civil engineers, mechanical engineers, and landscape designer are involved separately in their individual fields. By this way, conventional process often refuses to consider the buildings as a small system in the larger and complex systems. One problem solving in an issue may cause a number of problems in another place in the whole system. For instance, the architectural full glass envelopes may cause the poor indoor environment, for example, the high energy consumed on space cooling, over lighting and glare. The landscape designer fills the land with exotic green grass that requires a large amount of water throughout building lifetime.

To bring the integrated process into practices, the practitioners must adopt a new way of thinking and team working that might contradict with what they have been familiar in their past practices. Following the integrated process, participants must learn new skills such as teamwork, collaboration, communication, and critical thinking and questioning, and interpreting things based on the understanding of the natural process.

## 2.3 Review of Design Criteria for Sustainable Residential Building

This section is intended to build a reference source of design criteria for sustainable residential building. This reference source then directs the investigation of strategies inherent in vernacular houses and finding strategies and issues in HAB in HCMC, which leads to the list of strategies in the further steps.

### 2.3.1 Clarification on the Terminologies: Code, Standard, Guidelines, Assessment Tool and Rating System

Before embarking on the description of the sustainable building, it is necessary to clarify clearly terminologies associated with the systems delivering sustainable building quality. Understanding the definitions of terminologies would assist in the process of addressing the topics, criteria, or strategies of sustainable residential buildings.

The actual practices of sustainable building market, well known as green building, provide a number of systems used for guide, evaluation, rating or certification a degree of 'green' in building sector. Multiple ways are used to attach the sustainable quality to buildings, which are related to the intention of developers, managers, and designers. In a basic level, state administrators officially use building codes and standards as basic tools to manage the building quality at basically standardized level. The building code is the basic legislation in building sector which often specifies the mandatory level of building quality that planners, designers, and builders must obtain when carrying out an construction project within urban space. Meanwhile, official building standards offer the suggestions extended from the building codes, which guide the practitioners to a higher building performance that is desirable for the national or municipal context. As a result, the building code is often mandatory terms associated with governmental or municipal laws, sanctions, tax and other incentives. Building standards used by organizations and state administrators are often voluntary terms describing the standardized level of quality.

Aside from building code and standard, the trend of sustainability in building sector has activated a market for green building by the provision of diversified systems for raising the public awareness. Many terms are used to specify these systems such as 'method,' 'process,' 'scheme,' 'tool,' 'guidelines,' 'rating,' and so forth, of which, some terms may offer the same pattern. The systems referred in this dissertation fall into three popular categories: building guidelines, building assessment, and building ratings. Each system focuses on the different goals and produces different effects.[40]

> 'Green building guidelines offer recommended measures for conserving natural resources, using water and energy wisely, improving indoor air quality, and planning for livable and vibrant communities. Building with these measures helps to create healthy, durable buildings that reduce environmental impacts and cost less to operate and maintain.'[41]
>
> 'Rating systems take a systematic approach to evaluating implementation of green building measures to help compare projects on a level playing field.'[42]

The differentiation between the building codes and standards, guidelines,

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[40] These categories are specified in the John Carmody, William Weber, and Rolf Jacobson, "Design Guidelines for Sustainable Housing," (Center for Sustainable Building Research (CSBR), University of Minnesota: University of Minnesota, 2009).

[41] "Green Building Guidelines & Rating Systems," accessed August 20, 2014, http://www.builditgreen.org/green-building-guidelines-rating/.

[42] Ibid.

assessment tools, and rating systems is specified in the (Table 2-4).

Table 2-4 Comparison of building codes, standards, guidelines, assessment tools and rating systems[43]

| Aspect | Building Codes & Standards | Guidelines | Assessment Tools | Rating Systems |
|---|---|---|---|---|
| Goal | National or municipal administration | Instructional and educational purpose | Determine the environmental impacts of project | Gain the marketing advantages and market transformation |
| Feature | Management-oriented | Voluntary/ Management-oriented | Market-oriented | Market-oriented (most) |
| Measurement methods | Mandatory credits | Require or recommend the process guides; Best practices reference; No scores or points | Score-based system | Point-based system |
| Strength/ Weakness | Unfriendly for application | Hard to measure the outcome | Wide range of predetermined criteria | Point-based may accompany less exact calculation of environmental impacts |
| In charge activities | Official staffs | Management of governmental investment; Public education | Governmental/ organizational management in construction | Governmental/ organizational management in construction |
| Applied periods | During planning, design and construction process, | Integral planning, design and construction process | Commonly in complete construction; Less use in design process | Commonly in complete construction; Less use in design process |
| Examples | All national building code and standards, international standards | Living Building Challenge; Minnesota Sustainable Building Guidelines; Green Communities; The 2030 Challenge | GOBAS; Living Building Challenge; Minnesota Sustainable Building Guidelines; SBtool; PassivHaus; EcoEffect; NABERS Home; NABERS Office | CASBEE Home; HKBeam; GOBAS; GBCS-MURB; LEED for Neighborhoods; LEED for Homes; Austin Energy Green Building; Green Globes; NABERS Home; NABERS Office; SBATlite |

Since the global green building market has been intensely developed, the sustainable benchmarks attached to the guidelines, assessment tools, and rating

[43]Summarized and supplemented from "Design Guidelines for Sustainable Housing," 20-21.

systems have evolved to the high level and frequently upgraded to respond to the changing situation. The assessment tools, rating systems, and guidelines derived from developed world, therefore, potentially offer sources of common criteria and strategies covering comprehensive topics of sustainable buildings. The efficient way, thus, is tracking back the general topics or categories, criteria or credits, and strategies in foreign assessment tools, rating systems, and guidelines. The next section is to review the systems for addressing the topics and exploring the common criteria and strategies for sustainable buildings.

### 2.3.2 Addressing the Topic Areas of the Sustainable Buildings

The holistic approach of sustainability in built environment provides three dimensions environmental, social and economic dimension. In environmental dimension, sustainable building adopts the positive strategies that support the protection of natural resources and the ecosystem. The social aspect of built environment is occupant's health, satisfaction and the contribution of building's functionality and cultural value. The social dimension of sustainable building specifies the protection of occupant's health, safety, and comfort, maintenance of functionality and protection of aesthetic and urban development quality. The economic aspect indicates the capital or assets, the economic dimension of the sustainable building aims at minimizing life cycle costs, improvement of economic efficiency, and protection of capital or assets.[44] Table 2-5 summarizes the targets of the comprehensive approach to sustainable building.

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[44] Guideline for Sustainable Building, (Berlin: Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), 2014), http://www.nachhaltigesbauen.de/fileadmin/pdf/Systainable_Building/Guideline_for_Sustainable_Building_300DPI_141006.pdf. 24.

Table 2-5 Comprehensive approach to sustainability in built environment[45]

| Subject | Extent | Environmental Dimension | Social Dimension | Economic Dimension |
|---|---|---|---|---|
| Protective Resources | ***Sustainability in general*** | • Natural resources<br>• Natural environment | • Human health<br>• Social and cultural values | • Capital/assets<br>• Economic performance |
| | ***Sustainable building*** | • Natural resources<br>• Global and local environment | • Health<br>• User satisfaction<br>• Functionality<br>• Cultural value | • Capital/assets |
| Protective Targets | ***Sustainability in general*** | • Protection of natural resources/sustainable use and management of natural resources<br>• Efficiency improvement<br>• Reduction of pollution exposure/environmental influences<br>• Protection of atmosphere, soil, groundwater and waters<br>• Promotion of environmentally compatible production | • Protection and promotion of human health<br>• Reinforcing inclusion and solidarity<br>• Protection of cultural assets and values<br>• Equal opportunities<br>• Protection of capacity to work and jobs<br>• Fight against poverty<br>• Education/training<br>• Equal rights<br>• Integration<br>• Safety/liveable environment | • Reduction of life cycle costs<br>• Reduction of subsidy volume<br>• Reduction of debt<br>• Promotion of responsible entrepreneurship<br>• Creation of sustainable consumption patterns<br>• Creation of dynamic and cooperative international economic conditions |
| | ***Sustainable Building*** | • Protection of natural resources<br>• Protection of the ecosystem | • Protection of health, safety and comfort<br>• Maintenance of functionality<br>• Protection of aesthetic and urban development quality | • Minimising life cycle costs<br>• Improvement of economic efficiency<br>• Protection of capital/assets |

As the argument in above section 2.3.1, the efficient way to address the topics of sustainable building is to track back the foreign rating tools, assessment systems, and guidelines. Since every system accomplishes varied targets and creates varied effects, the synthesis of categories shows the common and the specific aspects of the systems. The topic areas commonly offer the general scope and structure of the systems in which each system may use different sets of criteria and strategies. The

45 Ibid.

majority of the systems work on the environmental issues, some systems pay high attention to the energy issues such as Architecture 2030 and Passiv Haus, while minority cover the comprehensive range of sustainable issues such as HK-BEAM, the Minnesota B3 Guidelines, and SBATlite.[46]

Many authors have made a review the topics area in the sustainable building. Of which, the research conducted by Carmody, et al. (2009) gathers the most systems and those are associated with residential building. Therefore, the result of Carmody, et al. (2009) research could be used in this section to address the categories or topics concerned in the designing the sustainable building. The research conducts a survey to show the range of the categories containing credits and criteria in the 19 sustainable building guideline, rating tool, and assessment system. The result of the survey is indicated in Table 2-6.

The survey shows that sustainable building criteria and credits are generally constituted of fourteen topic areas that are indicated in Table 2-6. Of the fourteen categories, the basic group is often presented in every single guidelines and systems. This group includes Energy, Water, Materials and Resources, IEQ/ Occupant health, Waste, and Site issues. The next group of frequently used categories include Location/Transport, Integrated Design, Operations/Maintenance, and Education/Awareness.

[46] "Design Guidelines for Sustainable Housing," 29.

Table 2-6 A survey of categories in 19 sustainable building guidelines, rating tools, assessment systems[47]

| | Systems | Energy use and building emissions | Water use | Materials and resources | IEQ and occupant health | Waste | Site design, ecology and storm water | Location, transport and neighborhood | Integrated design and project planning | Operations and maintenance | Function and service quality | Economic aspects and life cycle costs | Cultural and perceptual aspects | Awareness and education | Innovations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | CASBEE - Homes | O | O | O | O | O | O | × | × | O | O | × | O | O | × |
| 02 | HK-BEAM | O | O | O | O | O | O | O | O | O | × | × | × | O | O |
| 03 | GOBAS | × | × | × | × | × | × | × | × | × | × | × | × | × | × |
| 04 | GBCS - MURBs | O | O | × | O | O | O | O | × | O | × | × | × | O | × |
| 05 | LEED for Neighborhoods | O | O | × | × | O | O | O | O | × | O | × | × | × | O |
| 06 | LEED for Homes | O | O | O | O | O | O | O | O | × | × | × | × | O | O |
| 07 | Austin Energy Green Building | O | O | O | O | O | O | O | O | × | × | × | × | × | O |
| 08 | Living Building Challenge | O | O | O | O | O | O | O | × | O | × | × | O | O | × |
| 09 | MN B3 Guidelines | O | O | O | O | O | O | O | O | O | O | O | × | × | × |
| 10 | Green Communities | O | O | O | O | O | O | O | O | O | × | × | × | O | × |
| 11 | Green Globes | O | O | O | O | O | O | O | O | O | O | × | × | O | × |
| 12 | Architecture 2030 | O | × | × | × | × | × | × | × | × | × | × | × | × | × |
| 13 | Sbtool | O | O | O | O | × | O | × | O | × | O | O | O | × | × |

[47] Ibid., 30.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14 | Passiv Haus | ○ | × | × | ○ | × | × | × | × | × | × | × | × | × | × |
| 15 | UK Code for Sustainable Homes | ○ | ○ | ○ | ○ | ○ | ○ | × | × | × | ○ | × | × | ○ | × |
| 16 | EcoEffect | ○ | × | ○ | ○ | × | ○ | × | × | × | × | ○ | × | × | × |
| 17 | NABERS - Homes | ○ | ○ | × | × | × | × | × | × | ○ | × | × | × | × | × |
| 18 | NABERS - Office | ○ | ○ | × | ○ | ○ | × | × | × | ○ | × | × | × | × | × |
| 19 | SBAT lite | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | × |
| | Numbers of systems using the category | **18** | **15** | **12** | **15** | **13** | **14** | **10** | **9** | **10** | **7** | **4** | **4** | **9** | **4** |
| **Note: ○ : The category is adopted in the system; ×: The category is not adopted in the system** | | | | | | | | | | | | | | | |

## 2.3.3 Design Criteria for Sustainable Residential Buildings

### 2.3.3.1 Analysis Method

Today, assessment methods are popular in evaluating the sustainable building, the analysis of typical assessment methods used for rating residential buildings thus brings about the general criteria used to evaluate the sustainable residential buildings. Comparative analysis is used in this investigation for briefly exploring the general sustainable criteria.

Seven selected assessment methods are used for comparative analysis to exploring the design criteria for sustainable residential buildings. Only criteria for the pre-construction period are concerned in this review. In addition, only criteria for residential buildings, specifically HAB, are used.

### 2.3.3.2 Brief of Building Certification Development

Since the definition of sustainability was launched by the 1987 Brundtland Commission, a prospective market for green buildings has been developed by administrators from governments and non-profit organizations for promoting the sustainable development in building industry. Multiple certification systems, globally and locally, has opened a market in which the extent of environmental performance of a building is certified and provided respectively special treatments. The world's first official assessment method is the UK-based BREEAM (Building Research Establishment Environmental Assessment Methodology) published in 1990 by the Building Research Establishment (BRE). The BREEAM system has intensively changed the approaches to evaluating the green buildings through scientifically based criteria, sustainability benchmarks, and targets. Today, the assessment methods have been expanded in varied countries. Each region or countries are provided a certain assessment methods that respond to the specific contexts of climatic, cultural, economic, social, and legal situations. The assessment methods are known in various forms systems such as rating systems (point-based system), assessment tools (score-based system).

The benchmarks of assessment methods have made a large step in advancing the building quality and building performance. The development of assessment methods so far is acknowledged to reach two generations based on the dimensional coverage of the content of the benchmarks. The first generation is the early group of assessment methods and their subsequently based ones, such as BREEAM, LEED, and GBTool. The criteria for benchmarks of the first generation take into account the 'green' dimension that approach the building's quality in terms of ecological and energy efficiency-based criteria. Of the three dimensions of sustainability, the first generation tends to evaluate principally the environmental effects of the buildings. The second generation is latterly appeared as an upgrade of the first generation, such as SBTool and DGNB. The criteria for a benchmark of those belonging to the this generation often concern comprehensively on account of sustainability. This group holistically works on 'sustainable' level, not just refers the ecological and energy aspects as the first generation but also evaluates the more holistic quality, such as ecological, economic, socio-cultural aspects, technology, location and process quality, throughout the entire life cycle of buildings.[48]

In Southeast Asia region, the majority of countries have built individual

[48] Thilo Ebert, Natalie Essig, and Gerd Hauser, *Green Building Certification Systems: Assessing Sustainability, International System Comparison, Economic Impact of Certifications* (Walter de Gruyter, 2011), 26.

assessment methods that were developed based on benchmarks of advanced systems with revision responding to the local climatic, environmental, social and economic contexts. Singapore is a pioneer with the publication of the BCA Green Mark rating system in 2005, which in turn becomes a valuable reference for the others in the region. Sequent assessment methods are Malaysia's Green Building Index (GBI) in 2009, Indonesia's GreenShip and Philippines' Building for Ecologically Responsive Design Excellence (BERDE) and Thai's Rating of Energy and Environmental Sustainability (TREES) in 2010, and Vietnam's LOTUS in 2011 (Table 2-7).

Table 2-7 Worldwide and Southeast Asia's prominent green building assessment methods[49]

| **Region** | **Nation** | **Rating System** | **Year** | **Developed by** | **Based on** |
|---|---|---|---|---|---|
| Europe | Great Britain | BREEAM (Building Research Establishment Environmental Assessment Method) | 1990 | Building Research Establishment (BRE) | Original - First assessment system |
| | France | HQE (Haute Qualité Environnementale or High Environmental Quality) | 1996 | Association pour la Haute Qualité Environnementale (ASSOHQE) | BREEAM |
| | Germany | DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen) | 2007 | German Sustainable Building Council (DGNB) | BREEAM, LEED, CASBEE, HQE, Green Star |
| | Spain | VERDE | | | SBTool |
| North America | USA | LEED (Leadership in Energy and Environmental Design) | 1998 | U.S. Green Building Council (USGBC) | BREEAM |
| | Canada | Green Globes | 2004 | The Green Building Initiative (GBI) | BREEAM |
| | Canada | GBTool (Green Building Tool)<br>SBTool (Sustainable Building Tool) | 1998<br>2006 | International Initiative for a Sustainable Built Environment (iiSBE) | Original |
| Oceania | Australia | Green Star | 2002 | Green Building Council of Australia (GBCA) | LEED, BREEAM |
| | Australia | NABERS (National Australian Built Environment Rating System) | 2005 | Department of the Environment and Heritage (DEH), commercialized by Department of Energy, Utilities and Sustainability (DEUS) | n/a |
| Asia | Hong Kong | HK-BEAM (Hong Kong Building Environmental Assessment Method) | 1996 | HK-BEAM Society | BREEAM |
| | Japan | CASBEE (Comprehensive Assessment System for Building Environmental Efficiency) | 2001 | Japan Sustainable Building Consortium (JSBC) | BREEAM, LEED |

[49] Some information is extracted from ibid., 25. Carmody, Weber, and Jacobson, "Design Guidelines for Sustainable Housing," 6-17. Louise Jones, *Environmentally Responsible Design : Green and Sustainable Design for Interior Designers*, Wiley Books on Sustainable Design (Hoboken, N.J.: Wiley, 2008), 268-69.

| Region | Nation | Rating System | Year | Developed by | Based on |
|---|---|---|---|---|---|
| | Korea | GBCS-MURB (Green Building Certification System for Multi-Unit Residential Building) | 2002 | Korean Institute of Energy Research | GBtool, GBC |
| | China | GOBAS (Green Olympic Building Assessment System) | 2003 | Tsinghua University and other eight organizations | LEED, BREEAM, CASBEE |
| Africa | South Africa | SBAT Lite (Sustainable Building Assessment Tool) | 2004 | South Africa's Council for Scientific and Industrial Research | n/a |
| Southeast Asia | Singapore | Green Mark | 2005 | Building and Construction Authority (BCA) | n/a |
| | Malaysia | Green Building Index (GBI) | 2009 | Malaysia Institute of Architects (PAM) & Association of Consulting Engineers Malaysia (ACEM) | n/a |
| | Indonesia | Greenship | 2010 | Green Building Council of Indonesia (GBCI) | n/a |
| | Philippines | BERDE (Building for Ecologically Responsive Design Excellence) | 2010 | Philippine Green Building Council (PhilGBC) | BREEAM, LEED |
| | Thailand | TREES (Thai's Rating of Energy and Environmental Sustainability) | 2010 | Thai Green Building Institute (TGBI) | LEED |
| | Vietnam | LOTUS | 2011 | Vietnam Green Building Council (VGBC) | LEED, Green Star, BREEAM, GBI, Green Mark |
| Note: GBC: Green Building Challenge | | | | | |

#### 2.3.3.3 Selected Green Building Assessment Methods for Criteria Exploration

##### a. Selection of green building assessment methods

Seven assessment methods are selected as typical models used for exploring general criteria. Seven assessment methods are prevalent systems including three international, three regional and a domestic assessment methods (Table 2-8). All content of seven assessment methods are summarized and presented in Appendix D section.

Table 2-8 Seven selected green building assessment methods

| No. | Sign | Assessment Method Title | Version | Publishing Year | Country | Global | Regional |
|---|---|---|---|---|---|---|---|
| 1 | ① | Leadership in Energy and Environmental Design | LEED-NC V.3 | 2009 | USA | ✓ | |
| 2 | ② | Code for Sustainable Homes | - | 2010 | UK | ✓ | |
| 3 | ③ | The Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) | CASBEE-NC | 2014 | Japan | ✓ | |

| No. | Sign | Assessment Method Title | Version | Publishing Year | Country | Global | Regional |
|---|---|---|---|---|---|---|---|
| 4 | ❹ | BCA Green Mark Scheme | 4.1 | 2012 | Singapore | | ✓ |
| 5 | ❺ | Green Building Index (GBI) | GBI-RNC 3.1 | 2014 | Malaysia | | ✓ |
| 6 | ❻ | Building for Ecologically Responsive Design Excellence (BERDE) | BERDE-NC-VRD 1.1.0 | 2013 | The Philippines | | ✓ |
| 7 | ❼ | LOTUS | LOTUS-R EP | 2013 | Vietnam | | ✓ |

**b. Overview of seven green building assessment methods**

**Leadership in Energy and Environmental Design (LEED)**

LEED is one of the most prominent green building certification worldwide. LEED is a credit-based building rating system developed by the U.S Green Building Council (USGBC). A project is certified in the range of the four levels including platinum, gold, silver, and certified according to the number of credits gained. All credits fall into six categories including sustainable sites, water efficiency, energy and atmosphere, material and resources, indoor environment quality, and innovation and design. The latest version LEED V4 was introduced in November 2013 and proclaimed to be a mandatory application from June 2015 for multifamily midrise to high-rise projects.[50]

In regards to residential projects, LEED comes into play based on the family units and a number of floors. There are three categories corresponding to particular intent of projects, ranging from traditional houses, townhouses or apartment complexes (Table 2-9 and Figure 2-3).

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50 "Understanding LEED for Homes Version 4 Full 9 Part Webinar Series," accessed December 10, 2015, http://www.usgbc.org/education/sessions/understanding-leed-homes-version-4-full-9-part-webinar-series-5007674.

Table 2-9 LEED applied for residential projects[51]

| Categories | Descriptions |
|---|---|
| Homes and Multifamily Low-rise. | Single-family homes and multi-family residential buildings of 1 to 3 stories. |
| Multifamily Midrise | Multifamily residential buildings of 4 to 8 occupiable stories above grade. The building must have 50% or more residential space. |
| BD+C: New Construction and Major Renovation. | New construction or major renovation of buildings that do not primarily serve K-12 educational, retail, data centers, warehouses and distribution centers, hospitality, or healthcare uses. New construction also includes high-rise residential buildings 9 stories or more. |


Figure 2-3 LEED for Residential Projects[52]

**Code for Sustainable Homes, 2010**

The Code for Sustainable Homes (CSH) is the part of BREEAM, started as EcoHomes. At present, the CSH is owned by the Department for UK's Communities and Local Government and developed to become codes for housing design and construction. The publicly funded housing has been required to attain level 3 of the CSH. The contents of CSH include many issues same as BREEAM but used separate rating system ranging from 1 to 6, rather than Pass to

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[51] "The Residential Question: Homes, Midrise, or New Construction?," accessed March 20, 2015, http://www.usgbc.org/articles/residential-question-homes-midrise-or-new-construction.

[52] Ibid.

Outstanding of BREEAM system.[53] The system involves nine categories, including (1) energy and carbon dioxide emissions, (2) water, (3) materials, (4) surface water run-off, (5) waste, (6) pollution, (7) health & well-being, (8) management, (9) ecology.[54]

**The Comprehensive Assessment System for Building Environmental Efficiency (CASBEE)**

CASBEE a voluntary building assessment system introduced by the Japan Sustainable Building Consortium (JSBC) in 2001. To assess the building, the CASBEE system utilizes the statistical values of predicted consumption of Energy, water, land use, materials, and environmental emissions and indoor environmental conditions measurable attributes. The system has been applied for New Construction (NC), Existing Buildings (EB), Renovations (RN) Heat Island (HI), and Urban Development (UD).

So far, CASBEE system has been developed eight assessment tools[55] as following:

Table 2-10 CASBEE assessment tools

| **CASBEE Assessment Tools** | **English Version** |
|---|---|
| CASBEE for Building (New Construction) | Available |
| CASBEE for Building (Existing Building)<br>CASBEE for Building (Renovation) | |

53 Paul Appleby, *Integrated Sustainable Design of Buildings* (London ; Washington, DC: Earthscan, 2011), 58-59.

54 Department for Communities and Local Government, Code for Sustainable Homes: Technical Guide, (London: Communities and Local Government Publications, 2010), http://www.planningportal.gov.uk/uploads/code_for_sustainable_homes_techguide.pdf.

55 "CASBEE," accessed April 28, 2015, http://www.ibec.or.jp/CASBEE/english/.

| CASBEE Assessment Tools | English Version |
|---|---|
| CASBEE for Market Promotion | Available |
| CASBEE for Heat Island | |
| CASBEE for Urban Development | Available |
| CASBEE for Cities | Available |
| CASBEE for Home (Detached House) | Available |

CASBEE has a unique method to evaluate the building's environmental quality by providing a new principle of Building Environmental Efficiency (BEE) as the major indicator of overall performance. The BEE includes two parts: Building Environmental Loadings (L), which is counted as the impact the building on the outside environment beyond the suppositional project boundary, and Building Environmental Quality and Performance (Q), which is counted as improvements for the building users within the suppositional project boundary. Each sub-category of the two divisions is assigned a certain amount of points to evaluate the building's environmental performance. The final Building Environmental Efficiency (BEE) score is calculated as following:

$$\text{BEE} = \frac{\text{Q: Environmental Quality of Building}}{\text{L: Environmental Load of Building}} = \frac{25\times(\text{SQ} - 1)}{25\times(5 - \text{SLR})}$$

**BCA Green Mark Scheme[56]**

BCA Green Mark is Singapore's green building rating system managed by the National Environment Agency. The rating constitutes an extensive framework for evaluating the whole environmental performance of new and existing buildings for promoting the sustainable building practices in design, construction, and operations.

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[56] "BCA Green Mark Assessment Criteria and Online Application," accessed October 15, 2014, http://www.bca.gov.sg/greenmark/green_mark_criteria.html.

The latest updated version of BCA Green Mark is BCA Green Mark Criteria for new buildings Version 4.0 which come into play on 2010, Dec 1st.[57] The rating system is applicable for new buildings and existing buildings. The Green Mark Scheme for new building promotes the energy and water savings, healthier indoor environment and greenery in design and construction practices of developers and design teams. For existing building, the system encourages building owners and operators to fulfill the sustainable operations criteria to decrease the adverse impacts of the buildings on surrounding environment and occupant health over the building life cycle.

The benchmark falls into five major categories: (1) Energy Efficiency, (2) Water Efficiency, (3) Environmental Protection, (4) Indoor Environmental Quality, and (5) Other Green Features and Innovation.

**Green Building Index (GBI)**

Green Building Index (GBI), a voluntary green building rating tool, was first introduced in February 2010 by the Greenbuildingindex Sdn Bhd (GSB), an organization founded in 2009 by a cooperation of the Malaysia Institute of Architects (PAM) and the Association of Consulting Engineers Malaysia (ACEM). GBI Malaysia was developed to respond to the needs of a rating tool particularly applicable for Malaysian conditions including humid tropical climate, environmental and developmental context, cultural identity, and social and communal needs.[58]

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[57] Ibid.

[58] Construction Specifications Institute., *The CSI Sustainable Design and Construction Practice Guide* (Hoboken, New Jersey: John Wiley & Sons, Inc., 2013), 42.

**Building for Ecologically Responsive Design Excellence (BERDE)**

BERDE is the Philippines' National Voluntary Green Building Rating System, developed by the Philippines Green Building Council (PhilGBC). The PhilGBC started the BERDE Program in 2007 with the intention to develop a green building rating system special for the Philippines condition and applicable throughout the country. The BERDE rating system provides a criteria framework to measure, verify and monitor the environmental performance of buildings that go beyond the level of national mandatory regulations and standards.

The assessment process under BERDE rating system follows the process of Project Registration, Design Assessment, and Construction Assessment and BERDE Certification. The building owner first offers the project information and consigns the certification process with pre-intention of rating level during the Project Registration stage. The verifiable evidence such as design plans, specification, calculations and associated documents are required for verifying the compliance to the intent of BERDE during Design Assessment stage. When completing the construction works and starting occupation or operation, as-built plans, and relevant documents are required for BERDE Assessors to verify finally the compliance of the project's performance data to the intent of BERDE and to certify the rating level based on the points achieved.[59]

Early versions (1.0.0) of BERDE Green Building Rating Schemes was launched in 2010 for BERDE for New Construction (NC) and in 2011 for BERDE for Existing Buildings which is presently superseded by BERDE for Retrofits and

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[59] "BERDE Assessment and Certification for Buildings," accessed June 15, 2015, http://berdeonline.org/berde-assessment-and-certification-for-buildings.

Renovations and BERDE for Operations. Both cover four building types: commercial buildings, clustered residences, vertical residences and educational institutions (Table 2-11). There are five levels of award ranging from ‘1 Star’ to ‘5 Star’

Table 2-11 BERDE green building rating schemes[60]

| BERDE Green Building Rating Scheme | Version | Remarks |
|---|---|---|
| **BERDE for New Construction (BERDE-NC)** | 1.0.0 (2010); 1.1.0 (2013) | |
| Commercial Buildings (COM) | | |
| Clustered Residential Development (CRD) | | |
| Vertical Residential Development (VRD) | | |
| Educational Institutions (EDU) | | |
| **BERDE for Retrofits and Renovations (BERDE-RR)** | 1.1.0 (2013) | Superseding BERDE for Existing Buildings v.1.0.0 (2011) |
| Commercial Buildings (COM) | | |
| Clustered Residential Development (CRD) | | |
| Vertical Residential Development (VRD) | | |
| Educational Institutions (EDU) | | |
| **BERDE for Operations (BERDE-OP)** | 1.1.0 (2013) | |

Of all the versions, the BERDE for New Construction - Vertical Residential Development (BERDE-NC-VRD) is used particularly to evaluate the environmental performance of the high-rise residential building projects. There are mandatory criteria and point-scoring criteria.

**LOTUS**

LOTUS is currently the only green building rating tool in Vietnam, developed by Vietnam Green Building Council (VGBC). LOTUS rating tool is intended to build standards and benchmarks applicable to Vietnam, orienting the built industry towards natural resources efficiency and environment-friendly. LOTUS rating tool is developed on the reference of international green building rating systems

[60] "BERDE Green Building Rating Schemes," accessed June 15, 2015, http://berdeonline.org/rating-schemes/.

including LEED, Green Star, BREEAM, GBI, and Green Mark.[61] The LOTUS project was carried out with the establishment of the VGBC in 2008 and has developed three tools, including LOTUS-NR, LOTUS-R, LOTUS BIO (Table 2-12).[62]

Table 2-12 LOTUS rating tool system[63]

| **Rating tools** | **Non-Residential (NR)** | **Residential (R)** | **Buildings in Operation (BIO)** |
|---|---|---|---|
| **Version** | 2011 (V.1.0), 2013 (V.1.1) | Pilot stage | Pilot stage |
| **Stage of building** | Design & construction | Design & construction | Operation |
| **Type of building** | All non-residential buildings including office, cultural, educational, healthcare, retail, hotels, stadia, sport centres & factories, etc. | New or major refurbished residential projects, where a minimum of 70% of the gross floor area (not including car parking) is dedicated to residential use. | Any building type covered by LOTUS NR & R that has been in operation for >18 months & has >50% occupancy |
| **Categories rated** | 9 categories + innovation | 9 categories + innovation | 8 categories + innovation |
| **Certification points** | 150 (+ 8 bonus points for innovation) | 130 (+ 8 bonus points for innovation) | 100 (+ 8 bonus points for innovation) |

LOTUS NR & R provide nine categories while LOTUS BIO has eight categories with different allocated weighting (Table 2-13). The categories are arranged in regards to the sustainable building principles: energy and water efficiency, environmentally and occupant friendly, and waste and pollution reduction. Each category has specific credits with particular scoring points, and some have prerequisites (mandatory credits). Regarding dwelling projects,

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61 "LOTUS Green Building Rating & Classification System".

62 Ibid.

63 Ibid. Vietnam Green Building Council, *LOTUS Residential Extended Pilot: Technical Manual* (Hanoi: VGBC, 2013).

LOTUS-R is used for assessing all types of housing buildings including low-rise and high-rise. LOTUS-R is developed specially for new or major refurbished residential projects which residential area exceeds 70% of the gross floor area (not including car parking).

Table 2-13 LOTUS NR & R categories and characteristics[64]

| No. | Categories | Characteristics |
|---|---|---|
| 1 | Energy (E) | To reduce the energy consumption of a building through proper insulation, the use of natural ventilation and the installation of energy efficient equipment (HVAC, lighting, water heaters, etc.) |
| 2 | Water (W) | To reduce the water consumption of a building through the use of water-efficient fixtures, rain water harvesting, water reuse/recycling and associated measures |
| 3 | Materials (M) | To maximize the use of re-used and/or recycled materials and encourage a wider use of non-baked materials |
| 4 | Ecology (Eco) | To protect the ecology of the site of the building and surrounding area, assure the preservation of topsoil and maximize biodiversity. |
| 5 | Waste & Pollution (WP) | To promote the reduction of waste during the construction and operation of the building, as well as encourage extensive recycling practices |
| 6 | Health & Comfort (H) | To ensure high indoor environmental quality, through maximizing daylight, minimizing indoor noise and the optimization of indoor air quality. |
| 7 | Adaptation & Mitigation (A) | To ensure that all necessary adaptation and mitigation strategies are integrated at the design stage of a building (flood risk, strong wind protection, drought, etc) |
| 8 | Community (CY) | To promote the social integration of a building within its neighborhood, through public consultation, respect for cultural heritage and to facilitate access for persons with disabilities |
| 9 | Management (Man) | To ensure that, throughout the project, all targets set up for the various stages (design, construction, commissioning, and operations) are competently and effectively managed |
| 10 | Innovation (Inn) | To reward exceptional performance or initiatives which are above or not specifically addressed by LOTUS. This category carries bonus points. |

64 *LOTUS Residential Extended Pilot: Technical Manual*, 11.

#### 2.3.3.4 Findings and Discussion

Table 2-14 shows the synthesis of criteria in the seven selected assessment methods. This can be considered the general criteria for planning and designing sustainable residential buildings which can be a reference source for research in subsequent chapters. The detailed criteria can be found in Appendix D

Table 2-14 Synthesis of criteria of seven selected assessment methods[65]

| No. | Theme / Criteria | LEED-NC v.3 (2009) | | Code for Sustainable Homes, 2010 | | CASBEE -NC 2014 | Green Mark 4.1 2012 | | GBI–RNC 3.1 (2014) | | BERDE-NC-VRD 1.1.0 (2013) | | LOTUS-R EP (2013) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ① | | ② | | ③ | ❹ | | ❺ | | ❻ | | ❼ | |
| | | Index | Weight | Index | Weight | - | Index | Weight | Index | Weight | Index | Weight | Index | Weight |
| **Land Use & Ecology** | | | | | | | | | | | | | | |
| 01 | Site Selection | SS-1 | 1.00 | Eco 1 | 0.93 | ✓ | - | - | SM1 | 1.09 | LE-PT-1 | 6.00 | Eco-4 | 2.31 |
| 02 | Community Connectivity | SS-2 | 5.00 | - | - | - | - | - | SM3 | 4.35 | TR-PT-4; TR-PT-5 | 4.00 | CY-1 | 1.54 |
| 03 | Brownfield Redevelopment | SS-3 | 1.00 | (Eco 1) | (0.93) | - | - | - | SM2 | 1.09 | (LE-PT-1) | (6.00) | Eco-4 | 2.31 |
| 04 | Reduce Building footprint (Land Use Ratio) | - | - | Eco 5 | 1.87 | - | - | - | - | - | - | - | - | - |
| 05 | Vegetated Open Space and Biodiversity Promotion | SS-5.2 | 1.00 | (Eco 3; Eco 4) | (4.67) | ✓ | - | - | (SM11) | (5.43) | LE-PT-3 | 3.00 | Eco-3 | 1.54 |
| 06 | Ecological Features Preservation & Improvement | SS-5.1 | 1.00 | Eco 2; Eco 3; Eco 4 | 5.6 | ✓ | RB 3-3 | 5.41 | SM11 | 5.43 | LE-PT-2 | 6.00 | Eco -5 | 1.54 |
| 07 | Heat Island Effect – Hardscape | SS-7.1 | 1.00 | - | - | ✓ | - | - | SM12 | 2.17 | LE-PT-4 | 2.00 | A-4 | 1.54 |
| 08 | Heat Island Effect – Building Roof | SS-7.2 | 1.00 | - | - | ✓ | - | - | SM13 | 1.09 | - | - | (A-4) | (1.54) |
| 09 | Green Roof | (SS-7.2) | (1.00) | - | - | ✓ | (RB 3-3) | (5.41) | (SM13) | (1.09) | LE-PT-5 | 1.00 | Eco-6 | 1.54 |
| 10 | Light Pollution Reduction | SS-8 | 1.00 | - | - | ✓ | - | - | - | - | - | - | WP-5 | 0.77 |
| 11 | Stormwater Run-off Management (Quantity Control) | SS-6.1 | 1.00 | Sur 1 | 1.87 | ✓ | RB 3-6 | 2.03 | SM10 | 3.26 | - | - | A-2 | 2.31 |
| 12 | Stormwater Run-off Treatment (Quality Control) | SS-6.2 | 1.00 | Sur 1 | 1.87 | ✓ | RB 3-6 | 2.03 | (SM10) | (3.26) | - | - | A-2 | 2.31 |
| 13 | Flood Risk Minimization | - | - | Sur 2 | 1.87 | - | - | - | - | - | LE-PT-6 | 2.00 | A-1 | 1.54 |
| 14 | Planning & Design for Restriction of Wind Damage | - | - | - | - | ✓ | - | - | - | - | - | - | A-3 | **1.54** |

65 Only criteria for pre-construction stage are concerned in this analysis.

| No. | Theme / Criteria | LEED-NC v.3 (2009) | | Code for Sustainable Homes, 2010 | | CASBEE -NC 2014 | Green Mark 4.1 2012 | | GBI–RNC 3.1 (2014) | | BERDE-NC-VRD 1.1.0 (2013) | | LOTUS-R EP (2013) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ① | | ② | | ③ | ❹ | | ❺ | | ❻ | | ❼ | |
| | | Index | Weight | Index | Weight | - | Index | Weight | Index | Weight | Index | Weight | Index | Weight |
| 15 | Earthquake Resistance | - | - | - | - | ✓ | - | - | - | - | - | - | (A-3) | **(1.54)** |
| **Water** | | | | | | | | | | | | | | |
| 16 | Water Efficient Irrigation & Landscaping | WE-1 | 4.00 | - | - | ✓ | RB 2-3 | 2.03 | WE3 | 2.17 | WT-PT-3 | 2.00 | W-4 | 2.31 |
| 17 | Water Efficient Fittings & Fixtures | WE-P1 &3,(2) | 4.00 | Wat 1 | 4.67 | ✓ | RB 2-1 | 6.76 | WE4 | 4.35 | WT-PT-2 | 4.00 | W-1<br>WP-1 | 5.38<br>1.54 |
| 18 | Rainwater Harvesting and Reuse | (WE-2) | (2.00) | Wat 2 | 0.93 | ✓ | - | - | WE1 | 4.35 | (WT-PT-2) | (4.00) | W-3<br>(WP-1) | 2.31<br>(1.54) |
| 19 | Waste Water Treatment and Recycling | WE-2 | 2.00 | (Wat 1) | (4.67) | ✓ | - | - | WE2 | 2.17 | (WT-PT-2) | (4.00) | W-2<br>(WP-1) | 3.85<br>(1.54) |
| 20 | Water Usage Monitoring | - | - | - | - | - | RB 2-2 | 0.68 | - | - | WT-PT-1;<br>WT-RQ-1 | 1.00 | - | - |
| **Energy** | | | | | | | | | | | | | | |
| 21 | Energy Efficiency Performance | EA-1;<br>(EA-P2) | 19.00 | Ene 2 | 8.41 | ✓ | - | - | EE1;<br>EE2 | 14.13 | EN-PT-5 | 1.00 | - | - |
| 22 | Energy Sub-Metering | - | - | Ene 3 | 1.87 | ✓ | - | - | - | - | EN-PT-1 | 1.00 | - | - |
| 23 | Building Automation Systems | - | - | | | - | - | - | - | - | EN-PT-8 | 2.00 | - | - |
| 24 | On-Site Renewable Energy | EA-2 | 7.00 | Ene 1 | 9.34 | ✓ | RB 1-8 | 13.51 | EE3 | 5.43 | EN-PT-4 | 1.00 | E-7 | 1.54 |
| 25 | Off-Site Renewable Energy | EA-6 | 2.00 | Ene 1<br>(Ene 7) | 9.34<br>(1.87) | - | - | - | - | - | - | - | - | - |
| 26 | Provision of Passive Design Strategies | - | - | - | - | ✓ | - | - | - | - | - | - | E-PR-1 | R |
| 27 | Building Envelope Insulation | - | - | - | - | ✓ | RB 1-1 | 10.14 | - | - | EN-PT-6 | 1.00 | E-2 | 3.08 |
| 28 | Naturally Ventilated Design | - | - | - | - | ✓ | RB 1-2 | 14.86 | - | - | EN-PT-3 | 1.00 | E-3 | 3.08 |
| 29 | Energy Efficient Artificial Lighting | - | - | - | - | ✓ | RB 1-4 | 6.76 | - | - | EN-PT-2 | 1.00 | E-5 | 1.54 |
| 30 | Energy Efficient External Lighting and Control | - | - | Ene 6 | 1.87 | - | - | - | EE4 | 2.17 | - | - | - | - |
| 31 | Energy Efficient HVAC System | - | - | - | - | ✓ | (RB 1-2) | (14.86) | - | - | EN-PT-7 | 1.00 | E-4 | 2.31 |
| 32 | Energy Efficient Appliances/Equipment or Products | - | - | Ene 5 | 1.87 | ✓ | RB 1-7 | 4.73 | - | - | - | - | - | - |

| No. | Theme / Criteria | LEED-NC v.3 (2009) | | Code for Sustainable Homes, 2010 | | CASBEE -NC 2014 | Green Mark 4.1 2012 | | GBI–RNC 3.1 (2014) | | BERDE-NC-VRD 1.1.0 (2013) | | LOTUS-R EP (2013) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ① | | ② | | ③ | ❹ | | ❺ | | ❻ | | ❼ | |
| | | Index | Weight | Index | Weight | - | Index | Weight | Index | Weight | Index | Weight | Index | Weight |
| 33 | Energy Efficient Lifts | - | - | - | - | - | RB 1-6 (RB 1-7) | 0.68 (4.73) | - | - | - | - | - | - |
| 34 | Water Heating – Energy Efficient System | - | - | - | - | ✓ | (RB 1-7) | (4.73) | - | - | - | - | E-6 | 1.54 |
| 35 | Water Heating System – Solar Thermal System | - | - | - | - | ✓ | - | - | - | - | - | - | (E-6) | (1.54) |
| 36 | Use Geothermal Heat Usage Systems for Air Conditioning | - | - | - | - | ✓ | - | - | - | - | - | - | - | - |
| 37 | Home office & Internet Connectivity | - | - | Ene 9 | 0.93 | ✓ | - | - | EE5 | 1.09 | - | - | - | - |
| 38 | Application of Low and Zero Carbon Technologies (e.g. Microgeneration Certification Scheme (MCS), Combined Heat and Power (CHP)) | - | - | Ene 7 | 1.87 | - | - | - | - | - | - | - | - | - |
| 39 | Drying space | - | - | Ene 4 | 0.93 | - | (RB 1-7) | (4.73) | - | - | - | - | - | - |
| **Materials & Resources** | | | | | | | | | | | | | | |
| 40 | On-site Materials Reuse | MR-1.1 &1.2 | 4.00 | Mat 2; Mat 3 | 8.41 | ✓ | - | - | MR1 | 2.17 | MT-PT-3 | 2.00 | M-1 | 3.08 |
| 41 | Off-site Materials Reuse | MR-3 | 2.00 | (Mat 2) (Mat 3) | (8.41) | ✓ | - | - | (MR1) | (2.17) | (MT-PT-3) | (2.00) | (M-1) | (3.08) |
| 42 | Local/Regional Materials | MR-5 | 2.00 | - | - | ✓ | (RB 3-2) | (5.41) | MR3 | 2.17 | - | - | A-6 | 1.54 |
| 43 | Materials with Recycled Content | MR-4 | 2.00 | (Mat 2) (Mat 3) | (8.41) | ✓ | RB 3-2 | 5.41 | MR2 | 2.17 | MT-PT-1 (MT-PT-3) | 2.00 (2.00) | M-2 | 3.08 |
| 44 | Rapidly Renewable Materials | MR-6 | 1.00 | Mat 1 | 14.02 | - | (RB 3-2) | (5.41) | - | - | (MT-PT-3) | (2.00) | M-3 | 1.54 |
| 45 | Certified Wood | MR-7 | 1.00 | (Mat 2) (Mat 3) | (8.41) | ✓ | (RB 3-2) | (5.41) | MR4 | 2.17 | (MT-PT-1) (MT-PT-3) | (2.00) (2.00) | M-4 | 1.54 |
| 46 | Low Embodied Energy Materials | - | - | - | - | | - | - | - | - | - | - | - | - |
| 47 | Non-Baked Materials | - | - | - | - | - | - | - | - | - | - | - | M-5 | 3.85 |
| 48 | Reducing Usage of Materials | - | - | - | - | ✓ | - | - | - | - | - | - | - | - |
| 49 | Design for Favorably Reusable Components and Materials (Ease of | - | - | - | - | ✓ | - | - | - | - | - | - | - | - |

| No. | Theme / Criteria | LEED-NC v.3 (2009) | | Code for Sustainable Homes, 2010 | | CASBEE -NC 2014 | Green Mark 4.1 2012 | | GBI–RNC 3.1 (2014) | | BERDE-NC-VRD 1.1.0 (2013) | | LOTUS-R EP (2013) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ① | | ② | | ③ | ❹ | | ❺ | | ❻ | | ❼ | |
| | | Index | Weight | Index | Weight | - | Index | Weight | Index | Weight | Index | Weight | Index | Weight |
| | Disassembly) | | | | | | | | | | | | | |
| 50 | Use Durable Materials, Equipment and Services | - | - | - | - | ✓ | - | - | - | - | - | - | - | - |
| **Waste & Pollution** | | | | | | | | | | | | | | |
| 51 | Dedicated Recycling Storage Area | MR-P1 | R | Was 1 | 3.74 | ✓ | - | - | MR5 | 2.17 | WS-PT-2 | 5.00 | WP-4 | 0.77 |
| 52 | Composting | - | - | Was 3 | 0.93 | ✓ | (RB 3-3) | (5.41) | SM14 | 1.09 | - | - | - | - |
| 53 | Maximize Industrialized Building System and Reduce On-Site Construction | - | - | - | - | - | - | - | SM7 | 2.17 | - | - | - | - |
| 54 | Refrigerant Management (Low/Zero ODP & GWP) | EA-4 (EA-P3) | 2.00 (R) | - | - | ✓ | - | - | - | - | EM-PT-2 | 1.00 | WP-2 | 1.54 (R) |
| 55 | Low or Zero ODP/GWP Fire Retardant and Insulation Foaming Materials | - | - | - | - | ✓ | - | - | - | - | - | - | - | - |
| 56 | Implementation of Emission Control Strategies | - | - | - | - | - | - | - | - | - | EM-PT-3 | 1.00 | - | - |
| 57 | Air Pollutants and Greenhouse Gas Inventory (NOx, SOx, COx,… and Dust) | - | - | - | - | ✓ | - | - | - | - | EM-PT-1 | 2.00 | - | - |
| 58 | Public Transportation Access | SS-4.1 | 6.00 | - | - | - | RB 3-5 | 2.70 | SM8 | 8.70 | TR-PT-7 | 4.00 | A-5 | 0.77 |
| 59 | Contribution to Public Transport Amenities | | | - | - | - | | | | | TR-PT-6 | 3.00 | - | - |
| 60 | Bicycle Rider Amenities – Storage & Lane | SS-4.2 | 1.00 | Ene 8 | 1.87 | ✓ | (RB 3-5) | (2.70) | SM9 | 2.17 | TR-PT-1 | 1.00 | - | - |
| 61 | Appropriate Parking Capacity | SS-4.4 | 2.00 | - | - | ✓ | - | - | - | - | TR-PT-3 | 3.00 | - | - |
| 62 | Amenities for Low-Emitting and Fuel-Efficient Vehicles – Parking & Fueling Station | SS-4.3 | 3.00 | - | - | - | - | - | - | - | TR-PT-2 | 1.00 | - | - |
| 63 | Transportation Impact Assessment | - | - | - | - | - | - | - | - | - | TR-PT-8 | 2.00 | - | - |
| **Indoor Environmental Quality** | | | | | | | | | | | | | | |
| 64 | Environmental Tobacco Smoke Control | IEQ-P2 | R | - | - | ✓ | - | - | - | - | (EQ-PT-5) | (1.00) | H-PR-1 | R |
| 65 | Outdoor Air Delivery Monitoring | IEQ-1 | 1.00 | - | - | ✓ | - | - | - | - | - | - | - | - |
| 66 | Indoor Air Quality in Wet Areas | - | - | - | - | - | RB 4-4 | 1.35 | - | - | - | - | - | - |

| No. | Theme / Criteria | LEED-NC v.3 (2009) | | Code for Sustainable Homes, 2010 | | CASBEE -NC 2014 | Green Mark 4.1 2012 | | GBI–RNC 3.1 (2014) | | BERDE-NC-VRD 1.1.0 (2013) | | LOTUS-R EP (2013) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ① | | ② | | ③ | ❹ | | ❺ | | ❻ | | ❼ | |
| | | Index | Weight | Index | Weight | - | Index | Weight | Index | Weight | Index | Weight | Index | Weight |
| 67 | Controllability of Systems – Lighting & Thermal Comfort | IEQ-6.1; IEQ-6.2 | 2.00 | - | - | ✓ | - | - | - | - | EQ-PT-2; EQ-PT-4 | 2.00 | - | - |
| 68 | Ventilation in Car-Parks | - | - | - | - | - | RB 1-5 | 4.05 | - | - | - | - | - | - |
| 69 | Daylighting | IEQ-8.1 | 1.00 | Hea 1 | 2.80 | ✓ | RB 1-3 | 4.05 | EQ4 | 3.26 | EQ-PT-1 | 1.00 | H-3 | 3.08 |
| 70 | Proper Illuminance Level | - | - | - | - | ✓ | - | - | - | - | - | - | - | - |
| 71 | External View | IEQ-8.2 | 1.00 | - | - | - | - | - | EQ5 | 1.09 | (EQ-PT-1) | (1.00) | - | - |
| 72 | Glare Control | - | - | - | - | ✓ | - | - | - | - | EQ-PT-3 | 1.00 | - | |
| 73 | Ventilation for Indoor Air Quality Improvement | IEQ-2; IEQ-P1 | 1.00 | - | - | ✓ | - | - | EQ1 | 3.26 | EQ-PT-5 | 1.00 | H-1 | 1.54 |
| 74 | Sound Insulation & Noise Level | - | - | Hea 2 | 3.74 | ✓ | RB 4-1 | 0.68 | EQ6 | 1.09 | - | - | H-4 | 2.31 |
| 75 | Design HVAC Systems & Building Envelope for Thermal Comfort | IEQ-7.1 | 1.00 | - | - | ✓ | - | - | - | - | - | - | - | - |
| 76 | Indoor Chemical and Pollutant Source Control and Microbial Contamination Prevention | IEQ-5 | 1.00 | - | - | ✓ | - | - | - | - | EQ-PT-6 | 1.00 | - | - |
| 77 | Locating Refuse Chutes or Waste Disposal Area at Open Ventilation Areas | - | - | - | - | - | RB 4-3 | 0.68 | - | - | - | - | - | - |
| 78 | Provision of an Inclusive Outdoor Space Which is at least Partially Private (Private Space ) | - | - | Hea 3 | 0.93 | - | - | - | - | - | - | - | - | - |
| 79 | VOC Minimization - Adhesives & sealants; Paints & coatings; flooring Systems | IEQ-4.1; IEQ-4.2; IEQ-4.3 | 3.00 | - | - | ✓ | RB 4-2 | 1.35 | EQ2 | 2.17 | EQ-PT-7 | 1.00 | H-2 | 3.08 |
| 80 | Formaldehyde Minimization – Composite Wood and Agrifiber Products | IEQ-4.4 | 1.00 | - | - | ✓ | - | - | EQ3 | 1.09 | - | - | (H-2) | (3.08) |
| 81 | Humidity Control | - | - | - | - | ✓ | - | - | - | - | - | - | - | - |
| 82 | Reliable Services | - | - | - | - | ✓ | - | - | - | - | - | - | - | - |
| 83 | Provision of Amenities (Ceiling height and Décor Planning) | - | - | - | - | ✓ | - | - | - | - | - | - | - | - |

| No. | Theme / Criteria | LEED-NC v.3 (2009) | | Code for Sustainable Homes, 2010 | | CASBEE -NC 2014 | Green Mark 4.1 2012 | | GBI–RNC 3.1 (2014) | | BERDE-NC-VRD 1.1.0 (2013) | | LOTUS-R EP (2013) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ① | | ② | | ③ | ❹ | | ❺ | | ❻ | | ❼ | |
| | | Index | Weight | Index | Weight | - | Index | Weight | Index | Weight | Index | Weight | Index | Weight |
| **Social & Economic Aspects** | | | | | | | | | | | | | | |
| 84 | Heritage Features Protection & Promotion | - | - | - | - | ✓ | - | - | - | - | HC-RQ-1 HC-PT-1; HC-PT-2 | 4.00 | CY-PR-2 | R |
| 85 | Access for People with Disabilities | - | - | - | - | ✓ | - | - | - | - | - | - | CY-PR-3 | R |
| 86 | Provision Publicly Functional Space and Facilities | - | - | - | - | ✓ | - | - | - | - | - | - | CY-2 | 3.08 |
| **Management** | | | | | | | | | | | | | | |
| 87 | Public Consultation (Stakeholder Consultation) | - | - | - | - | ✓ | - | - | - | - | MN-PT-2 | 2.00 | CY-PR-1 | R |
| 88 | Design Charrette (Integrated design) | - | - | - | - | - | - | - | - | - | MN-PT-3 | 1.00 | (Man-1) | 1.54 |
| 89 | Security (Crime Prevention) in Buildings Design | - | - | Man 4 | 1.87 | ✓ | - | - | - | - | MN-PT-4 | 1.00 | - | - |
| 90 | Design with Maintenance Consideration | - | - | - | - | ✓ | - | - | - | - | - | - | - | - |
| 91 | Design for Flexibility and Adaptability to Future Changes in Building Use | - | - | Hea 3 | 3.74 | ✓ | - | - | - | - | - | - | - | - |

## 2.4 Brief Background of Vietnam

### 2.4.1 Natural and Climatic Conditions

Vietnam is located in Southeast Asia region, lying on the eastern Indochina Peninsula. The country shares border with China to the north, Laos to the northwest, Cambodia to the southwest and the East Sea (the South China Sea) to the east and southeast.


Figure 2-4 Vietnam in the Southeast Asia region[66]

Stretching over 15 parallels of latitude (from latitude 8°27’N and 23°23’N) and, Vietnam has a diverse geomorphological, hydrological and climatic condition.[67] Vietnam has a hot and humid tropical monsoon climate. Locating entirely in tropical belt makes Vietnam receive a high solar radiation all year round, and the sun mainly moves in the south sky. Some 3,260 km of coastline in the east brings in the southeast monsoon with high humidity. Meanwhile, Truong Son

[66] Image is extracted from "Vietnam World Map," accessed June 15, 2015, http://www.wpmap.org/vietnam-world-map/.

[67] W Neil Adger, P Mick Kelly, and Nguyen Huu Ninh, *Living with Environmental Change: Social Vulnerability, Adaptation and Resilience in Vietnam* (Routledge, 2012), 35-36.

mountain ranges, running along the west side, generate foehn effect causing extreme hot dry southwest monsoon to the central lowland.

The climatic characteristics of the lowland indicate three distinctive parts, the northern, central coastal and the southern lowlands. The northern lowland obviously has four seasons with short cold winter. The air temperature rarely falls below 5°C and occasionally reaches to 40°C. Rainfall and rain intensity are quite intensive. The central coastal lowland has a tropical climate with monsoons. The lowest temperatures rarely go beyond 10°C, and the highest temperatures possibly exceed 40°C. In summer, the hot-dry monsoon brings in extremely hot summer. Rainfall and rain intensity is quite large. The southern delta has typical hot and humid climate with high air temperature, solar radiation, and monsoons all year round. There are two distinguishing seasons, the dry season and the rainy season. The rain intensity is extremely high.

Aside from diverse terrain, Vietnam suffers series of natural disasters such as tropical typhoon, heavy rainfall, flooding, drought, overheat and humidity and so forth. Among that, tropical typhoon is the most influenced threat that annually strike the central coastline from June to December and cause considerable damages. The devastation has recently been intensified in frequency and scale associated with the anthropogenic impact on the natural environment in the expansion of habitat process. In outskirt areas, the loss of the protecting forest has resulted in soil erosion, landslide, and flooding. In the urban area, the overpopulation in urban areas and weak management in urban planning and construction causes urban inundation in large area on every heavy rainfall.

Vietnam belongs to most vulnerable countries suffering consequences of climate change seriously.[68] The impacts of climate change are evident in the coming decades through the increasing air temperature and rainfalls. The increasing temperature is foreseen phenomenon. There is considerably increasing average temperature by 0.5°C over the last 50 years (Figure 2-5).[69] The latest studies in 2012 illustrated that the average temperature over majority area of Vietnam will go up from 1.9-3.1°C, especially the number of intensive hot days (above 35°C) are projected to rise to 10-20 days.[70]

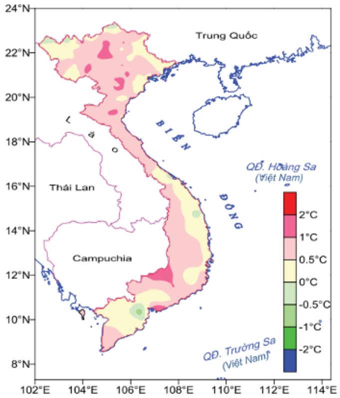


Figure 2-5 Annual average temperature (°C) during the last 50 years in Vietnam[71]

Besides, the annual precipitation tends to reduce in dry period and increases in rainy period, which accelerates drought and flooding risks (Figure 2-6). The flooding tends to increase extremely in the Mekong River Delta due to a

[68] Susmita Dasgupta et al., "The Impact of Sea Level Rise on Developing Countries: A Comparative Analysis," *World Bank policy research working paper*, no. 4136 (2007).

[69] Ministry of Natural Resources and Environment, *Climate Change, Sea Level Rise Scenarios for Vietnam* (Hanoi, 2009), 33.

[70] Ibid., 71.

[71] *Climate Change, Sea Level Rise Scenarios for Vietnam* (Hanoi, 2012), 8.

combination of increasing precipitation and sea-level rise. Consequently, the extreme weather tends to increase in amount and intensity. The typhoon frequency attacking to Vietnam has increased by 0.43 events per decade.[72]

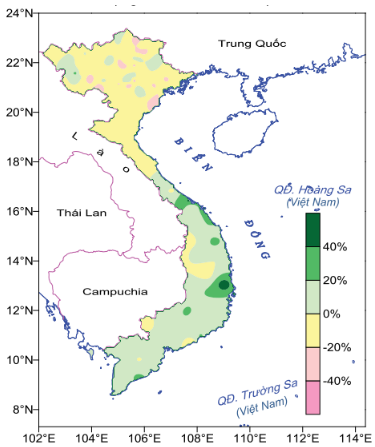


Figure 2-6 Precipitation (%) during the last 50 years in Vietnam[73]

### 2.4.2 Socio-Economic Background

Vietnam is a multi-ethnic country with 54 official recognized ethnic groups. Among ethnic groups, lowland Vietnamese (Kinh) is the most dominant group inhabiting in the low-lying deltas and coastal plains. Original Kinh people's culture derived from irrigated rice-based Red River civilization formed by those had inhabited along the basin of Red River Delta in northern Vietnam since 2nd century BC. The culture of irrigated rice-based civilization indicates a living highly subjects to the climatic situation and natural calamity. Thus, the relationship between human and nature plays a vital role in Vietnamese peasants'

[72] *Climate Change, Sea Level Rise Scenarios for Vietnam*, 71.

[73] *Climate Change, Sea Level Rise Scenarios for Vietnam*, 8.

consciousness and spirit.

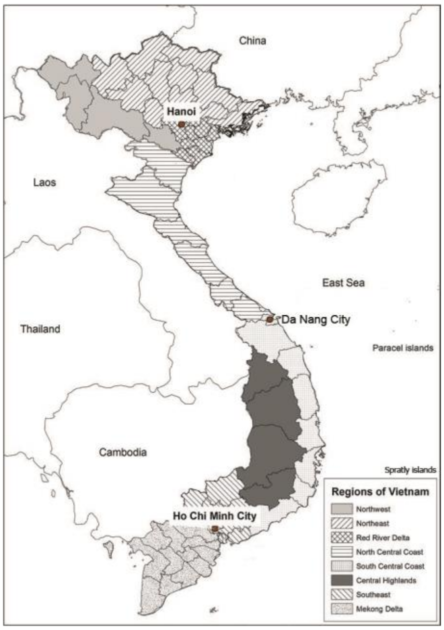


Figure 2-7 Regions of Vietnam[74]

Vietnam today is the third and thirteenth most populous country in Southeast Asia and the world. The country is the home of 85 million persons with annual growth rate of 0.7%. Urban areas are the place of 27% population, with urbanization growth rate of 1.9%, the urban population is predicted to ascend continuously up to 45% by 2020 and to 50% by 2030.[75] However, settlement of inhabitants is not evenly distributed, primarily concentrated in delta regions while sparse distribution in mountainous areas. Red River in the north and Mekong River

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74 Image is extracted from Philipp Schmidt-Thome et al., *Climate Change Adaptation Measures in Vietnam* (Springer, 2015), 5. with minor revision

75 Estimation is made in 2013, with reference of Asian Development Bank, *Viet Nam : Environment and Climate Change Assessment* (2013), 3.

Delta in the south are the two most concentration regions that account for 43% of nation's population (estimated in 2009)[76], in which, Hanoi and HCMC are the two populous pole of the country.

'Doi Moi' economic reform was introduced in 1986 aiming at solving the economic stagnation crisis caused by the backward of the economic system, changing from the centrally planned economy toward a 'socialist-oriented market economy.' The latter policies have resulted in the economic transformation through implementing the market economy that has gradually opened a housing market. The "Doi Moi" policy has brought in the intensive improvement in living standards and relatively changed the principle of housing development and planning responding to the higher needs of the public. People have more alternatives for selecting their house and possible to build a house by their favorite design. The total housing production in eight years from 1986 to 1993 accounted for 86% of houses and 93% floor area of total housing built in the period of nineteen years from 1975 to 1993.[77] The numbers indicate that housing production has been doubled every two or three years since 1986. From 1987 to 1989 about 4,000 housing units were added annually and that of the period from 1991 to 1993 reached 16,000.[78]

Specifically, land and housing market has considerably altered toward marketization. Though the urban land market was mostly disregarded until the

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[76] Central Population and Housing Census Steering Committee, *The 2009 Vietnam Population and Housing Census: Major Findings* (Hanoi: Statistical Publishing House Hanoi, 2010), 34.

[77] Japan Bank for International Cooperation, "Urban Development and Housing Sector in Vietnam," in *JBIC Research Paper No. 3* (1999), 74.

[78] Ibid.

1990s, the 1993 Land Law opened opportunities for the growing the land and housing market. This policy swiftly accelerated the transformation of farmland into urban land responding to the needs of urban expansion through formal and informal land transactions. The 2003 Land Law continuously fostered the trading activities on the land and housing market. The Land Price Framework was firstly issued to simulate the market price fluctuation. However, this official price was often lower than the 'real market' rates by 30-70%. It initially attained satisfactory results in attracting real estate investment though it also led to land speculation, land conflicts and raising the price to the end user due to the two price system.[79]

## 2.4.3 Built-Environment Settings

### 2.4.3.1 Policies and Legislation

Vietnam early affirmed the sustainable development at the Rio Earth Summit, Brazil in 1992 and reasserted the commitments by presenting National Agenda 21 at the 2002 Earth Summit in Johannesburg, South Africa. "Vietnam Agenda 21," officially titled "The Strategic Orientation for Sustainable Development in Vietnam," includes the fundamental strategies upon which the governmental administrators build the legal foundation for the coordination and implementation of the ministries, branches and localities, organizations and individuals.[80] The strategies for sustainable development were persistently planned for the period 2011-2020 that highlights protection of natural resources and environments

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[79] World Bank and Vietnam Country Office, *Vietnam Urbanization Review : Technical Assistance Report* (Hanoi: World Bank, 2011), 5.

[80] "Định Hướng Chiến Lược Phát Triển Bền Vững Ở Việt Nam (Chương Trình Nghị Sự 21 Của Việt Nam)," [Promulgating the the Strategic Orientation for Sustainable Development in Vietnam (Vietnam's Agenda 21)], Prime Minister Decision No. 153/2004/QD-TTg, (Hanoi: 2004).

through promotion of green/low-carbon growth, energy saving, efficient resources consumption, renewable resources enhancement, reducing the environmental pollution and degradation, practicing adaptation with climate change and natural disasters.[81] Specifically, the low carbon development is described in Vietnam National Green Growth Strategy (VGGS) released in 2012:

> "Green growth, as a means to achieve a low carbon economy and to enrich natural capital, will become the principal direction in sustainable economic development; reduction of greenhouse gas emissions and increased capability to absorb greenhouse gas are gradually becoming essential indicators in social-economic development."[82]

The VGGS emphasizes three major strategic tasks: (1) reducing greenhouse gas emissions and promoting renewable energy, (2) greening of production and lifestyles, and (3) promoting sustainable consumption.

The series of policies and legal documents has been issued to concretize the strategies of green growth, of which energy saving targets are the early specified. The government proclaimed 'National targeted program on energy efficiency and conservation'[83] in 2006 and updated in 2012.[84] From these documents, expected target is saving from 5% to 8% of the national energy consumption in the period of 2012-2015 compared to forecast energy demand. The strategies projected are managing efficiently, promoting the use of high-performance appliances, reducing

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[81] "Phê Duyệt Chiến Lược Phát Triển Bền Vững Việt Nam Giai Đoạn 2011-2020."

[82] VGGS was approved on September 25, 2012 by the Prime Minister through the Governmental Decision 1393/QD-TTg.

[83] "Phê Duyệt Chương Trình Mục Tiêu Quốc Gia Về Sử Dụng Năng Lượng Tiết Kiệm Và Hiệu Quả," [Approving the national strategic program on energy saving and efficiency], Prime Minister Decision No. 79/2006/QD-TTg, (Hanoi: 2006).

[84] "Phê Duyệt Chương Trình Mục Tiêu Quốc Gia Về Sử Dụng Năng Lượng Tiết Kiệm Và Hiệu Quả Giai Đoạn 2012-2015," [Approving the national strategic program on energy saving and efficiency in the period 2012-2015], Prime Minister Decision No.1427/QD-TTg (Hanoi: 2012).

fossil fuel consumption, and enhancing renewable energy. The documents especially highlight the implementing mandatory management in compliance with Vietnamese construction standards associated with energy efficiency for all new or renovated buildings.

The energy demand of Vietnam for the next 20-30 years is predicted to foster extremely in the context of shortage of energy sources, domestic fossil fuel depletion, and oil price fluctuation. Responding energy issues, governmental administrators affirm to increase the proportion of new and renewable energy sources to about 3% of the total amount of commercial energy by 2010; 5% by 2020, 6% by 2030, and 11% by 2050.[85] These targets initially set a foundation for developing the relative strategic technologies in exploiting the renewable energy.

Regards built environment, some major issues concerned are energy efficiency, greenhouse gas emission, solid waste, and non-baked building materials. Table 2-15 illustrates the governmental policies and concerned issues systematically.

Table 2-15 Governmental policies and legislation for sustainable development

| Year | Policy Title | Main Contents | Official Document | Concerned Issue |
|---|---|---|---|---|
| 2004 | Oriented strategy for sustainable development in Vietnam (Vietnam's Agenda 21) | Responding to the 1992 Agenda 21 in Rio de Janeiro, this document officially affirms the orientation for sustainable development in Vietnam | Prime Minister's Decision No. 153/2004/QD-TTg (Aug 17, 2004) | Sustainable development strategies in general |
| 2005 | First National Energy Efficiency Building Code (QCVN09:2005/BXD) | | Minister of Construction's Decision No. 40/2005/QD-BXD (Nov 17, 2005) | Energy efficiency, energy performance |
| 2006 | National targeted program on energy efficiency and | Saving 5%-8% total consumed energy of 2011-2015 period by management, | Prime Minister's Decision No. | Energy efficiency, renewable energy, |

[85] This facts are mentioned in the "Phê Duyệt Chiến Lược Phát Triển Năng Lượng Quốc Gia Của Việt Nam Đến Năm 2020, Tầm Nhìn Đến Năm 2050," [National energy development strategy up to 2020 and vision to 2050], Prime Minister Decision No. 1855/QD-TTg, (Hanoi: 2007). and "Phê Duyệt Quy Hoạch Phát Triển Điện Lực Quốc Gia Giai Đoạn 2011-2020 Có Xét Đến Năm 2030," [National master plan for power development for the 2011-2020 period with the vision to 2030], Prime Minister Decision No. 1208/QD-TTg, (Hanoi: 2011).

| Year | Policy Title | Main Contents | Official Document | Concerned Issue |
|---|---|---|---|---|
| | conservation | high-performance appliances, reducing fossil fuel and enhancing renewable energy | 79/2006/QD-TTg (Apr 14, 2006) | energy performance |
| **2007** | National energy development strategy up to 2020 and vision to 2050 | Increasing the proportion of new and renewable energies to about 3% of the total amount of commercial primary energy by 2010; 5% by 2020 and 11% by 2050. | Prime Minister's Decision No. 1855/QD-TTg (Dec 27, 2007) | Energy efficiency, renewable energy, energy performance |
| **2009** | National strategy for integrated management of solid waste up to 2025 and vision towards 2050 | Target concerning recycling, reuse and energy recovery of solid waste.<br>Proportion of solid waste being collected and treated and its recycled, reused or recovered:<br>+ Households 2015: 85%(60%) ; 2020: 90%(85%); 2025: 100%(90%); 2050: 100%(100%)<br>+ Construction sites: 2015: 50%(30%); 2020: 80%(50%); 2025: 90%(60%) | Prime Minister's Decision No. No.2149/QD-TTg (Dec 17, 2009) | Solid waste reduction, resources conservation |
| **2010** | Program on development of non-baked building materials up to 2020 | Replacing baked clay bricks with non-baked building materials at the rate of 20-25% by 2015 and 30-40% by 2020<br>From 2011, at least 30% of the total building materials in high-rises (higher than nine floors) use the light non-baked building materials. | Prime Minister's Decision No. 567/QĐ-TTg (Apr 28th, 2010) | Embodied energy materials (non-baked building materials) |
| **2010** | Law on Energy Efficiency and Conservation | Architectural design and planning adapt to natural conditions; Using heat-insulated materials; Using high-performance devices and equipment; Using automatic management and control systems; Using low embodied energy materials and non-baked materials, solar energy and biogas devices in construction works. | The National Assembly's Law No. 50/2010/QH12 (Jul 17th, 2010) | Energy efficiency, renewable energy, resources conservation, adaptation, embodied energy material, healthy environment |
| **2011** | National master plan for power development for the 2011 - 2020 period with the vision to 2030 | Develop renewable energy (wind power, solar power, and biomass power) for electricity production up to 4.5% by 2020 and 6% by 2030 | Prime Minister's Decision No. 1208/QD-TTg (Jul 21st, 2011) | Energy efficiency, renewable energy |
| **2012** | Sustainable development strategy of Vietnam for the period 2011-2020 | To gradually carry out green growth, low-carbon economic development; to economically and effectively use all resources. | Prime Minister's Decision No.432/QD-TTg (Apr 12th, 2012) | Green/low-carbon growth in general |
| **2012** | National strategy for green growth | Period 2011-2020: Reduce greenhouse gas emissions by 8-10% in the compared to the amount of 2010; Reduce energy consumption per unit of GDP by 1-1.5% per year; Reduce greenhouse gas emissions by at least 1.5-2% per year by 2030; Reduce greenhouse gas emissions by 1.5-2% per year by 2050. | Prime Minister's Decision No.1393/QD-TTg (Sep 25th, 2012) | Greenhouse gas emission, energy efficiency |
| **2012** | National targeted program on energy efficiency and conservation phase 2012-2015 | Saving from 5 - 8% of the total energy consumption of the country in the period 2012 - 2015 compared to forecast energy demand.<br>Implementation of mandatory management in compliance with Vietnamese Construction Standards "Energy efficiency construction buildings" from 2012, for 100% of new or renovated buildings within the scope of the Standards. | Prime Minister's Decision No.1247/QD-TTg (Oct 02nd, 2012) | Energy efficiency |
| **2012** | Stipulating on use of non-baked building materials in construction | Mandatory use of lightweight non-baked building materials in construction works (9 floors or more), from now by 2015, not less | Minister of Construction's Circular No. 09/2012/TT-BXD | Embodied energy materials (non-baked building |

| Year | Policy Title | Main Contents | Official Document | Concerned Issue |
|---|---|---|---|---|
| | works | than 30% and after 2015, not less than 50% in total used building materials | (Nov 28th, 2012) | materials) |
| **2013** | Energy Efficiency Building Code 2013 version (QCVN 09:2013/BXD) | Substitute of 2005 Energy Efficient Building Code | Minister of Construction's Circular No. 15/2013/TT-BXD (Sep 26th, 2013) | Energy efficiency |

In summary, the Vietnamese government is early aware of the needs for sustainable development by the proclamation of 'Vietnam Agenda 21' as the legal framework for the further actions. Some sequent strategies have been made to concretize the developmental tendency, specifically in terms of energy saving and renewable energy. Some significant aspects are highlighted recently in building industry to serve the targets of low-carbon growth (Table 2-16).

Table 2-16 Major issues addressed in policies and legislation on sustainability

| No. | Issues | Sub-Issues | Official Documents |
|---|---|---|---|
| 1 | Reduce energy consumption | • Automatic management & control systems<br>• Reduce fossil fuel-based energy<br>• High-performance appliances<br>• Use low embodied energy materials | 79/2006/QD-TTg;<br>1393/QD-TTg (2012);<br>1247/QD-TTg (2012) |
| 2 | Enhance renewable energy | • Wind energy<br>• Solar energy<br>• Biomass energy | 79/2006/QD-TTg;<br>1855/QD-TTg (2007);<br>1208/QD-TTg (2011) |
| 3 | Resources conservation | • Recycle, reuse or recover the solid waste | 2149/QD-TTg (2009) |
| 4 | Reduce greenhouse gas emissions | • Efficient use of resources<br>• Replace baked clay bricks with non-baked building materials | 567/QĐ-TTg (2010);<br>09/2012/TT-BXD (2012)<br>1393/QD-TTg (2012);<br>432/QD-TTg (2012) |

### 2.4.3.2 Standards System

Vietnam construction standards system was early established in the 1960s based on the systems of The Union of Soviet Socialist Republics (USSR) which are mostly mandatory standards. After the 'Doi Moi' policy, the conversion from a subsidized economy to a market-oriented economy led to a remarkable turn of the standards system, from mandatory to voluntary basis with intensive reference of the Western systems such as ISO, BS, UBC, ASTM. As estimation in 2006, Vietnam has some 7,500 national standards and nearly 20% of that is construction standards.[86] Today, Vietnam standard system involves standards and technical regulations or codes, the former are voluntary, and the latter are mandatory (Figure 2-8). The standards are prepared by National Standards Technical Committee (TCVN/TC) and approved and issued by Ministry of Science and Technology (MOST). Meanwhile, the technical regulations are prepared and issued by relevant ministries.[87] The central government releases the regulations in the form of decrees and ministries transform them into building codes.

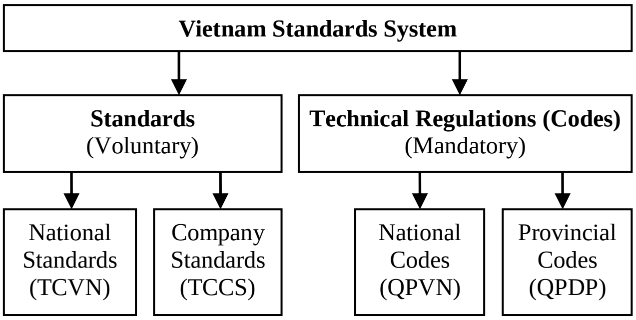


Figure 2-8 Vietnam Standards System[88]

The construction standards system is primarily graded into two levels: national and branch. The national construction standards include those with the code TCVN

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[86] Ngoc Ba Nguyen, "The Development of Vietnamese Codes and Standards in Construction" (paper presented at the ACECC workshop on Harmonization of Design Codes in the Asian Region, Taipei, 2006).

[87] Ibid.

[88] Ibid.

issued by MOST and code TCXD, TCXDVN issued by Ministry of Construction (MoC). The TCVN standards are often general specifications or production standards such as cement, tiles, reinforcement. The TCXD/TCXDVN standards often cover the remained fields such as design, construction, and planning. The branch construction standards with code TCN are standards of transportation construction issued by Ministry of Transportation (MT) and standards of agricultural construction issued by Ministry of Agriculture and Rural Development (MARD). Besides, there are also company construction standards that are only used within the company (Table 2-17).

Table 2-17 Structure of Vietnamese construction standards system[89]

| Level | Code | Field | Issue | Example |
|---|---|---|---|---|
| National | TCVN | General specifications; Production standards (cement, tiles, reinforcements, …) | MOST | TCVN 3992:1985 |
| | TCXD, TCXDVN | Other fields (design, construction, planning, …) | MoC | TCXD 238:1999<br>TCXDVN 375:2006 |
| Branch | 22 TCN | Transportation construction | MT | 22 TCN 45:79 |
| | 14 TCN | Agriculture construction | MARD | 14 TCN 63:2002 |
| Company | Used within company only | | | |

### 2.4.3.3 Legislation, Codes and Standards and Issues of Sustainability

In general, the ‘green’ features have been partly incorporated into the existing Vietnamese regulatory systems. Some of the latest standards associated with sustainable building design and construction are illustrated in Table 2-18.

[89] Ibid.

Table 2-18 Vietnamese Legislation, codes, standards associated with sustainable building design and construction[90]

| Category | Document No. | Type | Title |
|---|---|---|---|
| Management | QCVN 02 : 2009/BXD | C | Vietnam building code – Natural physical & climatic data for construction |
| | Decree 175/1994/ND-CP | L | Guidance of Enforcing Environmental Protection Law |
| | Decree 143/2004/ND-CP | L | Amended the article 4 of the Decree 175/1994/ND-CP |
| Site | 28/2001/QH10 & 32/2009/QH12 | L | Law on Cultural Heritage (Article 37.1 and 37.2) |
| Energy | QCXDVN 09:2013/BXD | C | Vietnam Energy Efficiency Building Code (EEBC) |
| Water | TCVN 5502:2003 | S | Domestic Supply Water – Quality Requirements |
| | QCVN 14:2008/BTNMT | C | National technical regulation on domestic wastewater |
| Waste | TCVN 7629:2007 | S | Hazardous waste thresholds |
| Indoor Environmental Quality | TCVN 5687:2010 | S | Ventilation – Air-conditioning – Design standards |
| | TCXDVN 306:2004 | S | Dwellings and public buildings – Parameters for microclimates in rooms |
| | TCXDVN 277:2002 | S | Sound insulation – Standards of building elements between rooms |
| | TCXDVN 175:2005 | S | Maximum permitted noise levels for public building - Design standard |
| Construction Administration | Decision 2920-QD-MTg (1996) | L | Decision on the application of Vietnam standards on the environment (mandatory application) |
| | Decree 209/2004/ND-CP | L | Quality management of construction works |
| | Decree 80/2006/ND-CP | L | Detailing and guiding the implementation of a number of articles of the Law on Environmental Protection (52/2005/QH11) |
| | Decree 21/2008/ND-CP | L | Amend and supplement a number of articles in Decree No. 80/2006/NĐ-CP with regard to regulations detailing and guiding the implementation of the following articles of Law on Environmental Protection: articles 4, 5, 11, 17, clause 1 article 6, clause 3 article 22 and supplements articles 6a, clause 1b article 13, articles 17a, 17b, 17c, 17d, 21a,23a. |
| | Decree 29/2011/ND-CP | L | Stipulated the assessment of strategic environment, environmental impact, and illusory commitment on environment (This Decree replaced regulations in articles 6,7,8,9,10,11,12,13,14,15,16 and 17 of the Decree 80/2006/ND-CP) |
| | TCVN 6647:2007 | S | Soil quality – Pre-treatment of samples for physic-chemical analysis |
| | TCVN 7370-2:2007 | S | Soil quality – Dissolution for the determination of total element content - Part 2: Dissolution by alkaline fusion |
| | TCVN 7538-5:2007 | S | Soil quality – Sampling (Part 5: Guidance on the procedure for the investigation of urban and industrial sites with regard to soil contamination) |
| | Circular 22/2010/TT-BXD | L | Labor Safety in Work Construction |
| | Circular 18/2011/TT-BXD | L | Provisions for the application of rules and standards in construction activities |
| Design Process | QCXDVN 01:2002 | C | Building Code of Construction Accessibility for People with Disability |

[90] With reference from Vietnam Green Building Council, *LOTUS Residential Extended Pilot: Technical Manual*, 12-13.

| Category | Document No. | Type | Title |
|---|---|---|---|
| | TCVN 2737:2006 | S | Loads and Effects |
| Note | S: Standard; C: Code; L: Legislation | | |

#### 2.4.3.4 Life Cycle Thinking

The energy price affects greatly to the awareness of energy saving and operating cost saving for a long run. Reducing electricity cost has not been paying much attention in Vietnam when the electricity taxes remains low compared to other countries in the region. Incentives and building codes associated with the issue of power prices are short of specific actions for encouraging the development of green building industry.[91] Although government is gradually shifting to the market price of electricity, it takes time to reduce inflationary pressures and the impacts on the low-income consumers. The increasing price of electricity has initially raised a demand for saving energy in buildings.[92]

Besides, the common acknowledgment in Vietnam is that the green building is often more expensive than the conventional one, thus, it is appropriate for those who can afford the high cost. This recognition creates great obstacles for promoting sustainable building in Vietnam. The more important issue is the tendency of short-term investment in constructing a building from investors. The real estate market have not encouraged owners to have a long-term view of project investment. Designers and planners, therefore, have no motive to pay attention to the life cycle issues.

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91 "Xây Dựng Xanh Ở Việt Nam," [Green construction in Vietnam], accessed April 15, 2015, http://moitruong.xaydung.gov.vn/moitruong/module/news/viewcontent.asp?ID=3465&langid=1.

92 Ibid.

### 2.4.4 Ho Chi Minh City at a Glance

HCMC, formerly known as Sai Gon City, is the most populous 300-year-old city and the economic capital of Vietnam. The city is developed following the model of the multipolar mono-centric megacity that involves the inner city area with a radius of 15 km and the four poles of development. Particularly, the multi-center region is formed by integrating existing urban area with other city centers located in four directions, including two primary directions of east and south and two secondary directions of northwest and west, southwest (Figure 2-9).[93]

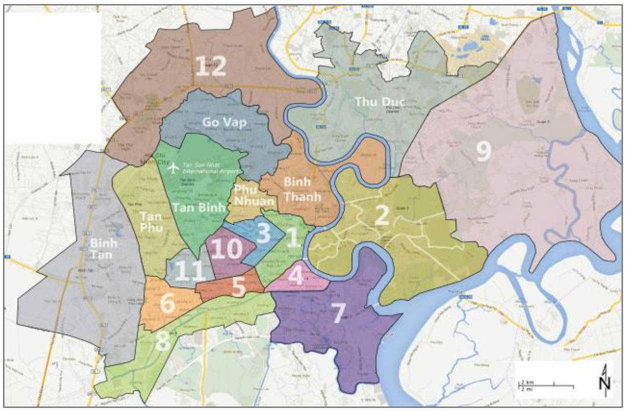


Figure 2-9 Districts of HCMC[94]

HCMC is the most concentration of population and maintains highest

[93] "Phê Duyệt Điều Chỉnh Quy Hoạch Chung Xây Dựng Thành Phố Hồ Chí Minh Đến Năm 2025," [Approval of Adjusting General Construction Planning of Ho Chi Minh City to 2025], Prime Minister Decision No. 24/QD-TTg, (Hanoi: 2010).

[94] Image is extracted from "District Map of Ho Chi Minh City," accessed October 15, 2015, https://codiemaps.wordpress.com/2013/07/27/district-map-of-ho-chi-minh-city/. with minor revision

population growth rate with a population of 7 million inhabitants (in 2009).[95] The population density reaches to 3,4 persons per km² (in 2009), far higher than population density in Hanoi, which is 1,926 persons per km².[96]

In the period of 1997 to 2003, HCMC's urban boundary was intensively expanded under the robust pressure of the profound urbanization. Conversion of farmland to urban land use was strongly accelerated that increased the total urban area of HCMC from 142.15 km² to 494 km² by 2008. The city outskirt's urban space was quickly transformed under the driver of industrialization with industrial parks, residential areas for factory workers, migrants, new emerging middle and high class.[97] The housing construction activities are currently centralized in large-scale urban expansion projects at city's outskirt areas. The population of HCMC is expected to be about 10 million people by 2025. The scale of urban construction land around 90,000-100,000 ha, of which the old urban area is 14,000 ha, the developed urban area will be 35,000 ha and suburban areas around 40,000-50,000 ha with a rural population of about 0.5 million people.[98]

Saigon South New Urban and Thu Thiem New City Center are two prominent new urban areas that bring about the incentive for urban development in HCMC,

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[95] Central Population and Housing Census Steering Committee, *The 2009 Vietnam Population and Housing Census: Major Findings*, 34-35.

[96] Ibid., 37.

[97] Phuoc Tan DU and Shigeru FUKUSHIMA, "Transformation of Socio-Economic Structure of Ho Chi Minh City under the Doi-Moi Policy and the Accompanying Globalization Process," *学 術 論 文 1 台湾の債券型ファンドの盛衰とその社債市場に与えた影響 林 冠汝* (2009).

[98] Tan Vinh Nguyen, "Vấn Đề Đô Thị Hóa Và Phát Triển Bền Vững Ở Thành Phố Hồ Chí Minh," [The issues of urbanization and sustainable development in Ho Chi Minh City], http://www.hids.hochiminhcity.gov.vn/c/document_library/get_file?uuid=4f09433f-fd12-478e-8644-db722890e968&groupId=13025.

altering the image of the city significantly. Saigon South New Urban, also known as Phu My Hung New Town, has been a pioneering urban planning project and typical urban in HCMC. The urban is located on wetland area in District 7 with 600 ha of residential and commercial areas. Since the new urban is located on the site of wetland with full of weak soil capacity and water surface, the success of the project has been out of the most optimist's thought. Saigon South New Town today accommodates over 25,000 inhabitants with an exceedingly high-quality master plan and becomes one of the most high-ranking residential area (Figure 2-10). The favorable outcome of the project has intensively pervaded to the surrounding areas and generated the most high-valued residential region in HCMC.[99]

Figure 2-10 Master plan of Saigon South New Urban[100]

Since 1990s, HCMC government has been starting the expanding plan of existing downtown area to the opposite side, the east bank of Sai Gon River in

[99] David Dapice et al., *Ho Chi Minh City: The Challenges of Growth* (United Nations Development Programme in Vietnam, 2009), 14.

[100] Image is extracted from http://scenicvalley.com.vn/gioi-thieu/gioi-thieu-ve-phu-my-hung/, accessed October 5, 2015

District 2, an empty and vast undeveloped wetlands for decades. This project, known as Thu Thiem New City Center, has been expected to relieve the density of the compacted historic quarters and bring about a newly modern and dynamic image of the city (Figure 2-11).


Figure 2-11 Master Plan of Thu Thiem New City Center[101]

[101] Image is extracted from http://www.thuthiem.hochiminhcity.gov.vn/image/image_gallery?uuid=f771e4fe-a7aa-4fad-ae1a-9acd4a819ba6&groupId=21232&t=1342689823316, accessed on October 5, 2015

## 2.5 Context of HCMC

As common megacities in emerging/developing countries, HCMC urban area today are inevitably struggling with various chronic problems in the urban living environment. This section introduces the general conditions of HCMC and argues the most critical issues that threaten living quality and environment of HCMC. These issues will support the criteria-driven for subsequently selecting the strategies for HAB in HCMC.

### 2.5.1 Climate and Foreseen Climate Change

#### 2.5.1.1 Urban Climate

Located in the tropical equatorial monsoon, the climate of HCMC is typically hot and humid with two distinctive seasons: the rainy season, from May to November, and the dry season, from December to April. Generally, HCMC has high air temperature and humidity, absorbs a great amount of solar radiation, and receives monsoons all year round.[102]

**a. Air Temperature**

Since HCMC is located in the tropical equatorial climate zone, the air temperature is quite high. The city is reported to receive 140 Kcal/cm² per year with insolation time of 5-9 hours per day and 160-270 hours per month. The

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[102] Vietnam Ministry of Construction, *QCVN 02: 2009/BXD Vietnam Building Code - Natural Physical & Climatic Data for Construction* (Hanoi: Vietnam Ministry of Construction, 2009). "Khí Hậu, Thời Tiết," [Climate, weather], Ho Chi Minh City Government, accessed October 15, 2015, http://www.hochiminhcity.gov.vn/thongtinthanhpho/gioithieu/Lists/Posts/Post.aspx?List=9efd7faa-f6be-4c91-9140-e2bd40710c29&ID=5497&Web=9d294a7f-caf2-456d-8ca0-36b393b8c052.

annually average temperature is as high as 27°C and 330 days per year have the average temperature of 25-28°C. April is the hottest month with the highest mean temperature (28.8°C) while the average temperature is lowest (25.7°C) between December and January. The absolute highest and lowest temperatures are 40°C and 13.8°C.[103]

### b. Humidity

The humidity is slightly high in HCMC. The mean relative humidity is 79,5% in annual, particularly 80% in the rainy season and 74.5% in the dry season. The absolute highest humidity is 100% while the lowest is 20%.[104]

### c. Rainfall

The rain intensity in HCMC region is significantly high. The annually average rainfall reaches 1,949 mm and approximately 90% of which happens in the rainy season from May to November. Average number of rainy days in annual is 159 days. June and September are the two months recorded the highest rainfall while January, February and March having no significant rainfall events.[105]

### d. Prevailing Wind Directions

Two principal prevailing monsoons are corresponding to the two seasons,

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[103] *QCVN 02: 2009/BXD Vietnam Building Code - Natural Physical & Climatic Data for Construction*. "Khí Hậu, Thời Tiết".

[104] *QCVN 02: 2009/BXD Vietnam Building Code - Natural Physical & Climatic Data for Construction*. "Khí Hậu, Thời Tiết".

[105] *QCVN 02: 2009/BXD Vietnam Building Code - Natural Physical & Climatic Data for Construction*. "Khí Hậu, Thời Tiết".

including the west-southwest monsoon flowing in the rainy season, from May to November, and north-northeast monsoon flowing in the dry season, from December to April. The west-southwest monsoon comes from the Indian Ocean with the average speed of 3.6 m/s and reaching the highest speed of 4.5 m/s in August. The north-northeast monsoon comes from the East Sea with the average speed of 2.4 m/s. Aside from the two main monsoons, the south-southeast monsoon occurs between March to May with the average speed of 3.7 m/s. Specifically, HCMC is located out of typhoon zone while the typhoon often strikes from the North to South Central Coast of Vietnam.[106]

#### 2.5.1.2 Foreseen Climate Change

The impacts of climate change have evidently acknowledged in Vietnam. Vietnam was enumerated into the most vulnerable countries suffering the consequences of climate change seriously.[107] Specifically, HCMC locates in the high-effect zone of this influence. Recent researchers show evidence that there are relations of climate change and unfavorable changes of weather factors in HCMC, such as increasing air temperature, rainfalls, and sea-level rise.[108]

The air temperature in HCMC tends to increase significantly in the coming decades. The average temperature is projected to increase 1°C by 2020 and 2.6°C

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106 *QCVN 02: 2009/BXD Vietnam Building Code - Natural Physical & Climatic Data for Construction*. "Khí Hậu, Thời Tiết".

107 Dasgupta et al., "The Impact of Sea Level Rise on Developing Countries: A Comparative Analysis."

108 Asian Development Bank, *Viet Nam : Environment and Climate Change Assessment*, 5.

by 2100.[109] Besides, the rainfall tends to decline during the dry season and increase during the rainy season.[110] Statistical documents of rainfall show an increasing trend of the intensity of annual highest intensity rainfalls with an average rate of about 0.8mm per year and frequency of high intensity (greater than 100mm) rainfalls is clearly enhanced (Figure 2-12 and Table 2-19). In addition, sea levels are predicted to rise 30 cm by 2050 and 65-100 cm by 2100 compared with average sea level during the period 1980-1999.[111] Consequently, the increasing frequency of heavy rains higher than 100 mm combined with more serious tidal flooding due to sea-level rise contributes critical urban inundation in HCMC urban area.

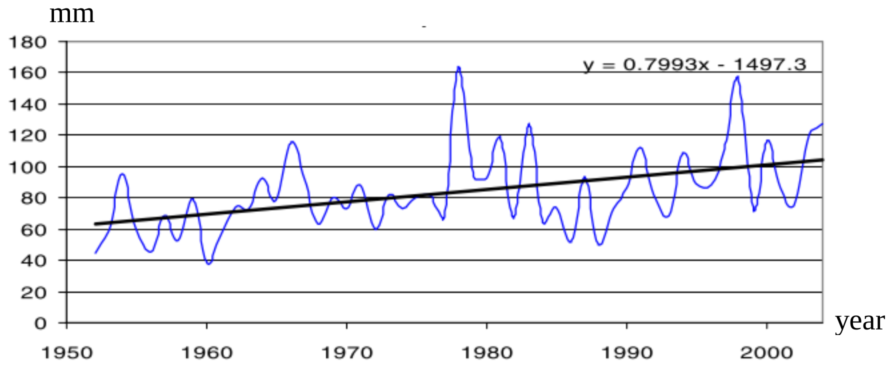


Figure 2-12 Trend of highest intensity rain in HCMC[112]

Table 2-19 The frequency of high-intensity rainfall (greater than 100 mm) lasting 180

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[109] "Biến Đổi Khí Hậu Và Hiệu Ứng Đảo Nhiệt Đô Thị Ở TPHCM," [Climate change and urban heat island effect in the Ho Chi Minh City], accessed June 15, 2015, http://quanlidothi.com/xem/1089/bien-doi-khi-hau-va-hieu-ung-dao-nhiet-do-thi-o-tphcm.html.

[110] Ibid.

[111] Ibid.

[112] Ho Long Phi, "Inundation and Stormwater Drainage in Ho Chi Minh City," 478.

minutes[113]

| Period | 1952-1961 | 1962-1971 | 1972-1981 | 1982-1991 | 1992-2002 |
|---|---|---|---|---|---|
| Occurred Times | 0 | 1 | 2 | 2 | 4 |

### 2.5.2 Environmental Risks

#### 2.5.2.1 Energy Consumption and Greenhouse Gas Emission

Located in the tropical belt, Vietnam possesses rich sources of renewable energy including solar energy, wind energy, and biomass. Despite having high potentials of renewable energy, majority energy consumed in HCMC is fossil fuel based sources and the exploitation of renewable energy is modest. The records show that HCMC consumes one third of nationwide commercial energy, daily consumes 40 million kWh and annually consume 14.6 billion kWh.[114] As a result, the greenhouse gas emission in HCMC is extremely increasing since the volume of greenhouse gas emitted is proportional to the amount of fossil fuel energy consumed. HCMC is responsible for one fourth of the nationwide greenhouse emission originated from oil and coal consumption.[115]

Due to climatic characteristics of HCMC, a large portion of electricity is consumed in residential buildings for maintaining a thermally comfortable indoor environment. Dehumidification and refrigerated cooling are primary strategies to alleviate overheat and humid air. With the development of mechanical cooling technologies, designers, builders and owners misused the HVAC equipment

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[113] Ibid., 477.

[114] According to Hynh Kim Tuoc, the Director of Energy Conservation Center of HCMC (EEC-HCMC) mentioned in Tran, "Phát Triển Nhà Ở Cao Tầng Thành Phố Hồ Chí Minh Theo Hướng Xanh - Hiện Đại - Bản Sắc".

[115] According to Prof. PhD Nguyen Huu Dung, Hanoi University of Architecture, mentioned in ibid.

without considering the energy efficient systems or indoor thermal comfort management. The rising household incomes accelerates the demands of using air conditioning for cooling interiors, in both office and residential buildings.[116]

Besides, the greenhouse emission is also directly from material processing and transportation. A large portion of private motorcycle vehicles is the principal contributor to air pollution, noise pollution and CO2 emission.

#### 2.5.2.2 Emissions into Land and Water

The construction activities are evidently taking a large part in land and water sources degradation in the HCMC. The expansion of the construction site to the vegetated areas, river and canal banks during urbanization process has reduced significantly the greenery area and narrowed the water surface. Due to the high demands of housing, a considerable greenery areas are cleared for construction purposes without recovering after finishing construction. HCMC urban area possesses multiple rivers and canals for regulating the water flows. However, the recent urban expansion shows that many large apartment projects lie at banks of the rivers and canals and sometimes even encroach on the rivers and canals. These actions have accelerated the flow alteration, river bank erosion, and urban inundation. Besides, the construction sites are often backfilled, leveled and remained empty long before the actual constructing activities to be carried out, which brings about erosion, land slips under heavy rains, and causing critical pollution in land and water sources.

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[116] Kenkyujo Nihon Enerugi Keizai, *APEC Energy Demand and Supply Outlook*, vol. 2 (Tokyo: Asia Pacific Energy Research Centre, Institute of Energy Economics, Japan, 2013), 215.

Moreover, HCMC construction activities contribute to solid waste with an essential proportion disposed into landfills. Reducing wastes is seldom paid attention in planning and design process. Most of the contractors do not consider seriously for classifying waste at construction sites and disposing of their construction waste in landfills. Only a small number of large contractors ready to pay more for waste management and disposition, the medium and small builders, however, often ignore treating waste properly. Moreover, most of the landfill sites are open to nature and lack of essential safety environmental protection methods to stop the solid waste, especially hazardous elements from penetrating into the soil, groundwater, river and the sea. These facts result from the unawareness of environmental protection, lack of public responsibility toward general safety, imbalance between profits and environmental preservation.

#### 2.5.2.3 Urban Inundation

Urban inundation has been a critical problem in HCMC. Many factors contribute to the flooding in HCMC, from natural elements such as low elevation, heavy rainfall, flood tide, and sea level rises to improper human activities in urban planning and construction activities. Vietnam belongs to the top ten countries that their land and population is situated in low-lying coastal areas, 10 m above mean sea level.[117] HCMC is situated mostly on low-lying and marshy land in the north-eastern plain of Mekong Delta, the most vulnerable to flooding due to its low-level plain, population concentration and economic activities. HCMC

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[117] Gordon McGranahan, Deborah Balk, and Bridget Anderson, "The Rising Tide: Assessing the Risks of Climate Change and Human Settlements in Low Elevation Coastal Zones," *Environment and Urbanization* 19, no. 1 (2007).

metropolitan area has a quite low level when 55% of the urban area being situated on one meter above mean sea level and only 28% being placed on two-meter level.

Sea level rise due to climate change is also a threatened potential since HCMC is 50 km from the sea. The sea level is reported to rise at the rate of 2-4 cm per decade[118] and could rise 30 cm by 2050, 75 cm by 2100 when 10% of the area of 204 km² will be inundated.

The mixture of factors including flood tide, sea level rise, and rainfall accelerates urban flooding in HCMC. The records show that if the occurrence of heavy rainfall over 100 mm, coinciding with the flood tide, the long spell of extensive flood might occur.[119] The flooding has occurred in most districts and seriously affected the health, living activities and production of citizens. The prolonged heavy rains often cause various roads of districts, e.g. District 6, 8, 11, Tan Phu, and Binh Tan, immersed in water, even in the new road and districts (Figure 2-13). This fact drives the city to face various side problems such as traffic congestion, environmental pollution, and public diseases.

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[118] Ministry of Natural Resources and Environment, *Climate Change, Sea Level Rise Scenarios for Vietnam*, 71.

[119] "'TP HCM Sẽ Lụt Như Bangkok Nếu Phát Triển Như Hiện Nay'," [Ho Chi Minh City will be in inundation as Bangkok if developing as current situation], accessed October 15, 2014, http://vnexpress.net/tin-tuc/thoi-su/tp-hcm-se-lut-nhu-bangkok-neu-phat-trien-nhu-hien-nay-2209538.html.

Figure 2-13 Urban inundation in HCMC after heavy rain[120]

Aside from the natural factors, improper human activities are also the reasons for the urban flooding, for example, the weak management in water conservation projects. To cope with the urban inundation, the city has carried out multiple steps for controlling flooding through many projects for renewing the capacity of the basin and drainage of canals such as Nhieu Loc – Thi Nghe, Tau Hu – Ben Nghe, Tan Hoa – Lo Gom. However, the implemented solutions partially solve the flooding in central areas, but new areas appear to be a brand new inundated place, especially in suburban areas. Due to the weak management of drainage infrastructure deployed projects, most of 'anti-flood' projects, however, have not been met the requirements and far late progress schedules.

## 2.5.3 Socio-Economic Issues

### 2.5.3.1 Shortage of Greenery and Open Space

Standards for the public greenery area and open space has been early prescribed in Vietnam planning and construction standards. The detailed ratio of

[120] Image is extracted from http://www.nhandan.com.vn/xahoi/tin-tuc/item/24483802-chong-ngap-ben-vung-o-tp-ho-chi-minh.html

greenery land for public use is defined in Decision 01/2006/QD-BXD with particular requirements as Table 2-20. Accordingly, HCMC, an extraordinary urban, must adopt the public greenery land as high as 12-15 m² per person. However, the city's greenery and open space for the public purposes, in reality, has been modest and unevenly distributed. Even though actual greenery area average per capita citywide reaches 13.74 m², the inner city attains only 1.95 m² per capita while suburban achieves an enormous number, 473.6 m² per capita.[121] The picture seems to get worse when the ratio of the greenery urban area tends to decrease in the context of increasing demands for city's infrastructure expansion and population concentration.

Table 2-20 Standard of area greenery land for public use[122]

| Urban Type | Standard of greenery land for public use (m²/person) | Standard of green park land (m²/person) | Standard of gardens plants land (m²/person) | Standard street trees land (m²/person) |
|---|---|---|---|---|
| Extraordinary | 12 - 15 | 7 - 9 | 3 - 3,6 | 1,7 - 2,0 |
| I & II | 10 - 12 | 6 - 7,5 | 2,5 - 2,8 | 1,9 - 2,2 |
| III & IV | 9 - 11 | 5 - 7 | 2 - 2,2 | 2,0 - 2,3 |
| V | 8 - 10 | 4 - 6 | 1,6 - 1,8 | 2,0 - 2,5 |

Responding to this situation, the city government has implemented many actions. In 2000, a project of HCMC's green park planning until 2010 was

[121] According to Mr. Nguyen Dang Son, Vice-President of the Institute for Urban Studies and Infrastructure Development (IUSID), mentioned in Tran, "Phát Triển Nhà Ở Cao Tầng Thành Phố Hồ Chí Minh Theo Hướng Xanh - Hiện Đại - Bản Sắc".

[122] "TCXDVN 362-2005 Quy Hoạch Cây Xanh Sử Dụng Công Cộng Trong Các Đô Thị - Tiêu Chuẩn Thiết Kế," [TCXDVN 362-2005 Greenery Planning for public uses in urban areas - Design Standards], Minister of Construction Decision 01/2006/QD-BXD, (Hanoi: 2006).

approved to set a short-term target for the city.[123] The greenery urban park must reach an average of 6-7 m² per capita by 2010, not including street trees, isolated trees in the industrial park, and private housing trees, of which, the existing urban is 3-4 m² per capita and new urban is 8-10 m² per capita. However, the above project was finally failed. The statistical data carried out at the end of 2011 showed an unexpected urban green park area achieved merely less than one m² per capita.[124]

HCMC administrators also made an effort to bring about greenery spaces by renovating existing urban systems through projects in 2009 with strategies learned from cases of Singapore. Accordingly, 28,000 m² of sidewalk in the old districts (District 1,3,5, and 10) was recovered with greenery area of grasses and plants (Figure 2-14). Besides, there were approximately 13,000 m² of land was covered with the green landscape in the overhead bridge sites such as An Suong, Tan Thoi Hiep, Nga Tu Ga and Tan Thuan overhead bridges.[125]

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[123] "Phê Duyệt Dự Án Quy Hoạch Công Viên Cây Xanh Thành Phố Hồ Chí Minh," [Approving projects of green park planning in Ho Chi Minh City], People's Committee of HCMC Decision No. 661/QD-UB-DT, (Ho Chi Minh: 2000).

[124] Van Nam, "TPHCM: Diện Tích Công Viên Giảm Gần 50%,"[Ho Chi Minh City: the park area decreasing by 50%], accessed October 15, 2014, http://www.thesaigontimes.vn/Home/dothi/hatang/27565/.

[125] Ibid.

Figure 2-14 HCMC urban greenery renovation in 2009[126]

Although taking many efforts to fill the gap of greenery area, HCMC government impossibly manages the ratio as the standard required. The principal reason is that many residential projects did not comply with greenery area as planned. Much of the land reserved for developing greenery space is used for another purpose due to economic issues. Meanwhile, the official managers did not fulfill their monitoring functions.

### 2.5.3.2 Transportation Issues

The city planning is still imperfect, and the public transportation facilities are limited. The urban rail systems, e.g. subway, are under construction while the bus systems are not favorable to public use. As a result, the majority of people prefer using the private vehicles, e.g. motorcycle and car. Accompanying with the predominant townhouses in HCMC, the motorcycle has been the most popular vehicles serving transportation demands of people. Highly relying on private motorcycles leads to a number of side effects in urban area such as greenhouse gas

[126] Ibid.

emission, air and noise pollution, traffic congestion, accidents, and disorder city residence. The city environment is significantly polluted with dust, noise and polluted air. Traffic congestion has been a critical issue in HCMC when the growing of traffic volumes is increasing over the existing road networks' capacity.

For reducing congestion and CO2 emission, in recent decades, the government has released policies to promote using bus systems in the city center with the efforts reducing the number of private motorcycles, however, the effects of those policies remain modest. In addition, the long-term mass transit systems, e.g. subways and sky trains, have been planned and constructed with the high expectation to be a good solution for solving the traffic issues.

#### 2.5.3.3 Little Public Interests on Sustainability

The majority of public in HCMC have been indifferent to the issues of sustainability due to the diverse reasons. This results from both managers and citizens' sides. From managers' side, the term sustainable development and its related themes have not been evidenced yet in the system of national laws, policies, and standards. The municipal planning has not been consistently connected with long-term plans on socio-economic development towards environment-friendly.[127] The city administrators are spending time for abundant social problems rather than issues of sustainability. On the public side, the environmental sustainability is likely not an urgent or mandatory issue rather than their basic living demands. Also, the environmentally friendly design or construction is often thought to be more expensive than the common method. People often believe that green building is

[127] "Định Hướng Chiến Lược Phát Triển Bền Vững Ở Việt Nam (Chương Trình Nghị Sự 21 Của Việt Nam)."

accompanied with the huge additional fees. As a result, organizations and businesses have no interest in issues of green building due to lack of financial motives.

Particularly, the limited knowledge and technology have narrowed the boundary of strategies for energy efficiency, reuse and recycle materials. The shortage of typically sustainable design also diminishes the encouragement for sustainable design. Weak financial foundation, short-term business and backward constructing fashions have hindered the research and implement the sustainable design and construction. The materials and equipment associated with sustainable construction are often imported that increases cost.

## 2.6 Priorities of Choosing Strategies for Sustainable HAB in HCMC

Above arguments go over the background of Vietnam, context of HCMC, and the discrepancies between low-rise and high-rise housing. This section summarizes those issues to support a set of priorities of choosing strategies for HAB in HCMC that would be used in subsequent steps. The priorities, thus, are divided into two groups, including climate & environment and socio-economic priority-drivens corresponding to the respective issues in HCMC.

### 2.6.1 Climate & Environment Priority-Driven

High air temperature all year round in HCMC requires that cooling habitat space becomes the principal concern while heating space is redundant indeed. The monsoon winds are potentials of passive cooling strategies. The monsoon context of HCMC results in the three main directions of prevailing winds for cooling space, including south, southeast, and southwest.[128] Therefore, these three directions should be given high priority to passive cooling purposes. In addition, although there are rare typhoon effects in HCMC, impacts of strong winds to high-rise buildings should be emphasized for HAB in HCMC.

Aside from air temperature, the high daily insolation hours are on one hand cause overheating in interior space, but on the other hand, provide high potentials

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[128] Vietnam Ministry of Construction, "Vietnam Building Code - Regional and Urban Planning and Rural Residental Planning," Vietnam Ministry of Construction QCVN 01: 2008/BXD, (Hanoi: Ministry of Construction, 2008). Ngoc Huan Giang, "Giải Pháp Thiết Kế Nhà Ở Cao Tầng Đáp Ứng Yêu Cầu Thông Gió Tự Nhiên Tại Tp. Hcm,"[Solutions for designing high-rise housing responding to the natural ventilation needs in HCMC], accessed June 15, 2014, http://kienviet.net/2009/09/11/giai-phaptk-nha-o-cao-tang-dap-ung-yeu-cau-thong-gio-tu-nhien-tai-tp-hcm.

of solar energy. Therefore, direct sunlight prevention and solar energy generation should be highlighted in the strategies for HAB in HCMC.

The present issues of emissions into land and water require that the strategies should emphasize on reducing as much as possible wastes, including material processing wastes, construction material wastes, operation wastes and wastewater.

The climate with a rainy season, the increasing the frequency of high-intensity rainfall, the low elevation of HCMC, and the weak urban drainage systems have resulted in critical urban flooding. This situation demands a special focus on the strategies that slow down the rainwater runoff, maximize the pervious surfaces, and minimize as much as possible the wastewater and rainwater exhausting to the municipal drainage system. Early processing water from buildings through pervious surfaces, small slope pavements could efficiently decrease the burden on the municipal drainage systems.[129]

### 2.6.2 Socio-Economic Priority-Driven

The shortage of greenery and open space in HCMC leads to the need of giving priority to increasing the green area as much as possible. The critical situation increasingly demands to restore the greenery area and open space within high-rise residential buildings. Thus, strategies that restore and preserve the green area and open space should be impressed in designing HAB in HCMC.

Regards transportation issues, the strategies should give priority to reducing using the private vehicles, and enhancing chances for using public transportation.

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[129] Harry Storch and Nigel K Downes, "A Scenario-Based Approach to Assess Ho Chi Minh City's Urban Development Strategies against the Impact of Climate Change," *Cities* 28, no. 6 (2011).

Reducing motorcycle use and demand of moving, enhancing the connection of residences to the public transportation hubs and facilities, thus, should be paid attention.

The little public interests on sustainability require strategies that encourage the involvement of the residents in the public life and sustainable acknowledgment. The solutions not only serve the building performance itself but also educate residents about the meaning of the designs in sustainability terms.

## 2.7 Literature Review

Vietnamese scholars early pay attention to the theme of Vietnamese vernacular house with a number of studies on architectural, social, and cultural aspects of traditional housing. Some of the striking books include *Understanding the History of Vietnamese Architecture*[130] and *Traditional Dwelling-House of Vietnamese Ethnic Groups*[131]. Researchers also have high interests on the issues of climatic adaptation in architecture. Particularly, Institute of Architectural Studies conducted a research on Vietnamese architecture in tropical climate with an influential publication, *Architecture and Vietnam Tropical Climate*[132]. This study provides an in-depth investigation of the climatic parameters of various regions and suggests a number of applicable strategies for Vietnamese urban housing based on the reference of vernacular houses and current practices. In the same regard, Professor Hoang Huy Thang worked on the more specific regional climatic concerns in the published book, *Tropical-Humid Architecture*[133]. This study spends considerable parts to interpret the vernacular housing in term of climatic adaptation.

The theme of sustainable development has recently attracted the attention of various Vietnamese scholars responding to the mainstream of the global scholastic

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[130] Huy Quynh Ngo, *Tìm Hiểu Lịch Sử Kiến Trúc Việt Nam* [Understanding the History of Vietnamese Architecture] (Hanoi: Xay Dung, 1992).

[131] Khac Tung Nguyen et al., *Nhà Ở Cổ Truyền Các Dân Tộc Việt Nam* [Traditional dwelling-houses of Vietnamese ethnic groups] (Hanoi: Vietnamese Association of Historical Sciences, 1993).

[132] Institute of Architectural Studies, *Kiến Trúc Và Khí Hậu Nhiệt Đới Việt Nam* [Architecture and Vietnam Tropical Climate] (Hanoi: Xay Dung, 1997).

[133] Huy Thang Hoang, *Kiến Trúc Nhiệt Đới Ẩm* [Tropical-humid Architecture] (Hanoi: Xay Dung, 2002).

movement. Professor Pham Duc Nguyen is a pioneer on the theme of ecological architecture and green architecture. His 2012 book, *Development of Sustainable Architecture, Green Architecture in Vietnam*[134], is one of the limited books addressing the subject of sustainable architecture systematically and comprehensively. The book includes eight chapters. The initial chapters summarize the background of sustainable development and sustainable architecture, green architecture rating system, sustainable architecture popular concepts. In the rest chapters, author principally concentrates on climate responsive architecture, concerns how to design architecture that well responds to surrounding climatic condition. Finally, the author suggests strategies for climatically responsive architecture in Vietnam, including shading devices, two-layer envelopes, shading facades, semi-open spaces, distributed plan, green surface and green roof, patio, urban heat island, and ecology conservation. Specifically, the author leaves a chapter specializing in daylighting. In conclusion, the author summarizes Vietnamese cultural characteristics and proposes a model to describe the appropriate method for developing green buildings in Vietnam. This model is described as 'Vietnamese architectural culture = Green architecture in 21st century + tropical architecture + traditional architectural values + modern technology.'

In particular, a number of researchers deal with environmental issues in high-rise housing. Giang (2007)'s master thesis works on design methods for high-rise housing in HCMC towards micro-climatic comforts and energy-efficiency. The author makes an effort to analyze traditional/vernacular

[134] Duc Nguyen Pham, *Phát Triển Kiến Trúc Bền Vững, Kiến Trúc Xanh Ở Việt Nam* [Development of Sustainable Architecture, Green Architecture in Vietnam] (Hanoi: Tri Thuc, 2012).

houses and draw lessons for developing climatically responsive design methods for high-rise housing in HCMC. However, this thesis merely investigates the climatically responsive aspects of high-rise buildings for energy saving purposes rather than a comprehensive approach to high-rise apartment buildings as a whole.[135]

Besides, Le (2011) suggests models of HAB in Vietnam based on the passive and unique characteristics in Vietnamese vernacular houses. In her dissertation, two stages were carried out. The first stage analyzes case studies of vernacular houses and townhouses for collecting passive design strategies. The second stage suggests typical models for HAB applicable to Vietnamese condition. Although this dissertation conducts a close investigation of Vietnamese vernacular houses, the application of those principles indicates a limitation on discussion the discrepancies between low-rise vernacular houses and HAB. In addition, the study also disregards the context of the high-rise housing in Vietnam when bypassing the economic and social situations of HAB.[136]

In summary, although Vietnamese scholars have been interested in the issues of sustainable HAB, most of them concern the environmental aspects rather than economic and social aspects. Additionally, in environmental regards, the scholars principally focus on the climatically responsive strategies for energy efficiency but

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[135] Ngoc Huan Giang, "Giải Pháp Thiết Kế Nhà Ở Cao Tầng Tại Tp.Hồ Chí Minh Theo Hướng Đảm Bảo Điều Kiện Tiện Nghi Vi Khí Hậu & Sử Dụng Năng Lượng Có Hiệu Quả [Design Methods for High-Rise Housing in Ho Chi Minh Towards Micro-Climatic Comforts and Energy Efficiency]" (Ho Chi Minh City University of Architecture, 2007).

[136] Thi Hong Na Le, "An Analysis of Passive Design and Unique Spatial Characteristics Inherent in Vietnamese Indigenous Housing and Their Applications to Contemporary High-Rise Housing in Vietnam" (Inha University, 2011).

having low regards for other aspects such as materials and resources, waters, and sustainable site. Currently, despite abundant of academic studies in ecological/bioclimatic architecture, green building/sustainable building criteria and guidelines applicable to HAB are still opaque in Vietnam. One of primary reason is that the concerns for sustainable development in building sector merely stop in the macro policies and propaganda purposes rather than substantial practices. Another reason is that the scholars slowly update the latest tendencies of international green building market. This gap of knowledge is an opportunity that this dissertation aims to fill in. Since high-rise apartment buildings become a major trend in Vietnam, this study focuses on creating design guidelines framework for sustainable HAB in HCMC.

# Chapter Three: Step-1: Defining Inherent Strategies in Vietnamese Vernacular Houses



This chapter proceeds the first step of a three-step process, Step-1, to find out strategies used in Vietnamese vernacular houses. The main scope of Step-1 is to study the Vietnamese vernacular settlement morphologies, searching for particular strategies inherent in the way the houses responding to the surrounding environment and satisfying the social and cultural context. Case study method is used with ten case models of vernacular houses, including eight cases of the rural house and two cases of the urban house.

## 3.1 Vernacular House in General

Vernacular architecture, also called indigenous, anonymous architecture, is the anonymous dwellings that can be found almost any human settlement.[137] According to *The Visual Dictionary of Architecture*, the definition of vernacular architecture is given as below:

> "Vernacular architecture is a type of architecture particular to a given place and time. This style of architecture uses locally available materials and will reflect the environmental, cultural and historical contexts of location in which it is erected".[138]

Vernacular architecture, as named by Rudofsky (1964, p. 8) 'Architecture without Architects,' reflects accumulated quintessence of ancestors from generation to generation responding to the surrounding environment. The vernacular settlement accumulated a great of unique features formed over the process of inhabiting and adapting to the immediate nature. It naturally provides many strategies to respond to specific climate and well-defined needs, which reflects the energy-efficient design and environment-friendly. For instance, Persian use wind catchers to advance the natural ventilation as can be seen in the city of Hyderabad. Solar-oriented earth shelter form of Oia, Santorini welcomes the sunlight as natural heating. The igloo dwellings are shaped with heat-efficient residential forms by using local materials. Egyptians' and Greeks' houses were built with consideration of solar orientation for daylighting sources and thermal mass retaining heat for

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[137] Javier Senosiain, *Bio-Architecture* (Routledge, 2013), 60.

[138] Gavin Ambrose, Paul Harris, and Sally Stone, *The Visual Dictionary of Architecture* (Lausanne, Switzerland; New York, N.Y.: AVA Pub. SA, 2008), 259.

passive heating and cooling.[139]

Vernacular settlement of Vietnam is originated from irrigated rice civilization in Northern parts of Vietnam. Northern area, where located the Red River, was the origin of the Vietnamese, the Kinh people, with an irrigated rice-based civilization thousands of years ago. During the 11st to the 18th century, the Vietnamese culture had been spreading southward where the original culture was interfered with the immediate culture to contribute the regional identities throughout the country. Vernacular houses are the visible elements showing how Vietnamese ancestors respond to the severe nature; maintain their comfort while still respecting nature, which often engages in their social and cultural activities.

Since vernacular architecture is embedded many naturally responsive characteristics, this chapter is intended to research on Vietnamese vernacular houses to explore inherent strategies, which are intended to be the foundation for approaching the sustainable HAB in HCMC. This chapter is the Step-1 of a three-step process to fulfill the strategy framework applicable to design guidelines for sustainable HAB in HCMC.

[139]Craig A. Langston and Grace K. C. Ding, *Sustainable Practices in the Built Environment* (Oxford; Boston: Butterworth-Heinemann, 2001), 137. ; Phillip Tabb and A. Senem Deviren, *The Greening of Architecture : A Critical History and Survey of Contemporary Sustainable Architecture and Urban Design* (Burlington, VT: Ashgate Pub. Co., 2013), 2-6.

## 3.2 Research Method and Case Study Models

### 3.2.1 Reasons for Choosing Vernacular House as Case Study Models

In a perspective of sustainability, a majority of scholar have agreed that vernacular architecture reveals many valuable lessons for contemporary planning, designing, and construction. Almusaed (2011) claims that vernacular architecture contains values in three aspects: conception, space, and architectural elements value.[140] Vernacular architecture can be seen as a model to contribute architecture closer to nature through its involved complex equilibrium between material, shape and natural context. Creangă, et al. (2010) argues the two key lessons of vernacular architecture for contemporary architecture: great respect and contact with the local nature and responding to user needs.[141] Additionally, the ancestors' living manners and their relationship and identity of their creators.[142] Also, the vernacular house is evident to offer an ideal model of housing wise management, effective economy and culturally proper interpretation to housing needs.[143]

Thousands of years of existence, Vietnamese vernacular settlement in rural areas has their particular characteristics that responding to the context and all the evolvement of the social, cultural and economic situation. Vernacular rural houses

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[140]Amjad Almusaed, *Biophilic and Bioclimatic Architecture : Analytical Therapy for the Next Generation of Passive Sustainable Architecture* (London : Springer, 2011), 229-32.

[141]E Creangă et al., "Vernacular Architecture as a Model for Contemporary Design," *Eco-Architecture III* (2010).

[142]Senosiain, *Bio-Architecture*, 61.

[143]Paul Oliver, *Encyclopedia of Vernacular Architecture of the World* (Cambridge; New York, NY, USA: Cambridge University Press, 1997), 134-35, 44-45, 55-56, 1462-64, 90-95, 540-551.

are recognized as a mirror reflecting the accumulated quintessences of ancestors from generation to generation, which had been evolved over time through the process of trials and errors. The investigation on rural vernacular houses, thus, brings about the fundamental characteristics of the Vietnamese settlement culture in terms of sustainability.

Vietnamese ancient urban houses, former townhouses or tube houses, have a lasting history of formation and development. The ancient urban dwelling is rooted from the vernacular house in rural area since the rural vernacular houses' methods of space distribution, climatic response, and wooden structures can be found in the urban vernacular houses.[144] Urban houses have been the dominant dwellings for the high-density neighborhood in the urban area of Vietnamese in ancient time, such as Hanoi or Hoi An ancient town. Hanoi ancient town was fallen into 36 towns with 36 specific crafts serving the merchant needs from the Thang Long imperial palace in the 11st century. During the 17th and 18th centuries, Hoi An ancient town had been an ancient port city associated with a bustling port where many Japanese, Chinese, and the western traders establishing the trading facilities.

In the time of today globalization, the traditional features are gradually blurred by the dominance of modern materials and construction technologies. The contemporary houses in HCMC have been dramatically changed over the fundamental characteristics of the vernacular houses, specifically the emerging HAB. Regarding sustainability, the emerging of HAB in HCMC in early period has reduced many valuable features of the Vietnamese habitation due to the imitating

[144] Institute of Architectural Studies, *Kiến Trúc Và Khí Hậu Nhiệt Đới Việt Nam*, 89.

the internationally modern living style without inheriting the local and traditional elements. By this reason, the research on Vietnamese vernacular houses is intended to be the starting step for developing proposed framework applicable to design guidelines for sustainable HAB in HCMC. Thus, case study models including rural and urban houses are used for conducting analysis searching for inherent characteristics of Vietnamese vernacular houses.

### 3.2.2 Research Method

This chapter conducts the first of three-step process to develop the strategies as a proposed framework applicable to design guidelines. The Step-1 comprehensively analyzes Vietnamese vernacular houses through ten case studies to define the inherent strategies in Vietnamese vernacular houses. The main scope of this chapter is to study the Vietnamese vernacular settlement morphologies to search for particular strategies inherent in the way the house responding to surrounding environment and community. The analyzing scope intensively focuses on specific features that respond to the locally severe environment, traditional building technology, and the rationality of housing forms with social activities.

Case study method is primarily used in this chapter with the provision of a combination of quantitative and qualitative analysis. The case study can serve the explanatory, descriptive and exploratory purpose.[145] The specification of case study method has been discussed in Section 1.3.1. Ten case study models are used which include eight cases of rural vernacular houses and two cases of urban vernacular houses.

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[145] Wang and Groat, *Architectural Research Methods*, 423.

### 3.2.3 Methods of Data Analysis

The data analysis aim at cultivating the inherent strategies inherent in the vernacular houses. The analysis finds the general features that all the cases share among the ten cases of vernacular houses. The categories and strategies created result from analyzing inherent characteristics of vernacular houses combined with the reference source of the topic areas and criteria of the sustainable residential building of the previous review in Section 2.3. Considering the fundamental features of vernacular houses on the base of design criteria of reference source, the basic categories should be eight main terms for the strategies for selection, including neighborhood formation, natural vegetation preservation, climatic response, exploitation of renewable energy, water conservation, natural calamity response, eco-friendly material, and occupant's comfort perception (Table 3-1).

Table 3-1 Categories of inherent strategies in Vietnamese vernacular houses

| Topic Areas of sustainable residential building (in Section 2.3.2) | Popularity Extent | Inherent characteristics of vernacular houses responding to nearby environment |
|---|---|---|
| Energy use and building emissions | High | Exploitation of renewable energy |
| Water use | ↑ | Water conservation |
| IEQ and occupant health | | Climatic response / Occupant's comfort perception |
| Site design, ecology and storm water | | Natural vegetation preservation / Natural calamity response |
| Waste | | - |
| Materials and resources | | Eco-friendly material |
| Location, transport and neighborhood | | Neighborhood formation |
| Operations and maintenance | | - |
| Integrated design and project planning | | - |
| Awareness and education | | - |
| Function and service quality | | - |
| Economic aspects and life cycle costs | | - |
| Cultural and perceptual aspects | | - |
| Innovations | Low | - |

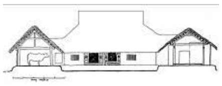
The ten case study models are analyzed through each topic areas of the eight main terms and draw the inherent strategies of vernacular houses in each theme. The list of strategies is drawn after analysis all the eight aspects of the sustainability of vernacular houses.

### 3.2.4 Description of the Case Study Models

Ten case study models of vernacular houses are selected for conducting the investigation, in which eight cases of rural houses and two cases of urban houses. Since a majority of long-standing vernacular houses was concentrated in the northern and the north-central region of the country and the concerned research area is the south, eight cases of rural vernacular houses include two cases in the northern, three cases in the central and three cases in the southern lowland areas. Two cases of urban vernacular houses include one in Hanoi and one in Hoi An ancient towns that are the two ancient towns remained good condition so far. The specification of the ten case study models is indicated in Table 3-2 and the location of them throughout Vietnam is presented in Figure 3-1.

Data sources are compiled from various sources, and self-site visits, of which the detailed drawings of each case are illustrated in Appendix A. In cases of data available only drawings, the dimensions of the houses are calculated through drawings with supporting of AutoCAD software.

Table 3-2 Ten case study models of vernacular house[146]

| Case | Vernacular/Old House | Location | Region | Year of Cons | Architectural Style | Function | Construction Method | Image |
|---|---|---|---|---|---|---|---|---|
| **Rural Houses** | | | | | | | | |
| **V1** | Mr. Hung's house | Sui Duoi hamlet, Mong Phu village, Duong Lam commune, Son Tay town, Son Tay province | North | 1649 | Northern traditional style | Living space & agricultural activities | Northern traditional methods, wooden structures are constructed by the locally skilled carpenter bands |  |
| **V2** | Quan Nhan house | Khuong Dinh ward, Thanh Tri district, Hanoi | North | Unknown | Vernacular style | Living space & agricultural activities | Northern methods, wooden structures are constructed by the locally skilled carpenter bands |  |
| **V3** | Di Luan house | Hien Luong commune, Vinh Linh distirct, Quang Tri province | North Central | Unknown | Vernacular style | Living space & agricultural activities | Timber framing, thatch roofs and walls, bamboo, rattan, cane and earthen walls |  |
| **V4** | Huynh Anh old house | Loc Yen village, Tien Canh ward, Tien Phuoc district, Quang Nam province | South Central | 1850 | Ruong house of Quang Nam traditional style | Living space & agricultural activities | Wooden structure, constructed by local skilled carpenter bands at Van Ha village |  |
| **V5** | My Hoa house | My Hoa commune, Phu My town, Binh Dinh province | South Central | Unknown | La Mai house of Binh Dinh vernacular style | Living space & agricultural activities | Timber framing, thatch and earthen roofs and walls, bamboo, rattan, cane and earth walls |  |
| **V6** | Nha Tram Cot old house | Cau Ngang hamlet, Long Huu Dong ward, Can Duoc district, Long An province | South | 1901 | Traditional style of Ruong house in Hue | Living space & agricultural activities | Wooden structures are constructed by the skilled carpenter bands that are originated from Central Vietnam |  |
| **V7** | Chau old house | Cai Lay district, Tien Giang province | South | n/a | Traditional southern style, (influenced by south central style) | Living space & agricultural activities | Wooden structures are constructed by the locally skilled carpenter bands |  |
| **V8** | Mr. Kiet's old house | Phu Hoa hamlet, Dong Hoa Hiep ward, Cai Be district, Tien Giang province | South | 1838 | Traditional southern style (influenced by south central style) | Living space & agricultural activities | Wooden structures are constructed by the skilled carpenter bands that are originated from Central Vietnam |  |
| **Urban Houses** | | | | | | | | |

[146] The detailed drawings of housing cases are provided in the Appendix A.

| Case | Vernacular/Old House | Location | Region | Year of Cons | Architectural Style | Function | Construction Method | Image |
|---|---|---|---|---|---|---|---|---|
| **V9** | Urban house in Hanoi | 87 Ma May St., Hang Buom Ward, Hoan Kiem Dist., Hanoi | North | 1890 | Traditional style | Commercial and living space | Wooden structure, wooden floors, brick walls |  |
| **V10** | Urban house in Hoi An | 77 Tran Phu St., Hoi An City | South Central | 1850s | Traditional style | Commercial and living space | Wooden structure, wooden floors, brick walls. Constructed by local skilled workers of traditional carpenter bands |  |

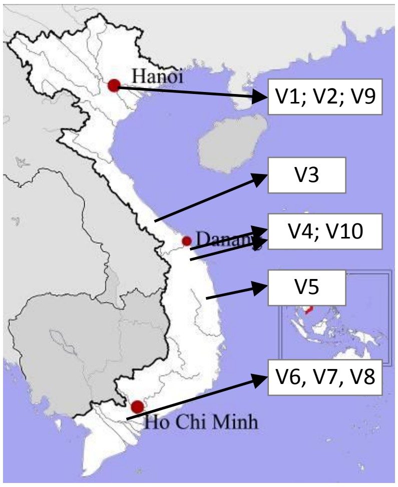



Figure 3-1 Location of the ten case study models of vernacular house[147]

[147] Image edited with original extracted from www.vi.wikipedia.org

## 3.3 Cases Analysis and Findings

As mentioned in section 3.2.3, the analysis brings about eight main terms including neighborhood formation, natural vegetation preservation, climatic response, exploitation of renewable energy, water conservation, natural calamity response, eco-friendly material, and occupant's comfort perception.

### 3.3.1 Neighborhood Formation

The northern village had been the origin of the Vietnamese village that can be regarded as essentially representative village morphology of indigenous habitation of Vietnamese ancestors. The widespread area of northern lowland is patterned as numbers of villages scattered over the background of a paddy field. The village disposition manifests a perfect living system. Vietnamese peasants often build their village near rivers, on the dry elevated ground in the middle of the paddy field. Its perimeter is often defined obviously by protective bamboo range, which plays a primary role as boundary hedge forming the village as a closed system. There are often two or three gates to enter a village, a main gate for the primary circulation, the first supplemental gate for going to a wharf or paddy field, and the second supplemental gate leading to the cemetery (Figure 3-2).[148] The living system of the village is constituted of various elements, including banyan trees, village wells, marketplace, community hall and houses. Bamboo ranges play a role as the natural hedge of the village and houses, offering a solar shading and cool microclimate,

[148] Dinh Thi Nguyen, "Giá Trị Kiến Trúc Truyền Thống: Nhà Ở Nông Thôn Mới Vùng Đồng Bằng Bắc Bộ," [The Value of Traditional Architecture: New Rural Houses in the Northern Delta.] *Vietnam Architecture Journal*, no. 3.2012 (2012).

protecting from typhoon and cold wind while being sources of constructive materials.

Figure 3-2 Mo Trach village (Hai Duong Prov.) a typical Vietnamese village[149]

Since a vernacular house is a member of a village, the traditional village can be seen as a neighborhood in which the villagers are living, working, entertaining together. In neighborhood scale, the traditional village offers community connectivity and collective participation among villagers.

#### 3.3.1.1 Community connectivity

The traditional village contributes intimate community connectivity among villagers through the close interaction and cooperation among residents in the common daily activities. Since traditional village acts as an independently administrative and economic unit, the order and relationship among residents are defined by the village customs that are sometimes more powerful than the remote king's rule as a Vietnamese proverb said: 'The will of king yields to the people's customs.' In this sense, the village maintains distinctively cultural identities of the

[149] Image extracted from Google Maps on 14th July 2014

community, which invisibly define the behaviors of villagers.[150]

Various formation characteristics of a village that help connect residents together, including the provision of essential services and amenities in walking distance and provision of space for community involvement. First, the village offers all the essentially nearby services and amenities for all villagers such as water well, playground, small shops for living stuff and individual production (Figure 3-3). These services and amenities support the essentially physical and spiritual needs of residents. Second, the village maintains a close relationship among villagers and a unique identity by the provision of space for community involvement. Communal hall and religious temples are such spaces for gathering villagers for varied important events such as harvesting festivals, genie ceremonies, tutelary god ceremony, judgment for internal contradiction, marriage ceremonies, and ancestor's death anniversaries. Thanks to above features, the traditional village becomes a closed and stable settlement where villagers are securely sheltered while cultivating in adjoining paddies.[151] The village becomes the only place where all the villagers belong to no matter who they are, whether the rich or the poor, the officials or common residents. In this regard, the village is considered as the indicator to be differentiated from others.

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150 Huy Le Phan et al., *The Traditional Village in Vietnam* (Hanoi: The Gioi, 1993), 5.

151 Ibid.

Figure 3-3 Water well (Sinh Lien village) & communal hall (Mong Phu village)[152]

In short, the traditional village as a neighborhood offers two strategies for reinforcing the community connectivity, including:

- *Provision of essential services and amenities in walking distance*
- *Provision of space for community involvement*.

### 3.3.1.2 Collective Participation

Collective participation is necessary for the agricultural works in which people share the work together, cooperation and support each other. The spirit of peasants when working in the paddy field is likewise applied to the daily living within a roof of the village. For instance, constructing a house often interests the involvement of many villagers who participate in multiple roles such as designers, builders, feng-shui master, and workers. All the individuals share ideas and works as if they are working in the paddy field.[153] The involvement of villagers in the process of constructing a house indicates the open and collective spirit in the awareness of villagers. Thus, the strategy implied in collective participation is:

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[152] Image sources: (left) http://news.zing.vn/Ve-dep-gieng-lang-Bac-Bo-post521380.html; (right) http://vietlandmarks.com/upload/137362270551dfd1b101e5f.jpg, accessed October 5, 2015

[153] Phan et al., *The Traditional Village in Vietnam*.

- *Involvement of villagers with multiple roles in the process of constructing a house*

### 3.3.2 Natural Vegetation Preservation

#### 3.3.2.1 Vegetation Enhancement

Gardens and vegetated areas are the significant part of the majority of the rural vernacular house cases. Table 3-3 shows five examples of front vegetated areas of the cases V1, V4, V6, V7, and V8. It is evident from Table 3-3 that the landscaping of the houses tends to preserve the existing vegetation of the site (cases of V4 and V6) and enhance vegetated areas and biodiversity (all the five cases). There are varied functions of the gardens, including sources of food, provision of microclimate, aesthetics, and protection from natural calamity. It is evident that ancient occupants are aware of planning the vegetated open spaces with multiple kinds of trees and plants to serve such purposes, such as bonsais and flowers, vegetable and areca palms, timber fruit trees, and protective plants. Nguyen (2012) implies that there are often four types of gardens in northern rural vernacular houses.[154] Center garden is flowers and bonsais surrounding the front courtyard, which plays a role as an aesthetic landscape. East garden is a place for planting vegetable and areca palms. West garden is a place for timber fruit trees while bananas are often planted in the north garden, the back of the main house.

To sum up, two strategies are largely adopted in the vernacular cases for vegetation enhancement as following:

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[154] Nguyen, "Giá Trị Kiến Trúc Truyền Thống: Nhà Ở Nông Thôn Mới Vùng Đồng Bằng Bắc Bộ."

- *Preserve the site with existing and adapted vegetation*
- *Enhance vegetated open space and biodiversity*.

Table 3-3 Preservation and enhancement of vegetated open space in vernacular cases[155]

| | | |
|---|---|---|
|  **V1** |  **V4** |  **V6** |
|  **V7** |  **V8** | |

### 3.3.3 Climatic Response

#### 3.3.3.1 Building Orientation

Orienting buildings are extremely vital when peasants start setting up a plan of a house. Traditionally, the main building is often located at the highest place of the land to welcome the cool wind and resist the damp. Vietnamese proverb said, 'A

[155] Image sources: (V1) http://vietlandmarks.com/module/groups/action/viewimages/id/913/album/0#0; (V4) https://nguyenanhtuandn.wordpress.com/2013/08/21/nha-co-dat-quang-nam/; (V6) http://ak091261.violet.vn/entry/show/entry_id/1522144; (V7) Giang, "Giải Pháp Thiết Kế Nhà Ở Cao Tầng Tại Tp.Hồ Chí Minh Theo Hướng Đảm Bảo Điều Kiện Tiện Nghi Vi Khí Hậu & Sử Dụng Năng Lượng Có Hiệu Quả [Design Methods for High-Rise Housing in Ho Chi Minh Towards Micro-Climatic Comforts and Energy Efficiency]."; (V8) http://dulich.nld.com.vn/goc-anh-lu-hanh/nha-co-o-tien-giang-20110912040153861.htm

house naturally should face south just as a man should marry a woman' to impress the south is the best direction for constructing a house.[156] Accordingly, the main block frequently directs south to welcome the cool prevailing wind while prevents the house from solar radiation in the east and west and protects from cold winter wind in the north. Among the ten cases except the two cases of urban houses, the central houses orient to the south in the cases of V2, V4, V5, and V6. The remaining cases (V1, V3, V7, and V8) direct to another direction because of various individual reasons, such as a limitation on site conditions (case V1), river or canal direction (cases of V7 and V8). In summary, the strategy of building orientation in vernacular houses is:

- *Building orientation to the south for taking advantage of solar shading, prevailing winds, and preventing from cold wind*

#### 3.3.3.2 Buffer space

Buffer space is the space or zone that insulates interior space from directly climatic impacts. In cases of vernacular house, veranda space can be regarded as the buffer space when it offers shading, heavy rainfall prevention and filtering cool wind. The veranda space acts as a buffer space between the courtyard and interior space within a chain of the continuity of various spaces: living room, veranda, courtyard and garden (Figure 3-4).

[156] Phan et al., *The Traditional Village in Vietnam*, 17.

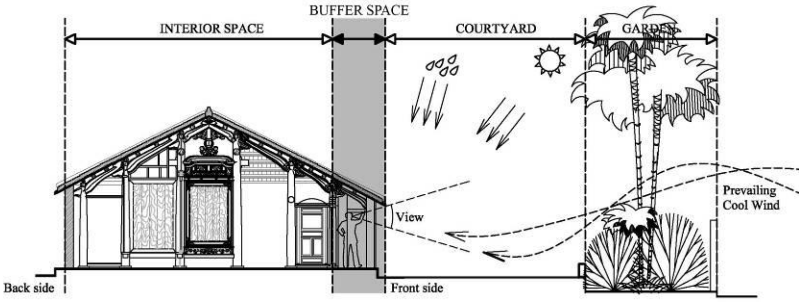
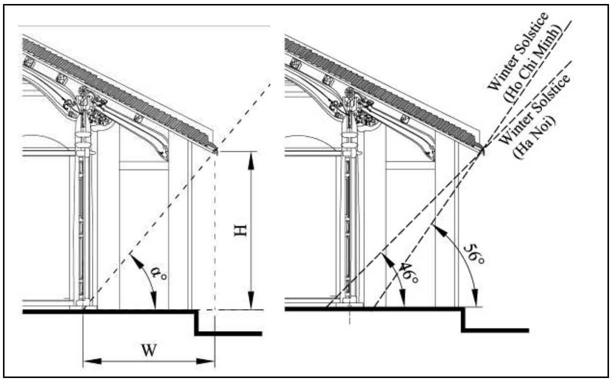



Figure 3-4 Veranda as a buffer space

The veranda spaces in the majority of cases are formed by doors to interior, row of outer columns, and roof overhang. The low and deep overhang protects the interior space from climatic impacts while offers underneath space where informal activities may take place. Sunlight is likely the size-driven factor of the veranda. The analysis showed in Table 3-4 indicates that the ratio between the depth of the veranda and the height of the eaves is corresponding to the solar altitude angle with the assumption that the house faces to the south, a dominant orientation of Vietnamese vernacular house.

Table 3-4 The association between size of veranda space and sunray[157]

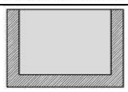



[157] Analysis conducted by author

| House Case | W(m) | H(m) | αº |
|---|---|---|---|
| V1 | 1.68 | 2.33 | 54 |
| V2 | 1.85 | 2.05 | 48 |
| V3 | 1.86 | 1.46 | 38 |
| V4 | 1.60 | 1.95 | 51 |
| V5 | 2.53 | 1.42 | 29 |
| V6 | - | - | - |
| V7 | - | - | 46 |
| V8 | n/a | n/a | n/a |
| V9 | - | - | - |
| V10 | - | - | - |

It is evident that buffer space is incorporated into main building of the ten cases of vernacular house. The coverage of buffer space can be at least the main façade of the house in the cases of V1, V2, V3, V4, V6 or all three or four sides of the building as the cases of V5 and V7 (Table 3-5).

Table 3-5 Coverage of buffer space in the cases of vernacular house

| Coverage of buffer space | Ratio | Housing case |
|---|---|---|
|  | $\frac{4}{5}L$ | V3 |
|  | L | V1; V2; V4; V6 |
|  | 2L+2W;<br>2L+2W | V5, V7 |

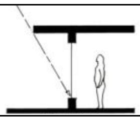
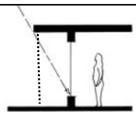
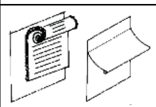
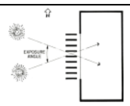
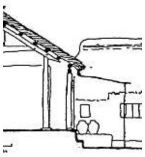
In summary, the strategy adopted in the ten vernacular houses would be:

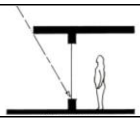
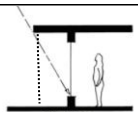
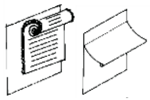
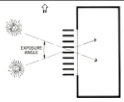
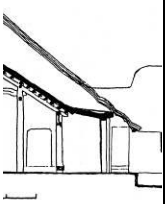
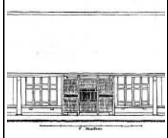
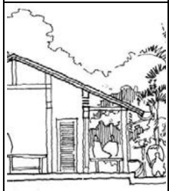
- *Incorporate the buffer space as veranda space to at least the main façade of the building for preventing interior space from direct sunlight and heavy rainfall*

### 3.3.3.3 Shading devices

The solar shading is the dominant strategy of the ten cases for responding to the hot climate. There are varied types of shading devices adopted in the ten cases as shown in Table 3-6. The most popular method is the overhang. Table 3-6 indicates that all the ten cases adopt overhangs for preventing interior space from direct sunlight. The overhang often goes with the buffer space to enhance the shading effects. The shading screen method is also used, which includes fixed screen and removable screen. The fixed screens made of bamboo are often mounted on the overhangs of the buffer space, which are used in the cases of V1 and V2. The movable screens are often made of bamboo, cane, or rattan and mounted on the overhangs, which can be found in the cases of V1, V3, and V10. Specifically, the case of V3 has multi-functional shading devices. The cane screening mounted on the roof overhang works as shading devices and overhangs simultaneously. The case of V8 is a unique case that uses the movable vertical louvers, which involves multiple movable parallel slats covering all perimeter of the house.

Table 3-6 Shading devices adopted in the ten vernacular cases

| **Overhang** | | | **Fixed Screen** | **Movable Screen** | **Movable Louver** |
|---|---|---|---|---|---|
|  | | |  |  |  |
|  V1 |  V2 |  V3 |  V1 |  V1 |  V8 |

| Overhang | | | Fixed Screen | Movable Screen | Movable Louver |
|---|---|---|---|---|---|
|  | | |  |  |  |
|  V4 |  V5 |  V6 |  V2 |  V3 | |
|  V7 |  V8 |  V9 | |  V10 | |
|  V10 | | | | | |

The above analysis indicates two popular strategies for shading devices in Vietnamese vernacular houses as following:

- *Incorporating exterior shading devices (e.g. overhangs, screens, and louvers)*
- *Use occupant-controlled shading devices*

### 3.3.3.4 Lightweight and insulated envelope

Envelope plays a key role in vernacular house for resisting the hot and humid climate, especially the roofing structures. Prominent solutions in the ten cases is the using lightweight and insulated envelopes. The roof used in the ten cases is the thatch roof (cases of V2, V3 and V5) or roof tiles (cases V1, V2, V4, V6, V7, V8, V9, and V10). Whether the roof material is thatch or roof tiles, the roof structure is thick and multi-layer to serve the insulation function. The case V5 is a special case that two-layer roof is used. The lower layer is constructed of dry rammed mud with bamboo framing while the upper layer is made of thatch. Since the roof area is the largest surface exposed to the sun, this feature shows the unique way in responding to the hot climate of the central lowland area. Two layers offer distinct conducting ratios that provide efficient heat insulation. Not just heating insulation, this special roof serves as fire protector as well. The mud layer is a perfect protector for space below in the case of the upper thatch roof being on fire, especially since the main frame of the lower parts are made of valuable timbers and traditional sculpture.

In addition, the ten cases of housing are primarily made of organic materials that are often lightweight structures, such as bamboo, thatch, earth, mud. Lightweight envelope enables the building to dissipate the heat quickly at nighttime.

In short, two inherent strategies in this term is:

- *Use lightweight structures for building envelope*
- *Use insulated roof and two-layer roof*

#### 3.3.3.5 Climatically responsive landscape

The data related to the garden is not clear in the ten cases. However, this term can be discussed on the remaining narratives and studies about the general characteristics of the garden in vernacular houses. Garden in vernacular houses plays a role as climatic mitigation and sources of daily green vegetables, seasonal fruits, construction timbers and landscaping. The scale of gardens is dependent on the scale of the house. The large house has garden surroundings while the small house has the garden located just beyond the courtyard confronting the main building.[158] East garden is a place for planting vegetable and areca-palms, which shade the main blocks on high-level sunlight while allowing the prevailing wind on the low-level. West garden is a place for fruit timber trees, which at the same time shade the building from the afternoon sunlight. North garden is often located in the back of the main block where bananas are often planted for preventing northeast monsoon cold wind from entering internal space. Garden organization reveals the precision in responding to natural conditions. Traditional experience, "betel-nuts in the front, banana in the back", reflects the experience in response to nature for optimizing the microclimate, cooling enhancement in summer and cold prevention in winter. The strategy, thus, is as following:

- *Plan the landscaping to work with the site microclimate (e.g. shading, ventilation, and daylighting)*

### 3.3.4 Exploitation of Renewable Energy

#### 3.3.4.1 Space Composition

Within eight cases of rural houses, the L-shaped and U-shaped layouts are used as a strategy to incorporate the courtyard or void space as a place to enhance daylighting, air movement and solar heat (Table 3-7)

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[158] Phan et al., *The Traditional Village in Vietnam*, 21.

Table 3-7. In general, the houses often involve a complex of various separate facilities, including main building (living room and bedroom), side buildings (kitchen, sheds and working place), toilets, ponds, gardens, and cattle sheds. Courtyard as a void space is a major factor creating the L-shaped or U-shaped layout. As seen from Table 3-7, the facility buildings gather around the courtyard that makes the courtyard act as a center space linking the main building with other facilities (e.g. the side building, the cattle sheds, and gardens). Additionally, the courtyard practices a social function that silently maintains the spirit of the house. Together with veranda space, the courtyard becomes an open space for informal outdoor activities as well as extending the space of the main block in special ceremonies (weddings, funerals, death anniversary).[159] This composition might result from the desire of enhancing daylighting and natural ventilation for quickly dissipate the overheating. The courtyard, by this way, is an important element constituting charming beauty and sense of the house.

The same principle of strategy is specially adopted in the two cases of urban vernacular houses of V9 and V10 with minor changes responding to the context of high density. The urban houses like cases of V9 and V10 in Vietnamese ancient town are often planned with tube-like layouts and small, simple, and monotonous scales. The narrow land lot of the two cases make the composition of space tending to vertical rather than horizontal direction. While rural houses tend to expand widely, the urban houses tend to go up to utilize the upper space for living. Trading is a key income of the residents in urban residence. The two cases of urban houses serve a dual functions living and small trading. The houses offer mixed use with

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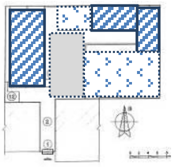
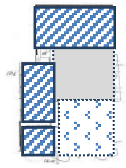
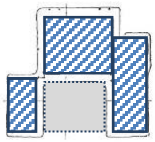
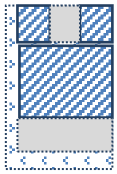
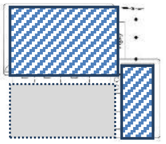
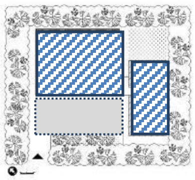
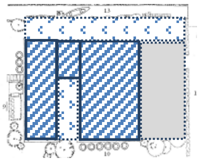
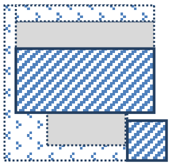
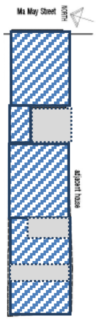
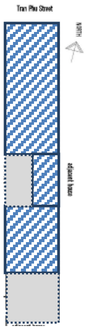
[159] Hoang, *Tropical-Humid Architecture*, 28. Phan et al., *The Traditional Village in Vietnam*, 21.

small trading in front space and living in the remaining spaces. The layout principle from rural houses is applied to the urban house cases in a manner that the housing layouts of the two cases are planned by alternating the building blocks and patio (voids) along the depth of the house (Table 3-7). The central courtyard in the rural house is transformed into the small courtyard or void space in the urban houses cases of V9 and V10. The alternated voids permit the natural ventilation, sunlight penetrating deeply into interior spaces. For maximizing effects, two small courtyards, the middle and the back courtyards, are used. The alternating voids enhance the chances for cross ventilation, and the high level of the house increases the chances for stack ventilation. In addition, the interior spaces of the two cases are formed that enables room-through air circulation while maintaining interior space secretive to the outside. The small courtyard spaces are places of interior bonsais and gardens contributing a comfort vision and filtering the polluted indoor air (Figure 3-5).

Figure 3-5 The middle courtyard in the cases of V9 and V10[160]

[160] Source: (left)http://thanglong.gocom.vn/47220p1c30/pho-co-ha-noi-nha-bao-ton-87-ma-may.htm;(right)http://www.tripadvisor.com/LocationPhotoDirectLink-g298082-d7590313-i135059786-Nha_Co_Quan_Thang-Hoi_An_Quang_Nam_Province.html accessed on November 4, 2015

Table 3-7 Layout composition of the ten cases with the provision of the courtyard and void space

<table>
<tr><th colspan="5">Rural vernacular houses</th></tr>
<tr><td>U-shaped Layout</td><td><br>V1</td><td><br>V2</td><td><br>V5</td><td><br>V6</td></tr>
<tr><td>L-Shaped Layout</td><td><br>V3</td><td><br>V4</td><td><br>V7</td><td><br>V8</td></tr>
<tr><th colspan="5">Urban vernacular houses</th></tr>
<tr><td>Alternative courtyard/void space</td><td colspan="2"><br>V9</td><td><br>V10</td><td>Legend:<br>Building block<br>Courtyard<br>Gardens, ponds, cattle sheds</td></tr>
</table>

In conclusion, the strategy of the space composition inherent in rural and urban vernacular houses is as following:

- *Incorporate courtyard as a place to exploit energy from nature in forms of daylighting, air movement and solar heat*

### 3.3.4.2 Natural Ventilation

Natural ventilation is significant to dissipate the heat and release the humidity.

Ten cases of the vernacular house reveal many strategies to enhance the natural ventilation in interior space. Building forms, walls, partitions, doors and windows are detailed for maximizing air circulation within spaces. Proper roof type takes part in enhancing cross and stack ventilation in interior space. Hipped roof type in cases of V2, V3, V4, V5, V6, V7, and V8 enhances ventilation by creating 'khu di' on the top of the roof which enables the warmed air to get out and forces the lower cool air getting into the interior space (Figure 3-6).


Figure 3-6 Hipped roof type for enhancing natural ventilation[161]

For all the ten cases, the building form, the doors, windows, walls and partitions are constructed in a direction to allow air circulation within space, especially warmed air in a high level. Doors and windows are arranged in the way of opening to nature and welcoming prevailing wind for cooling the interior space and allowing air circulation across the house. Doors and windows are organized to open to the veranda and welcoming prevailing winds for cooling the interior space and indirect daylighting. Slits are adopted to doors and windows for protection while allowing air passage. Bang Khoa doors which have upper bars and lower panels ('thuong song ha ban' in Vietnamese) allowing circulation of the passage of

[161] Image source: Ngoc Van Anh Le, "Housing Development Situation and Climate Adapted Design Solutions for Hue City" (Marche Polytechnic University, 2013), 52.

air. Interior partitions are often open at the high level to prevent blocking off the airflows (Table 3-8 and Figure 3-7).

Table 3-8 Typical doors, windows and partitions allowing air circulation[162]

| | | |
|---|---|---|
|   |  (V4)  (V8) |  (V6)  (V9) |
| Bang Khoa door (V4) | Partitions with upper openings | Doors and interior space |

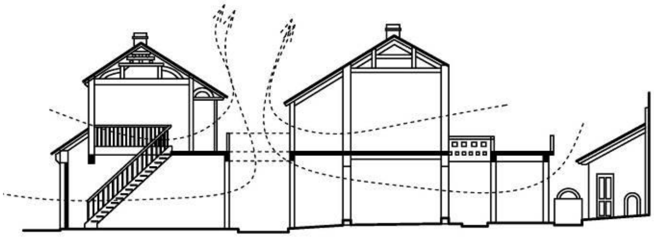


Figure 3-7 Natural ventilation in urban house in Hanoi (case of V6)

In summary, the strategies of natural ventilation dominant in the ten vernacular cases are:

- *Arrange the openings in opposite sides to enhance the cross ventilation*

[162] Image source: see Appendix A

- *Use center courtyard for enhancing stack ventilation*
- *Incorporate the slits and openings to doors, windows, walls, and partitions to enhance the air circulation across spaces*
- *Use hipped roof type to enhance the stack ventilation*

#### 3.3.4.3 Daylighting

The majority of vernacular house cases use the indirect lighting as daylighting strategy. The popular strategies are using courtyard, landscapes, and adjacent buildings as reflectors to reflect sunlight deep into interior spaces. These strategies are efficient, but they often create glare, especially case of lighting reflected from the courtyard (Figure 3-8).

Figure 3-8 Typical daylighting strategy (V7 & V10) and glare effect in the ten cases[163]

In the case of urban houses (V9 and V10), solutions are mostly inherited from the rural houses such as materiality, doors and windows, overhangs, and so on.

[163] Image source: (left) Norbert Lechner, *Heating, Cooling, Lighting : Sustainable Design Methods for Architects*, Fourth edition. ed. (Hoboken, New Jersey: John Wiley & Sons, Inc., 2015), 135.

(middle) Giang, "Giải Pháp Thiết Kế Nhà Ở Cao Tầng Tại Tp.Hồ Chí Minh Theo Hướng Đảm Bảo Điều Kiện Tiện Nghi Vi Khí Hậu & Sử Dụng Năng Lượng Có Hiệu Quả [Design Methods for High-Rise Housing in Ho Chi Minh Towards Micro-Climatic Comforts and Energy Efficiency]."

(right)_http://www.tripadvisor.com/LocationPhotoDirectLink-g298082-d7590313-i135059786-Nha_Co_Quan_Thang-Hoi_An_Quang_Nam_Province.html accessed on 4th November 2015

Specific solution is alternately arranging the blocks and patios (voids) along the depth of the house to maximize daylighting. Thus, daylighting mainly comes from the middle courtyard. The glare effect is reduced since the sunlight reflects many surfaces and distributes evenly into the interior space.

Strategies of daylighting inherent in ten cases of vernacular houses, thus, are as follows:

- *Maximize opening on main façades for increasing daylighting and natural ventilation*
- *Use courtyard as diffuse reflecting surface*
- *Use vegetation and surrounding facilities as sources of diffusing daylighting*

#### 3.3.4.4 Occupant Controllability

The openings for lighting and ventilation are not fixed but flexible in the majority of the ten cases. The main façade could maximize openings by opening all the doors for welcoming the cool winds while could be adjusted the extent of closed doors in the scorching sun at lunch time of the summer day. In the same sense, the degree of doors opened is adjusted to be compliance with the preferred comfort, preventing the indoor environment from the cold wind in the winter (Figure 3-9). Specifically, the V3 and V8 cases reveal evidently the flexibility responding to the outdoor environment. In V3 case (Figure 3-9b), the doors are, at the same time, the overhang and the shading devices. The doors work in the nighttime, and in the daytime, they become the efficient overhangs and shading devices permitting natural ventilation and daylighting. This multiple functions could be swapped to respond to the fluctuation of the surrounding environment. In the V8 case (Figure 3-9c) case, all the perimeters of the house are covered with multiple parallel vertical slats that function as the protective ‘door’. The degree of opening can be adjusted by the number of wooden slats to be removed. This system has dual functions, the protective cover permitting air circulation and daylighting while as the same time the shading devices.

In short, it is evident that flexible controllability of the openings is the inherent strategy of the Vietnamese vernacular houses:

- *Use flexible occupant-controlled openings (doors and windows) in regularly occupied spaces for natural ventilation and daylighting control*

(a) (b) (c)

Figure 3-9 Flexible controllability of the openings in vernacular cases[164]

## 3.3.5 Water Conservation

### 3.3.5.1 Minimizing water use

The majority of the ten cases have gardens with the native plants and trees. Certainly, planting native vegetation in most of the cases is not because of the

[164] Image sources:

(a) Tuan Anh Nguyen, "Nhà Cổ Đất Quảng Nam,"[Ancient houses in Quang Nam], accessed June 15, 2015, https://nguyenanhtuandn.wordpress.com/2013/08/21/nha-co-dat-quang-nam/.;

(b) http://landtoday.net/vn/print/38844/index.aspx accessed June 15, 2015

(c) http://www.dulichhanhtrinhviet.com/2014/06/tham-quan-nha-co-ba-kiet-o-cai-be.html accessed June 15, 2015 water saving. However, in some special houses in the salt-water area, native vegetation are planted for less water used for irrigating, such as the case of V7. Thus, the strategy of saving water by planting native vegetation is as follow:

- *Landscaping with native and indigenous vegetation*

#### 3.3.5.2 Water reuse

Responding to the high rainfall condition, drainage and rainwater collecting systems are adopted in the form of the retaining water tank such as cases of V1, V2, V5. Water tank is often located in a discreet corner of the yard or the middle of the main house and the kitchen collecting rainwater from the building's roof systems.[165] Rainwater collected supplements domestic water use. Figure 3-10 shows examples of the collecting rainwater system in the cases of V6 and V7.

Figure 3-10 Rainwater harvesting system in V6 & V7 cases and typical rural houses[166]

The strategy of water reuse is:

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[165] Phan et al., *The Traditional Village in Vietnam*, 21.

[166] Source: (left) https://ssl.panoramio.com/photo/13830096 accessed on October15, 2015; (middle) Giang, "Giải Pháp Thiết Kế Nhà Ở Cao Tầng Tại Tp.Hồ Chí Minh Theo Hướng Đảm Bảo Điều Kiện Tiện Nghi Vi Khí Hậu & Sử Dụng Năng Lượng Có Hiệu Quả [Design Methods for High-Rise Housing in Ho Chi Minh Towards Micro-Climatic Comforts and Energy Efficiency]."; (right) http://megafun.vn/cuoc-song/suc-khoe/kien-thuc/201208/dung-thay-mua-la-voi-vang-hung-nuoc-220612/?mode=mobile accessed on October 15, 2015

- *Collecting and storing rainwater for later use*

#### 3.3.5.3 Stormwater runoff infiltration

Beside the rainwater collecting systems, the drainage system is planed with provision of open permeable drain and water pond in rural vernacular houses. The water pond often stands beside the garden, collecting surface water. Water pond plays a role as increasing permeable surfaces, landscape aesthetics, regulating the microclimate and facilitating rainwater runoff and fish farming as well.[167] To sum up, Vernacular houses enhance the infiltration of drainage system by:

- *Maximize the permeable surfaces*

### 3.3.6 Natural Calamity Response

The northern and central regions of Vietnam confront with many natural calamities annually, such as flooding and typhoon.

#### 3.3.6.1 Flooding prevention

There are various strategies applied in the ten cases of vernacular houses to prevent and respond to flooding events. The most popular strategies are located the main building in the elevated position. This strategy is reflected in most of the cases and popular as the tip of building a house in tradition. Another strategy shows clearly in the case V10, an urban house in Hoi An. Hoi An suffers flooding annually, the design of the two-story urban house with consideration for flooding. All the living activities will move up to the second floor in the flooding situation and turn back when the flooding is over. Thus, the two strategies used in vernacular

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[167] Phan et al., *The Traditional Village in Vietnam*, 21.

houses for responding to flooding are as follows:

- *Locate the building on elevated position*
- *Design multi-storey building with the ground storey reserved for flooding situation*

#### 3.3.6.2 Typhoon prevention

All the cases located in the northern and central regions, such as V1, V2, V3, V4, and V5, V9, V10, have characteristics responding to the typhoon. Frequent typhoon forces the house to possess short and simple shape, high-slope and thick roof, robust frame wooden structure, thick rammed mud or brick wall and more numerous columns with short bays. Especially the case V5 with the two-layer roof, the low-heavy roof layer of mud is the ideal protector of the upper roof from destruction by the typhoon. Thus, the prominent strategy for typhoon prevention is as follow:

- *Design building form and structure, especially roof shape stable to strong wind (broad and sturdily low building)*

### 3.3.7 Eco-Friendly Material

The materials used in the ten cases indicates four main terms: (1) local materials, (2) reuse and recycling of building materials and components, (3) disassemblable building components, (4) rapidly renewable materials and (5) low-emitting materials

#### 3.3.7.1 Local materials

Materials used in the ten cases are often exploited from the local sources.

Cases of V2, V3 and V5 use timber, bamboo, cane and rattan for frames and partitions, going with a mud wall and thatch roof. The bamboo frame is used to reinforce rammed mud wall and thatched roof. Cases of V1, V4, V6, V7, V8, V9, and V10 use timber for frames (trusses, columns, and beams), drystone walls, clay tiles roof. Timber, bamboo, thatch, cane, rattan mud, and drystone are largely exploited from nearby sites, natural rain forests, self-planted garden, wastes of agriculture works. The strategy implied in this regard is:

- *Use materials available in nearby the site*

#### 3.3.7.2 Reuse and recycling of building materials and components

Wooden material and components made of wood are easily reused and recycled by skilled carpenters. Due to the high value of construction materials, Vietnam ancestors had a habit of reusing construction materials. At the end of the house's life, the wooden frames, doors, and windows are enabled to be reused or recycled for constructing a new house.[168] Besides, the structural wooden frames are formed by connecting multiple components of individual timber rods with specific joints that facilitate for reusing a component for another building (Figure 3-11). In addition, the wooden materials used for structural framing and furnishings are careful selected, often using the high-quality rainforest timber such as kingwood. In short, the strategy inherent in this term would be:

- *Reuse the building structural materials*

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[168] Huy Quynh Ngo, *Searching the History of Vietnam Architecture*, Vietnamese ed. (Hanoi: Xay Dung Publisher, 1992). Ba Dang Nguyen, Vu Phuong Nguyen, and Hoang Van Ta, *Traditional Vietnamese Architecture* (The Gioi, 2004).

- *Reuse building nonstructural components (e.g. doors, windows, panels)*
- *Use reusable, recyclable materials*
- *Use the reused, refurbished, and salvaged materials*
- *Use materials with appropriate durability*

#### 3.3.7.3 Disassemblable building components

In all ten cases, the housing structures are assembled from various components through specific joints without a nail. As seen from Figure 3-11, multiple components of individual timber rods are connected to be a complete frame. The structural framing is constructed with the intention of easy assembly and disassembly. As a result, the house is readily disassembled and transferred to another place or reused for further needs.

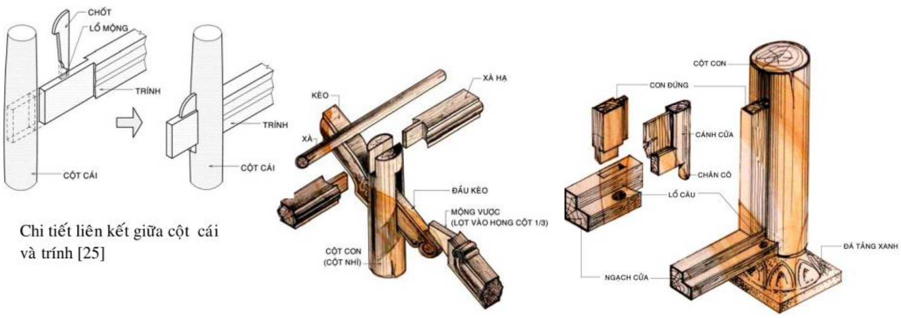


Figure 3-11 Components and joints of wooden structural frame[169]

Thus, the strategy emerged here is:

- *Design for easy disassembling and reassembling of building components*

[169] Image source: Nguyen Hoang Long Truong, "Solutions for Residential Architecture in Typhoon Area in the Central Coast of Vietnam [in Vietnamese]" (Ho Chi Minh City University of Architecture, 2007), 45.

### 3.3.7.4 Rapidly renewable materials

The majority of materials used in ten cases of vernacular houses is organic or nature-based materials such as wood, bamboo, rattan, thatch, and earthen materials. Nature-based materials have biodegradable features that act in a friendly way with the immediate environment. At the end of the materials' life, they quickly melt down to the earth and recover substances to the environment as part of the cycle of nature. In today concern of sustainability, these sources of materials are preferred due to its part of the cycle in nature, which is often called rapidly renewable materials. In this sense, it is evident through the ten cases that vernacular houses uses strategies as followings:

- *Use natural/organic materials for building structures*
- *Use natural/organic materials for building nonstructural elements*
- *Use natural/organic materials for furnishings*

### 3.3.7.5 Low-Emitting materials

All the ten cases of vernacular houses use wood for structural frames. To ensure the wood resisting decay, insect attack, and rot problems, the timbers and woods for framing are treated naturally by special methods of the popular experience, which is often natural method.[170] Thus, the strategy found here is:

- *Use timbers with natural treatment methods*

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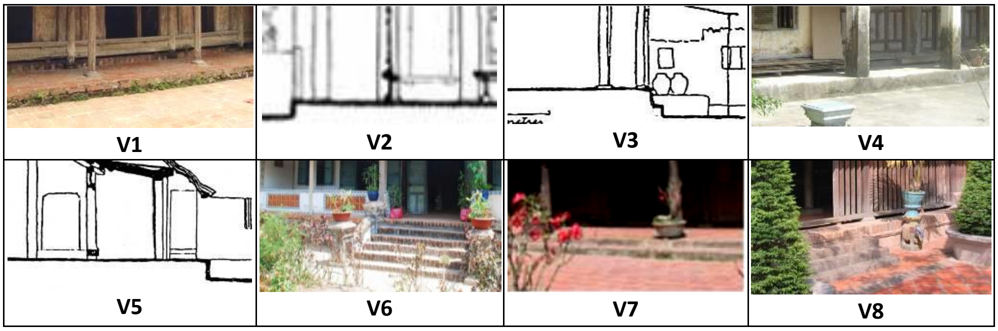
[170] Nguyen, Nguyen, and Ta, *Traditional Vietnamese Architecture*. Huy Le Phan, Akira Matsumoto, and Institute of International Culture - Showa Women's University, *Kiến Trúc Phố Cổ Hội an Việt Nam* [The Architecture of Hoi An Ancient Town - Vietnam], Vietnamese ed. (Hanoi: The Gioi, 2003).

## 3.3.8 Occupants' Comfort Perception

### 3.3.8.1 Thermal comfort

Vietnam has a humid and hot climate. Humidity together with hot weather creates an extremely uncomfortable indoor environment for living. Besides, the high humidity makes the surface damps and mold easily to proliferating especially in rainy season. The wooden structures are easily getting rot and decay in the damp condition. Preventing house from humidity is the essential method of the eight cases of rural vernacular houses. The most popular strategy is elevating the ground level of the house to surrounding land as evident in Table 3-9.

Table 3-9 Elevated ground floor for humidity prevention in rural vernacular houses[171]




Thus, the strategy popular in vernacular houses is:

- *Elevated ground floor for humidity prevention*

### 3.3.8.2 Vision comfort

[171] Images are modified from various sources. See section Appendix A

Table 3-7 shows the general space composition of the ten cases of vernacular houses. Accordingly, the living room, which is the main spaces of the houses, is always greatly open to the courtyard and the front garden. The opening not only enhances natural ventilation but also maximizes the external views from interior space, which supports the occupant's senses of the house. It is evident that the views to outdoor environment are the crucial demand of vision comfort in the Vietnamese vernacular houses (Figure 3-12).

Figure 3-12 Examples of view to outdoor environment in case V7, V9, and V10[172]

Thus, the strategy here is:

- *Provision of views to outdoor environment*

[172] Image source: (left) Giang, "Giải Pháp Thiết Kế Nhà Ở Cao Tầng Tại Tp.Hồ Chí Minh Theo Hướng Đảm Bảo Điều Kiện Tiện Nghi Vi Khí Hậu & Sử Dụng Năng Lượng Có Hiệu Quả [Design Methods for High-Rise Housing in Ho Chi Minh Towards Micro-Climatic Comforts and Energy Efficiency]."; (middle)http://hanoitrip.net/dia-diem-du-lich/noi-thanh-ha-noi/nha-co-87-ma-may/ accessed on June 15, 2015; (right)http://www.tripadvisor.com/LocationPhotoDirectLink-g298082-d7590313-i159591367-Nha_Co_Quan_Thang-Hoi_An_Quang_Nam_Province.html

## 3.4 Inherent Strategies in Vietnamese Vernacular Houses

As vernacular houses are regarded as an ideal model for sustainable building, inherent strategies in Vietnamese vernacular houses would contribute a foundation for expanding the strategies for the contemporary houses. Through analysis of the ten case study models, the inherent strategies in vernacular houses are drawn. Table 3-10 indicates a result of Step-1, a summary of inherent strategies in Vietnamese vernacular houses, which involves 40 strategies fallen into eight sections: (1) neighborhood formation, (2) natural vegetation preservation, (3) climatic response, (4) exploitation of renewable energy, (5) water conservation, (6) natural calamity response, (7) eco-friendly material, and (8) occupants' comfort perception.

Table 3-10 Step-1: Inherent strategies in Vietnamese vernacular houses

| Code & Section | Code & Term | No. | Code & Strategy |
|---|---|---|---|
| **A- Neighborhood Formation** | A1 Community connectivity | 01 | A1.1.V Provision of essential services and amenities in walking distance |
| | | 02 | A1.2.V Provision of space for community involvement |
| | A2 Collective participation | 03 | A2.1.V Involvement of villagers with multiple roles in the process of constructing a house |
| **B- Natural Vegetation Preservation** | B1 Vegetation Enhancement | 04 | B1.1.V Preserve the site with existing and adapted vegetation |
| | | 05 | B1.2.V Enhance vegetated open space and biodiversity |
| **C- Climatic Response** | C1 Building orientation | 06 | C1.1.V Building orientation to the south for taking advantage of solar shading, prevailing winds, and preventing from cold wind |
| | C2 Buffer space | 07 | C2.1.V Incorporate the buffer space as veranda space to at least the main façade of the building for preventing interior space from direct sunlight and heavy rainfall |
| | C3 Shading devices | 08 | C3.1.V Incorporating exterior shading devices (e.g. overhangs, screens, and louvers) |
| | | 09 | C.3.2.V Use occupant-controlled shading devices |
| | C4 Lightweight and insulated envelope | 10 | C4.1.V Use lightweight structures for building envelope |
| | | 11 | C4.2.V Use insulated roof and two-layer roof |
| | C5 Climatically responsive landscape | 12 | C5.1.V Plan the landscaping to work with the site microclimate (e.g. shading, ventilation, and daylighting) |
| **D- Exploitation of Renewable Energy** | D1 Space composition | 13 | D1.1.V Incorporate courtyard as a place to exploit energy from nature in forms of daylighting, air movement and solar heat |
| | D2 Natural ventilation | 14 | D2.1.V Arrange the openings in opposite sides to enhance the cross ventilation |
| | | 15 | D2.2.V Use center courtyard for enhancing stack ventilation |
| | | 16 | D2.3.V Incorporate the slits and openings to doors, windows, walls, and partitions to enhance the air circulation across spaces |
| | | 17 | D2.4.V Use hipped roof type to enhance the stack ventilation |
| | D3 Daylighting | 18 | D3.1.V Maximize opening on main façade for increasing daylighting and |

| Code & Section | Code & Term | No. | Code & Strategy |
|---|---|---|---|
| | | | natural ventilation |
| | | 19 | D3.2.V Use courtyard as diffuse reflecting surface |
| | | 20 | D3.3.V Use vegetation and surrounding facilities as sources of diffusing daylighting |
| | D4 Occupant Controllability | 21 | D4.1.V Use a flexible occupant-controlled openings (doors and windows) in regularly occupied spaces for natural ventilation and daylighting control |
| **E- Water Conservation** | E1 Minimizing water use | 22 | E1.1.V Landscaping with native and indigenous vegetation |
| | E2 Water reuse | 23 | E2.1.V Collecting and storing rainwater for later use |
| | E3 Stormwater runoff infiltration | 24 | E3.1.V Maximize the permeable surfaces |
| **F- Natural Calamity Response** | F1 Flooding prevention | 25 | F1.1.V Locate the building on elevated position |
| | | 26 | F1.2.V Design multi-storey building with the ground storey reserved for flooding situation |
| | F2 Typhoon prevention | 27 | F2.1.V Design building form and structure, especially roof shape stable to strong wind (broad and sturdily low building) |
| **G- Eco-Friendly Material** | G1 Local materials | 28 | G1.1.V Use materials available in nearby the site |
| | G2 Reuse and recycling of building materials and components | 29 | G2.1.V Reuse the building structural materials |
| | | 30 | G2.2.V Reuse building nonstructural components (e.g. doors, windows, panels) |
| | | 31 | G2.3.V Use reusable, recyclable materials |
| | | 32 | G2.4.V Use the reused, refurbished, and salvaged materials |
| | | 33 | G2.5.V Use materials with appropriate durability |
| | G3 Disassemblable building components | 34 | G3.1.V Design for easy disassembling and reassembling of building components |
| | G4 Rapidly renewable materials | 35 | G4.1.V Use natural/organic materials for building structures |
| | | 36 | G4.2.V Use natural/organic materials for building nonstructural elements |
| | | 37 | G4.3.V Use natural/organic materials for furnishings |
| | G5 Low-Emitting Materials | 38 | G5.1.V Use timbers with natural treatment methods |
| **H- Occupants' Comfort Perception** | H1 Thermal comfort | 39 | H1.1.V Elevated ground floor for humidity prevention |
| | H2 Vision comfort | 40 | H2.1.V Provision of views to outdoor environment |

## 3.5 Summary

This chapter conducts Step-1 to define the strategies inherent in Vietnamese vernacular houses. Step-1 brings about 40 strategies divided into eight categories coded from A to H. These strategies then become the foundation for the subsequent Step-2 to expand further through the analysis of contemporary houses in HCMC, which is the principal works of the Chapter Four.

# Chapter Four: Step-2: First Expansion of Strategies through Contemporary House Analysis



This chapter proceeds the second step, Step-2, that holistically and systematically investigates the contemporary HAB in HCMC. The contemporary houses in HCMC are examined to figure out the strategies of current practices and solutions for critical issues of HCMC urban context. The inherent strategies drawn from vernacular houses in Step-1 has further expanded in Step-2 through analyzing ten major case study models of HAB and five secondary case study models of townhouse in HCMC. Finally, a new list of strategies is summarized as the result of Chapter Four.

## 4.1 HCMC Urban Housing Classification

### 4.1.1 Residential Development Process

The process of housing development in HCMC can be segregated into two fundamental periods that offer old and new houses. The old houses are those built during the period of 1950s-1990s when the urbanization process had not intensely expanded yet. The urban planning policy in this period tended to distribute to the market merely separate land lots for individual self-build rather than developing large urban housing projects. This policy brought about disorder urban space and housing construction creating fragmented functional zoning and urban architecture.

The new housing generation has boomed since 2000s when a variety of 'untied' policies were promulgated, typically the 1991 Ordnance on Housing, 1998 Law on Land, and 1999 Decree No.17. The urbanization process has been exploded in all facets of the municipal society, which required a great progress in building code and standards. Typically, new building code 181/2004/ND-CP stipulates that the investors must complete the urban residential projects, including land planned and houses built, before officially transferring to occupants. This rule has stopped self-build houses in new urban areas and allowed large urban housing projects to be completely planned and built by qualified developers. As a result, HCMC is gradually transferred to a modern-like city since the neighborhood, instead of being split into various parts, is developed completely by only one qualified investor.

Regarding prospective tendency, HCMC has been an overpopulated city, and the city's population is predicted to increase incessantly in the coming decades. By

2025, the population is expected to reach 10 million of inhabitants and 2.5 million unregistered inhabitants, of which urban residents are accounted for about seventy percent. Responding to the population growth, the city is expected to expand up to 100,000 ha, half of which is the urban area.[173] However, present housing fund has been far lower than the actual demands. Therefore, the expansion of HAB has become the only strategic policy of HCMC administrators. The officially legislative documents highlighted the itinerary for transforming from the existing residential morphology towards the HAB. The Governmental Decision No. 2127/QD-TTg (2011) paid attention to developing HAB for saving the land resources. In particular, the ratio of HAB within every residential project in HCMC should reach over 80% by 2015 and 90% by 2020.[174] The area per capita is expected to reach to 26 m² per capita by 2015, 29 m² per capita by 2020.[175] *The Program for Urban Development* carried out in HCMC ambitiously delivers 100 to 120 million m² of new dwellings in 2011-2025.[176] Besides, the government highlighted the need for increasing the green building projects to 5% providing energy saving, environment-friendly living spaces.[177] In short, the HAB have been the major ongoing tendency of housing development in HCMC in the coming

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173 "Phê Duyệt Điều Chỉnh Quy Hoạch Chung Xây Dựng Thành Phố Hồ Chí Minh Đến Năm 2025."

174 "Phê Duyệt Chiến Lược Phát Triển Bền Vững Việt Nam Giai Đoạn 2011-2020."

175 Ibid.

176 The Phuong Ly, "A Critical Regionalist Approach to Housing Design in Vietnam: Socio-Environmental Organisation of Living Spaces in Pre-and Post-Reform Houses" (Queensland University of Technology, 2012), 37.

177 "TP.HCM Xây 39 Triệu m2 Sàn Nhà Ở Trong 5 Năm Tới,"[Ho Chi Minh City will build 39 million square meters in the next five years], accessed July 24, 2014, http://mag.ashui.com/tintuc-sukien/vietnam/4922-tphcm-xay-39-trieu-m2-san-nha-o-trong-5-nam-toi.html.

decades, of which, buildings with the ‘green’ features are favored.

### 4.1.2 Classification of Housing Typologies

It is necessary to overview the general background of HCMC urban housing typologies for mapping out the typologies that could be used for studying the contemporary living fashions of HCMC residents. Since the urban space of HCMC involves a mixture of permanent, semi-permanent, and temporary houses, the investigation into urban housing mainly focuses on permanent construction houses located in the municipal areas. The urban housing typologies fall into three types, comprising townhouses, villas, and apartment buildings with the provision of two sub-typologies including old and new (Table 4-1).

Table 4-1 HCMC urban housing typologies[178]

| **Typology** | **Sub-typology** | **Description** | **Tendency** | **Period** |
|---|---|---|---|---|
| Townhouses | Old | Old townhouses and old ‘tube house’ in alley located in old area | Decrease in quantity | 1950s~1990s |
| | New | Rebuilt or renovated townhouses in old areas and new townhouses in large housing projects located in new urban areas | Increase in quantity | 2000s to present |
| Villas | Old | Older colonial and center city villas | Disappearing | Early 20th century ~ 1990s |
| | New | New villas in old areas and new luxury villas in massive housing projects | Increase in quantity | 2000s to present |
| Apartment Buildings | Old | Old social housing, tenement and apartment | Mostly deteriorated | 1960s~ 1990s |
| | New | New high-quality apartment blocks built by major developers and new apartment for resettlement and new social housing located in both old and new urban areas | Increase in quantity | 2000s to present |

178 These typologies are considered on the permanent construction housing only. This classification is made with reference to UN-Habitat, Vietnam Housing Sector Profile, (Hanoi, 2013).

The distribution of the three typologies in HCMC is shown in Figure 4-1 based on the data collected in 2009. Accordingly, townhouses are the most dominant in HCMC and two-thirds of which are the old houses. Apartment buildings are the secondly popular dwellings, and villas are the minority. This distribution reveals that the townhouses and apartment buildings would be the potential subjects for studying the living fashions of today HCMC residents.

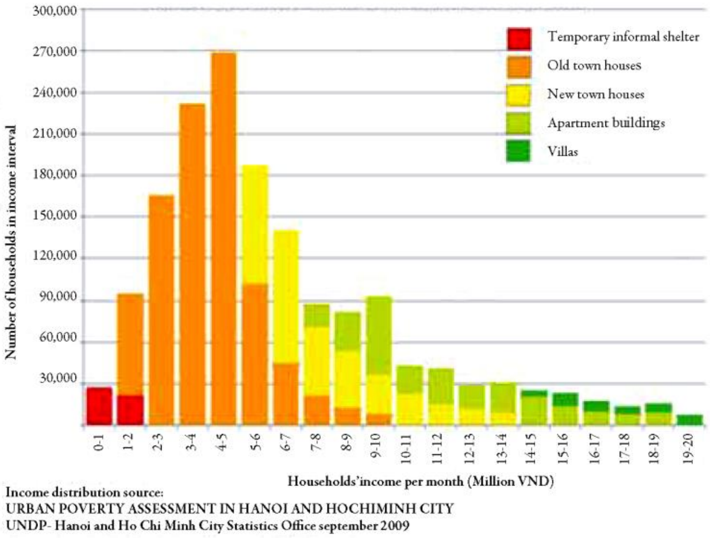


Figure 4-1 Distribution of housing typologies and household income in HCMC[179]

The two main typologies, townhouses and apartment buildings, are made a descriptive analysis in the following parts.

#### 4.1.2.1 Townhouses

Of the three typologies, townhouse, also known as a row house, tube-house, or

[179] Illustrative approximation from World Bank and Vietnam Country Office, *Vietnam Urbanization Review : Technical Assistance Report*, 116.

shophouse has been the most dominant in HCMC. The contemporary townhouses are associated with vernacular houses in Hanoi and Hoi An. Their layouts are often narrow and long, 4-5 meter in width by 25-30 meter in length approximately. Mixed use and flexibility are the most advantages of the townhouse that efficiently meet the demands of urban residents. Today townhouses fundamentally do not go beyond its original functions of serving living space and street trading. Accordingly, the lower floors are often reserved for trading or working purposes while the upper floors are places for living. However, the over-expanding townhouse in HCMC old urban areas has challenged planning functional zones and public traffic systems. Overdeveloping multifunctional townhouses (living, trading, working) has intensively blurred the boundary of residential, public, trading zones, which creates obstacles for expanding the public transport such as bus and subway routes.

The old townhouses were mostly constructed freely by individuals to meet their needs. Since residents are allowed to buy a separate land lot and build a house for themselves, the state administrators merely manage the indicators of the built house, such as the density, number of floors, height, and the depth of overhang. Except the official requirements, owners have all rights of planning, designing and constructing the house as their will. The construction process is even possible to be carried out in multiple times depending on the occupant needs and financial status. As a result, the old townhouses are constructed in diverse models regardless the whole aesthetic of the residential area.

Figure 4-2 Old townhouses in Nguyen Chi Thanh Street, District 11, HCMC[180]

The new townhouses can be found in many large housing projects located in new residential urban areas and in rebuilt and renovated projects situated in the old areas. The emerging large and compound housing projects have brought about new facets and high-quality standards for the townhouses living space. In these projects, the ratio of townhouses is balanced with the other typologies such as apartment buildings and villas. Only one developer completely builds all the townhouses in a project. Consequently, only a few townhouse's typical designs are applied for all townhouses blocks, which contributes order and equilibrium in planning due to their united features. These practices result in the more livable environment, land saving and reducing cost (Figure 4-3).

[180] Image extracted from Google Maps using Google Street View tool

Figure 4-3 New townhouses of Mega Village project in District 9, HCMC[181]

#### 4.1.2.2 Apartment Buildings

Most of the old apartment projects in HCMC were developed in the 1960s-1990s with a mixture of low-rise and HAB. Apartment buildings built in this periods have specific features that can be discriminated from today apartment buildings. The building blocks were often designed with single-loaded and double-loaded corridor layouts due to using mostly staircases for vertical circulation. The facades often have small size of glazing, using louver doors and windows, and concrete overhangs. The majority of old apartment buildings have been outdated, downgraded and being replaced gradually (Figure 4-4).

[181] Image source: http://www.reic.info/tien-do-du-an/594/tien-do-xay-dung-mega-village-thang-08-nam-2015.html accessed on October 15, 2015

Figure 4-4 Old apartment building at 727 Tran Hung Dao Street built in 1966[182]

New apartment buildings have been developed since 2000s with the majority of high-rise buildings. The expansion of material industry has brought in multiple choices of building structural and decorative materials, equipment and furniture. The dominance of glass and air-conditioner have defined a new form of architecture. The new buildings tend to cut down the climatically responsive elements like overhangs, louver windows and increase the free forms and larger glazing partition (Figure 4-5).

[182] Image source: http://www.baomoi.com/Khu-chung-cu-xuong-cap-tram-trong-o-TP-HCM-Vua-o-vua-run/c/9619073.epi accessed on October 5, 2015

Figure 4-5 Estella apartment project in District 2 built in 2012[183]

There are discrepancies in developing the new apartment projects between the old and new districts. In the old districts, the land is largely filled with townhouses as the consequence of planning policies before the 2000s. The new high-rise apartment projects in these areas come merely from rebuilding the deteriorated buildings or using the empty land from changing purpose. As a result, the HAB are scattered and loosely connected with the general urban planning. The scale of the project is often two or three blocks in average. In the new districts, e.g. District 2 and District 7, the situation is more favorable because of the effects of the new planning policies. Larger housing projects are thoroughly planned and developed. The high-rise apartment projects are often provided with multiple blocks and well connected with the public infrastructures, services, and utilities. Nonetheless, due to the limitation of financial capacity and market demands, the scale of the projects remains modest compared to other regional countries (Figure 4-6).

[183] Image source: http://horizon-arch.vn/du-an/chung-cu-estella-quan-2-tphcm-307.html.VkD20UeUeFs accessed on October 5, 2015

Figure 4-6 New apartment buildings built in the old and new districts of HCMC[184]

[184] Image source: (left) http://phongbanve.vn/giao-ve-may-bay-mien-phi-tai-quan-tan-binh.html accessed on October 5, 2015, (right) http://www.thesaigontimes.vn/107519/Xay-he-thong-cap-khi-dot-tu-nhien-dau-tien.html accessed on October 5, 2015

## 4.2 Transformation from Low-Rise to High-Rise Housing

Throughout the history, the habitation of Vietnamese is principally low-rise housing, from rural houses to townhouses in urban area. The most of the dwellings in HCMC was low-rise townhouses until 1960s. The high-rise residence is a replacement of old low-rise dwellings in the context of high density urban, which is inevitable tendency in a megacity like HCMC. The transformation from low-rise living, e.g. townhouses, into high-rise dwelling fashion evidently has resulted in a fundamental changes in many aspects, including living space composition, sense of community, climatically responsible strategies, social connection and so forth. The high-rise residential buildings built in HCMC needs to import the characteristics of traditional living fashions for bringing about the place-identity of HCMC. Since the low-rise living is different from a high-rise habitation, lessons from established low-rise housing, such as vernacular houses and modern townhouses, can be applied to apartments in high-rise residential buildings with the consideration of the appropriateness. This consideration contributes the principal mechanism when analyzing the inheritance of inherent vernacular strategies by filtering out the inappropriate strategies from vernacular houses or improving the improper strategies to become applicable to high-rise residence.

The followings will specify some potentials of inappropriate aspects between established low-rise and new high-rise housing in HCMC:

### 4.2.1 Appropriate and Inappropriate Aspects

The HAB in HCMC can inherit the climatically responsive strategies of established low-rise housing. Particular in the building scale, building form often shaped by the environment factor. As Vietnamese vernacular houses, High-rise buildings in HCMC could respond to the climatic elements: wind, external temperatures, and humidity. The Vietnamese vernacular houses also offer lessons of the energy-saving strategies such as natural ventilation, solar shading, and daylighting for high-rise residential buildings. Façade with openings for natural ventilation, climatic buffer zones (e.g. halls, atria), heat insulation and sun protection, employing energy recovery systems are some typical examples.[185]

However, not just appropriate aspects, some strategies from vernacular houses and townhouses is improper to HAB in HCMC. Some aspects such as building form, structure, construction materials, and so forth. Building form of low-rise housing favorable to natural ventilation or daylighting is likely far different with high-rise housing. The wooden structure with disassemblable function is hard to apply to high-rise building. Finally, the high-rise building is impossible to use natural materials in nearby site for its structures.

### 4.2.2 New Aspects of Sustainability in High-Rise Housing

Sustainability in high-rise residential buildings in HCMC could be approached in various issues. In urban scale, the high-rise residential buildings are associated with the high-density built form or compact city. The compact city with high-rise dwelling buildings reveals numerous strengths in diminishing unfavorable effects on the environment. Inhabitants of the high-density area have a lesser demand to travel by car, which offers the potentials of pedestrian and mass transit, thus lead to reducing environmental impacts. The concentration of population is favorable for planning the public transport system, thus better accessibility to services and

[185] Klaus Daniels, *The Technology of Ecological Building : Basic Principles and Measures, Examples and Ideas* (Basel ; Boston: Birkhäuser Verlag, 1997), 15.

facilities, more efficient exploitation the infrastructure and conserving the outskirt lands.

The high-rise residence comes together with the drawbacks in sustainability. Advantages and disadvantages of residential high-rise residence as can be summarized in Table 4-2.[186]

Table 4-2 Sustainability advantages and disadvantage of high-rise residence

| **Advantages** | **Disadvantages** |
|---|---|
| Less land consumption: *saving land for green spaces and infrastructures* | Insufficient urban and housing land: *risks of overdeveloping the infrastructure capacity leads to shortage of facilities, living space, and highly congested townscapes or expanding to valuable lands.* |
| Higher energy efficiency: *less exposed wall area, no heat-loss roof, transport energy reduction* | High operation energy: *high embodied energy in the operation due to high level of investment in fixtures and fittings; consuming large amounts of energy for lighting, heating, cooling and air-conditioning, lifts operation; no chance for orienting the dwelling.* |
| Lower resources consumption: *consuming lesser building materials per capita than detached dwelling, affording waste collection, reuse and recycling, mixed land-uses that reducing automobile use* | Less desirable living environment: *being over-exposed to wind and day lighting, overcrowding, noise, pollution, lifestyle conflict, loss of identity, reduction in privacy* |
| Better liveability: *diversity of easily accessible services, walkable distance services and facilities* | |

186 Wenjian Zhu and Rebecca LH Chiu, "The Planning and Design of Environmentally Sustainable High-Rises," in *High-Rise Living in Asian Cities* (Springer, 2011).

## 4.3 Research Method and Case Study Model

The case study research strategy is used as the main method for all studying argument of this chapter. The general specification of the case study research method has been discussed in Section 1.3, this section further argues detailed settings of the case study analysis, including reasons for choosing case study houses, method of data analysis and case study analysis.

### 4.3.1 Reasons for Choosing Case Study Houses

The above Section 4.1 indicates that townhouses are the most dominant of housing typologies in HCMC and HAB is the secondly prevailing dwellings. HAB in HCMC certainly are the main subject of the case studies in this chapter though they are not the most dominant because HAB is the primary subject of this thesis. Additionally, townhouse as the most prevailing and long-standing house typologies in HCMC should be additionally involved in the case studies for elucidating the living culture and evolvement of building elements which can contribute another basis for providing the strategies to HAB in HCMC. The chosen cases of contemporary houses, thus, include the major cases of HAB and secondary cases of townhouses.

The implementing case study on contemporary HAB is intended to perform an in-depth analysis the current high-rise dwellings in HCMC. HAB cases are also the realistic foundation for further discussion the applicability of strategies in this and subsequent steps. Since the chosen HAB cases in HCMC are not sustainable buildings, their insights may be positive or negative strategies. In addition, the strategies of vernacular houses in Step-1 and contemporary townhouses may be applicable or inapplicable for the sustainable HAB. The degree of applicability is discussed under the support of the ten major cases of HAB.

The reasons behind the choosing townhouses as secondary cases are varied. Townhouse has been the earliest urban housing type in Vietnam as evidence in Hanoi and Hoi An ancient town. The lasting existence of this housing type in Vietnamese urban areas demonstrates the potentials of strategies that responding to the immediate environment as results of the process of adaptability. The long-standing of the townhouses evidently bring about many characteristics showing the evolvement from vernacular houses to modern houses though they might be positive or negative effects regarding sustainability. Besides, townhouses as the most popular housing typologies consolidate the arguments associated with available living style, everyday life and activities applied to HAB living quality.

The question, ‘How many case studies are proper?’ then is raised. As the discussion in Section 1.3, multiple case studies should be used to reveal the comprehensive context of the contemporary houses. The number of cases selected should cover all houses with particular situations such as high-class, medium-class and low-class and also being located in various districts including old and new districts. The chosen cases of HAB and townhouses should be the new townhouses and apartment buildings[187] because they are presently developed housing types. Since major cases of HAB and secondary cases of townhouses are applied, the ten cases of HAB and five cases of townhouses are used, which is appropriate to the purposes and the scale of the research.

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[187] See the housing classification revealed in Table 4-1

### 4.3.2 Methods of Data Analysis

The process of considering strategies for contemporary houses from the basis of Step-1 is the main work of the Step-2. The Step-1 has built a list of inherent strategies of Vietnamese vernacular houses that are engaged with thousands of years of existence of ancient Vietnamese habitation. Today, the modern HCMC is far different from the ancient villages where the vernacular houses were situated. The contemporary houses in HCMC have been situating in a totally different living environment and society and been confronting with many problems contrasting with the issues of vernacular houses. For instance, the contemporary houses have been adopting new constructing fashions, such as technologies, materials, constructing methods, and confronting with climate change, environmental devastation, air pollution, traffic congestion, overpopulation and so forth. Evidently, the strategies in the Step-1 are not totally applicable to the contemporary houses in HCMC.

Therefore, these strategies in Step-1 should be reconsidered with the engagement of the conditions of the contemporary houses. The consideration of appropriateness shoould be based on two elelments. In General, the priorities of choosing strategies for sustainable HAB in HCMC as discussed in Section 2.6, in paricular, As the major subject of the study, the cases of available HAB are examined to find out the essences of the planning, designing the high-rise residential projects based on the light of strategies obtained from vernacular houses. together with reference to the design criteria and its insights of reference sources obtained from section 2.3.3. The case studies on townhouses are a secondary argument supporting the provision of strategies for HAB in HCMC rather than finding the solutions. Both positive strategies and negative issues are analyzed on ten HAB case studies. The positive strategies will be enhanced to input into the strategies of the proposed guidelines while the negative problems will be examined to offer an appropriate solution to input as a potential strategy.

## 4.3.3 Description of Case Study Models

### 4.3.3.1 Ten Major Case Study Models of HAB in HCMC

Ten cases are selected to examine the contemporary features of HAB in HCM on the base of inherent vernacular strategies. The ten cases cover all rank of apartment projects for reflecting the quality performance of the building holistically. Of which, cases of A1, A2, A3, A4, and A5 are the high-class apartment buildings (level A) and cases of A6, A7, A8, A9, and A10 are medium- and low-class (level B). The related data and detailed drawings of the ten cases can be found in the Appendix B. For the cases that have multiple tower designs, only one typical tower and apartment unit are selected for analysis. Table 4-3 illustrates a list of the ten cases with the general specification and Figure 4-7 shows the location of the ten cases across HCMC.

Table 4-3 Ten cases of HAB

| Case | Apartment Project | District | No. of Block | No. of Story | Completion | Function | Level |
|---|---|---|---|---|---|---|---|
| A1 | Hoang Anh River View | 2 | 3 | 25 | 2011 | Living and office space | A |
| A2 | The Vista | 2 | 5+1 | 28 | 2011 | Living, office and commercial space | A |
| A3 | Tropic Garden | 2 | 5 | 27 | 2014 & | Living, office and | A |

| Case | Apartment Project | District | No. of Block | No. of Story | Completion | Function | Level |
|---|---|---|---|---|---|---|---|
| | | | | | UC | commercial space | |
| A4 | Sky Garden III | 7 | 9 | 12-20 | 2014 | Living space | A |
| A5 | Sunrise City – South Towers | 7 | 6 | 30-34 | 2012 | Living, office and commercial space | A |
| A6 | Ky Nguyen Era Town – Area 1 | 7 | 5 | 30 | 2014 | Living and commercial space | B |
| A7 | Him Lam Cho Lon | 6 | 8 | 31-35 | 2015 | Living space | B |
| A8 | The Eastern | 9 | 2 | 22 | 2013 | Living space | B |
| A9 | Le Thanh Twin Towers | Binh Tan | 2 | 19 | 2014 | Living space | B |
| A10 | Phuc Loc Tho | Thu Duc | 3 | 16 | 2013 | Living and commercial space | B |
| Note: UC: Under Construction; Level A: high-class ; Level B: medium- and low-class | | | | | | | |

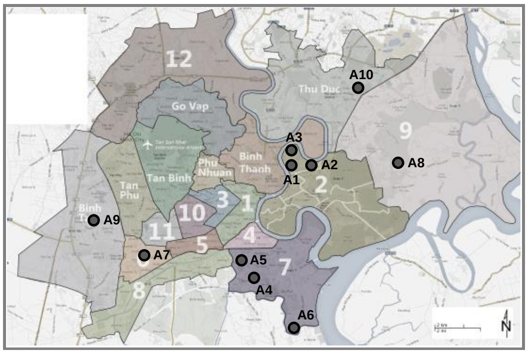



Figure 4-7 Location of the ten major case study models[188]

### 4.3.3.2 Five Secondary Case Study Models of Townhouse in HCMC

Since townhouse is the most dominant typology, examining townhouses will bring about the realistic insights of present settlement in HCMC urban. The cases of townhouse may have the features originated from tradition and also new features

[188] Map image is extracted from "District Map of Ho Chi Minh City".

or issues as the responding strategies to the new environment. There are totally five cases to be studied. Of which, three cases (T1, T2, and T3) are the new townhouses in the old urban area, those rebuilt or renovated from the old ones, and two cases (T4 and T5) are the new townhouses in the new residential urban areas (see Table 2-15 and Section 4.2.2 about housing typologies). Table 4-4 indicates the principal specification of the five cases. The detailed drawings of the five cases can be found in the Appendix C section and the location of the five cases of townhouses across HCMC is presented in Figure 4-8.

Table 4-4 Five secondary case study models of townhouses

| Case | Owner / Location | Year of Construction | Land lot W(m) x L(m) | Description |
|---|---|---|---|---|
| T1 | Mr. Quang's House | 2013 | 3.9 x 14.05 | 5 Floors |
| T2 | Mr. Hai's House | 2012 | 4.03 x 17.3 | 4 Floors |
| T3 | Mr. Cuong's House | 2009 | 4 x 27<br>(Built 4 x 21) | 3 Floors |
| T4 | Park Riverside Residential Area | 2014 | 5 x 16.35<br>(Built 5 x 11.35) | 3 Floors |
| T5 | Mega Village Townhouse Type No.5 | 2014 | 5 x 17<br>(Built 5 x 12) | 3 Floors |

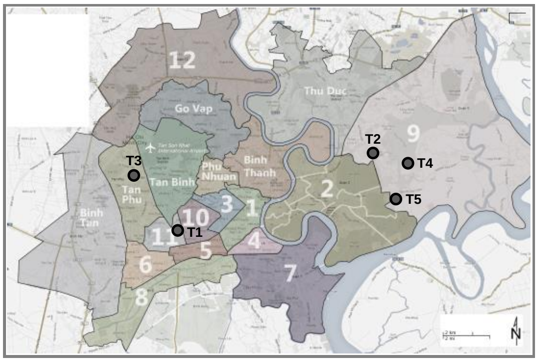



Figure 4-8 Location of the five secondary case study models of townhouse[189]

[189] Map image is extracted from ibid.

## 4.4 Case Study Analysis and Findings

### 4.4.1 Neighborhood Formation (A)

#### 4.4.1.1 Community connectivity (A1)

***(Step-1) [A1.1.V] Provision of essential services and amenities in walking distance***

The five cases of townhouses do not use this strategy.

In vernacular house cases, houses are often belong to a closed village in which all the essential services and amenities is available in walking distance. The model of that can be expanded in the urban situation like HCMC. The walking distance of the village boundary can be equivalent to a neighborhood unit in the urban area. The services and amenities in urban context include banks, playground and public park, religious center, restaurant & coffee shop, traditional market or supermarket, kindergarten, schools, college or university. Besides some other services and amenities are community center, assembly hall, stores, clinic center, bookstore, and post office. The close services and amenities encourage the walking and cycling rather than using private transport, which contributes GHG emission.

In the context of HCMC, the high priority to reducing private vehicles and enhancing public transportation leads to the demand of locating the building in walking distance to services and amenities. Of the ten cases, for those cases in the existing urban area like cases of A1, A3, A7, A8, A9, A10, there are various available communities' services and amenity in a walking distance, such as private townhouse stores and services, public park, post offices, banks. However, for the cases in the new urban area, it tends to incorporate the services and amenities into apartment projects to become a complex, for instance, the cases of A2, A4, A5, A6.

Another important aspect is the transportation hubs. Since apartment is high-density residence, the bus stop and subway station are important to reduce the needs of private traffic. Therefore, the hub transport location is important amenities. In HCMC, the bus stop is the only public transportation when the subway system is under construction. Therefore, select the site that well connects to bus stop and future subway station is preferred.

Therefore, the spirit of previous strategy of traditional village could be applied to the HAB in HCMC with minor revision for matching with the present conditions of the city. The revised strategies include:

- *A1.1.Ha Locate a site in walking distance to many community services and amenities*
- *A1.1.Hb Locate a site in walking distance to public transit stops (bus stop and urban rail station)*

***(Step-1) [A1.2.V] Provision of space for community involvement***

The five cases of townhouses do not use this strategy.

A project of HAB involves multiple towers accommodating thousands of residents. Thus, there are likely two scales of the community, the small community of inhabitants in the same tower and the large community of multiple towers in the residential area. The structure of a complex and completed project is that residents share the same public facilities and services, such as parking, parks, kindergarten, playgrounds, recreation facilities, shops, landscapes. Therefore, the public facilities and services play a role as the village facilities where people gather and interact each other.

The ten cases have quite adopted this strategy. All the ten cases have a proper building footprint, leaving open space, green space for personal demands and the community interactions. There are also diverse facilities that can gather residents such as swimming pool, gym, tennis courts, walkways and playground. However, the high-class group (A1, A2, A3, A4, and A5) seems to provide diverse facilities interesting residents than the medium-class group.

The spirit of the strategy of vernacular houses cases can be applied to contemporary HAB in HCMC. The strategy can be recomposed as following:

- *A1.2.H Incorporate space for community involvement within project by providing dedicated community facilities flexible for varied activities (e.g. recreational facilities, meeting room, childcare facilities)*

#### 4.4.1.2 Collective participation (A2)

***(Step-1) [A2.1.V] Involvement of villagers in the process of constructing a house***

The five cases of townhouses do not use this strategy.

In vernacular houses, the participation describes the involvement of many villagers with multiple roles in building a house. The participation in the context of HAB would be the involvement of residents in the design process. In pre-construction stage, the planning, and designing should be processed with reference to the opinions of the future residents.

The participation of residents in most of the high-rise residential projects in HCMC reveals weak, so do the ten cases. The participation would not happen when investors, planners or designers plan and design the building separately before selling it to public.

Most of the design of HAB in HCMC have not concerned the involvement of local residents/occupants that results in many issues in transferring the building to occupants. For example, in the HAB projects for resettlement of the residents whose houses was clear away by the projects of rectification Nhieu Loc Thi Nghe canal in HCMC. The lacking of reference of occupant opinions during designing the resettlement projects leads to critical problems after the handover of the housing. As a result, when the apartment building was in use, the residents gradually move to another place to set up new slums because they do not have earning jobs when living in the new apartments.

Since this strategy is extremely critical for HCMC, this strategy of vernacular house cases thus can be applied to present condition with a minor revision as below:

- *A.2.1.H Involve local residents in the design process from an early stage through events such as public notification and consultation meeting*

## 4.4.2 Natural Vegetation Preservation (B)

### 4.4.2.1 Vegetation enhancement (B1)

***(Step-1) B1.1.V Preserve the site with existing and adapted vegetation***

***(Step-1) B1.2.V Enhance vegetated open space and biodiversity***

These two strategies are the basic strategies in term of sustainable buildings. Preserving site with existing and adapted vegetation and enhancing vegetated open space and biodiversity are essential when HCMC shortage of greenery and open space (Section 2.5.31). The two strategies are thus essential for sustainable HAB in HCMC.

### 4.4.2.2 Land use optimization (B2)

Land use optimization is clearly reflected in the ten cases of the HAB. The main strategy is optimization of the layout and reduction of the development footprint to save land and natural resources, and preserve open space. This is partly defined in Vietnamese code about the density of the HAB in HCMC. Vietnamese building code QCXDVN 01: 2008 defines the maximum ratio of HAB projects as indicated in Table 4-5. Accordingly, the building density is subject to the building height and the area of land lot. The highest building density possible to attain is 75% for the land lot less than 3,000 m2, and the lowest building density is 35% for the land larger than 3.5ha and the building higher than 46m. Although the building code is clearly defined, the practices in actual situation tend to break the requirement for the economic purpose.

Table 4-5 Maximum building density required for HAB in Vietnam[190]

| Building height (m) | Maximum building density (%) | | | |
|---|---|---|---|---|
| | ≤3,000m2 (Land lot) | 10.000 m2 | 18,000m2 | ≥35,000 m2 |
| ≤16 | 75 | 65 | 63 | 60 |
| 22 | 75 | 57 | 55 | 52 |
| 31 | 75 | 48 | 46 | 43 |
| 40 | 75 | 43 | 41 | 38 |
| >46 | 75 | 40 | 38 | 35 |

The ten cases of HAB are merely enough matching with the requirement. However, the sustainable building is encouraged to save as much land as possible

[190] Data extracted from Vietnam Ministry of Construction, "Vietnam Building Code - Regional and Urban Planning and Rural Residental Planning."

for vegetation and open space. In general, the strategy of building density is fundamentally applied in the ten cases though it requires advanced performance. In summary, there is a new strategy applied in the ten cases as follow:

- *B2.1.H Optimize the layout and reduce the development footprint to save land and natural resources, and preserve open space*

## 4.4.3 Climatic Response (C)

### 4.4.3.1 Building orientation (C1)

***(Step-1) [C1.1.V] Building orientation to the South for taking advantage of solar shading, prevailing winds, cold wind prevention***

For townhouses, it is impossible to orient the house individually since no many options for selecting the house's direction. The housing direction is merely decided when planning the road systems of the urban residential area.

For vernacular houses, south-facing is the most preferred for welcoming prevailing winds while preventing buildings from direct solar sunlight in the east, west direction, and cold wind in the north direction (for houses in the northern area). In HAB, it is certainly impossible to orient the building to satisfy all the apartment units. However, there are chances for minimizing the effects of climate due to orientation. In particular, there is no cold wind in HCMC, preventing the building from overheating by direct sunlight and opening to prevailing winds are significant. The prevailing wind in HCMC comes from the three predominant direction south, southeast, and southwest.[191] Therefore, buildings designed with

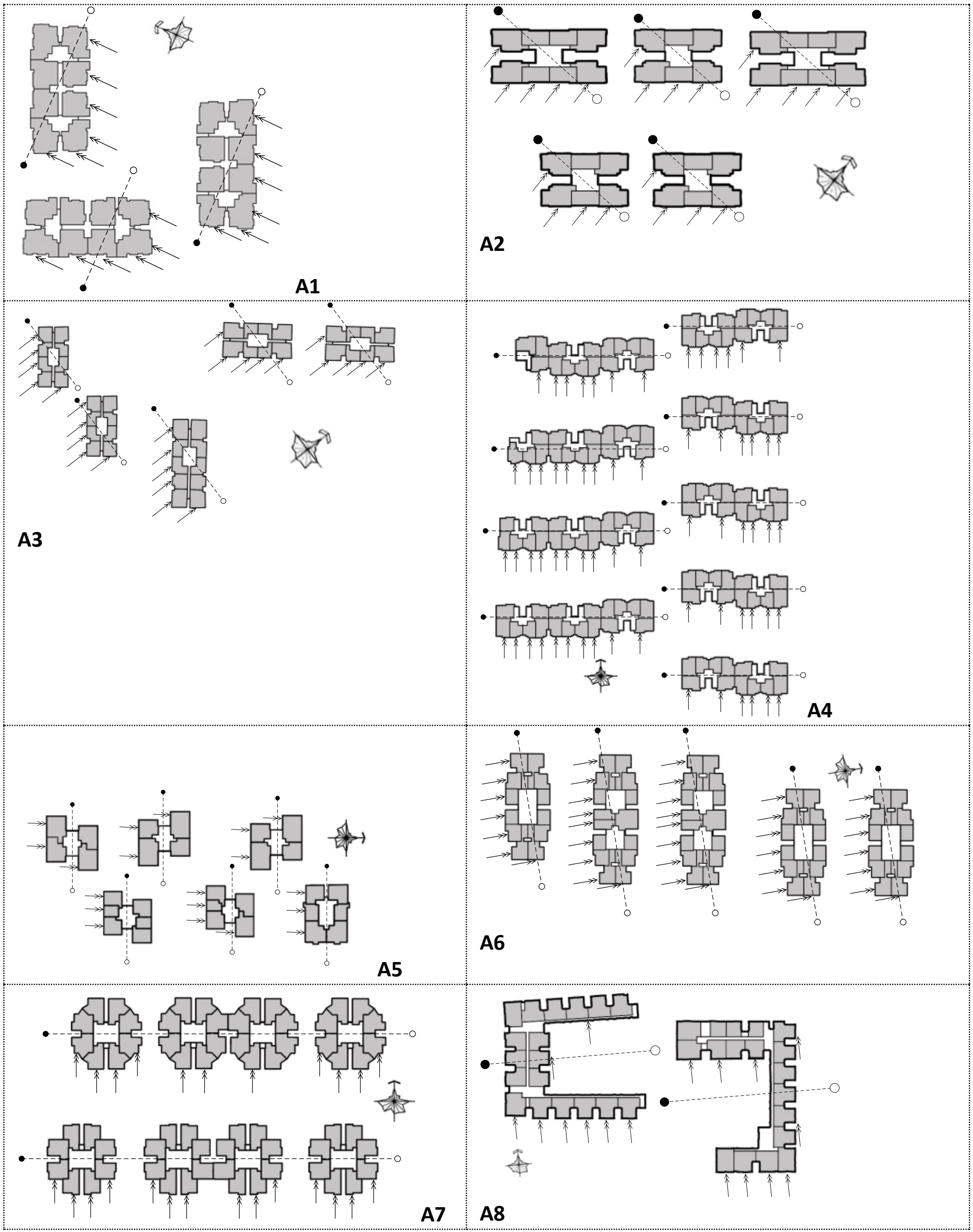
[191] Ibid. Giang, "Giải Pháp Thiết Kế Nhà Ở Cao Tầng Đáp Ứng Yêu Cầu Thông Gió Tự Nhiên Tại

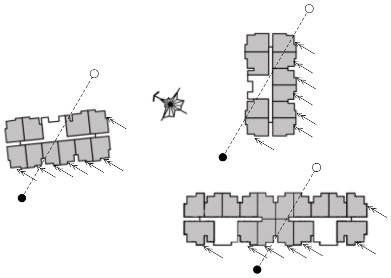
window openings facing south direction attain advantage of the prevailing wind condition and avoid the solar radiation, which improves the indoor thermal comfort. Thus, the south direction is the best choice for the buildings in HCMC, which is similar to the vernacular experience. For evaluating the site planning of the ten cases, it is not necessary to assess the window openings to be placed perpendicularly to the south direction, but the oblique angle to southeast and southwest is acceptable.

The analysis of the site plan regarding building orientation of the ten cases is illustrated in Table 4-6. Accordingly, the designers involved in the ten cases was aware of optimizing the building orientation. The analysis shows that the spirit of building orientation is well absorbed in planning the site when a majority of apartment units in the ten cases face to around the north-south axis. The towers that do not face north-south axis belongs to the cases with constrained land lot. In cases that the land lot is large enough, the design of the projects is consistent with the optimal direction such as the cases of A2, A4, A5 A6, and A7. Conversely, in those cases that the land lot is constrained, then, losing partly the buildings orientation is acceptable, such as the cases of A1, A3, A8, A10. In conclusion, the experience of building orientation from the vernacular house have applied to the HAB in building orientation regard.

Tp. Hcm".

Table 4-6 Analysis of building orientation in the ten cases



| | |
|---|---|
| |  A10 |

Therefore, the strategy C1.1.V of vernacular houses could be recomposed for being compliance with the context of HAB in HCMC, as the strategy of C1.1.H below:

- *C1.1.H Optimizing the building orientation for maximizing the number of apartments facing south for taking advantage of solar shading and prevailing winds*

### 4.4.3.2 Buffer Space (C2)

***(Step-1) [C2.1.V] Incorporate the buffer space as veranda space to at least the main façade of the building for preventing interior space from direct sunlight and heavy rainfall***

(For townhouses)

Buffer spaces, like veranda space, evidently play a key role in preventing buildings from the solar radiation, heavy rainfalls. While buffer space is evident in vernacular houses, of the five cases of townhouses, the indication of buffer space would be loggias and balconies. The five cases indicate the providing the buffer space in different ways and scales. The balconies are specified by the building code, subject to the street width, ranging from 900mm to 1200 roughly. In some cases like T2, T3, the buffered space area is reduced to increase more occupancy area.

There is a discrepancy in the way of setting buffer space in modern townhouses and the urban vernacular houses. The buffer space of the ancient urban house often occupies all the length of the facades to maximize the protection from solar radiation, and heavy rain. Meanwhile, the buffer spaces in the contemporary townhouses have principal changes. The buffer spaces in some cases occupy merely part of the façade, such as cases of T2, T3, T4, and T5. This discrepancy can be explained that the ancient house is often constructed of timbers and clay bricks that are easily decayed by the impacts of the severe weather, such as heavy raining, high humidity, and direct solar radiation. However, those reasons would be not the major concern of the modern house cases when the buildings are constructed of concrete, brick walls, glass, aluminum framing and so on.

(HAB)

The buffer space in vernacular houses is the veranda space that often occupies at least entire main façade of the houses. In an apartment unit, space that functions as the buffer space is merely the loggia or balcony. Table 4-7 is an analysis the buffer space in the five typical cases of the ten HAB cases via the appearance of balconies or loggias. It shows that only loggias are used, and the number of loggias used is least in the five cases. The loggias are often used as buffer space of the living room (cases of A1, A6), bedroom (cases of A3, A8), and kitchen (cases of A1, A2, A3, A8, A6). One apartment unit has one or two loggias.

Table 4-7 Buffer spaces in five typical cases of the ten HAB cases[192]


It evidences that the loggia is not used merely as a buffer space but rather being used due to the living functions. At least one loggia is used, and priority is assigned to kitchen due to the service purposes (e.g. washing, drying). This fact totally converses with the vernacular house where the buffer space can cover all perimeter of the building. This contradiction can be explained that the using of loggias is associated with the unit pricing and thus using loggias as minimum will contribute a competitive price. Therefore, the effects of buffer space are not the most priority and the interior space contacts directly to outside, which is acceptable

[192] Apartment plan drawings of cases are extracted from various sources. See Appendix B

in contemporary high-rise apartment. In conclusion, the buffer space is potential but not applied in contemporary HAB.

In light of sustainability, the maintaining the buffer space will bring about comfort indoor environment and reduce the cost of energy consumed for cooling the heated air by direct solar light. Without buffer space, the initial apartment unit cost may be cheaper but the occupants must pay back on electricity bills during building operation.

In short, the strategy C2.1.V originated from vernacular houses is evolved in the townhouses and HAB. The C2.1.V, thus, should be recomposed as below:

- *C2.1.T Incorporate the buffer space as veranda, balcony or loggia space for preventing interior space from direct sunlight and heavy rainfalls*

Besides, the responding to the west side has appeared in vernacular house cases in term of vegetation planning. In HCMC, west direction receives most of the solar radiation in the afternoon when the air is getting hotter. The buffer on the west side, therefore, is put in highest priority. Planning the secondary spaces for the purpose of buffer space is the optimal strategy for the context of HCMC. Therefore, one new strategy is emerged as follow:

- *C.2.1.Ha Provide buffer spaces like staircases, lifts, store, toilets, etc., on majority of the west wall*

#### 4.4.3.3 Shading devices (C3)

***(Step-1) [C3.1.V] Incorporating exterior shading devices (e.g. overhangs, screens, and louvers)***

Shading devices in the HAB may be the louvers, overhangs, light-shelves.

Table 4-8 shows the detailed main façade of the buildings in the ten cases. Accordingly, case A6 uses large overhangs and cases of A1, A2, A5, A7, A10 use small overhangs at every window or going through the length of façade. Meanwhile, the cases of A3, A4, A8, A9 do not use any significant shading devices. It evidences from the images that the shading devices used are not greatly subject to avoiding the sunlight but rather serving the aesthetic of the façade. This can be explained that there are many alternative methods to avoid and reduce solar radiation such as Low-e glass, double layers glass, curtains. In short, the contemporary HAB do use the shading devices as one of strategies for reducing the solar radiation, however, the application is not strictly. Thus, the strategy C3.1.V is applicable but weak performance

Table 4-8 Shading devices used in the ten HAB cases[193]

| | | | | |
|---|---|---|---|---|
|  A1 |  A2 |  A3 |  A4 |  A5 |
|  A6 |  A7 |  A8 |  A9 |  A10 |

[193] Apartment facades images of cases are extracted from various sources. See Appendix B

***(Step-1) [C.3.2.V] Use occupant-controlled shading devices***

The same situation as the strategy C3.1.V which is discussed above. The strategy C.3.2.V is thus recomposed as following:

- *C.3.2.T Use an occupant-controlled shading system on all windows, glazed doors and roof lights in regularly occupied spaces*

### 4.4.3.4 Lightweight and insulated envelope (C4)

**(Step-1) C4.1.V Use lightweight structures for building envelope**

This strategy is not used in five cases of the townhouse and ten cases of HAB. However, this strategy is essential for hot climate like Vietnam. Thus, it should be promoted in HAB in HCMC.

**(Step-1) C4.2.V Use insulated roof and two-layer roof**

In a vernacular house, roof insulation is crucial because the roof surfaces are often the largest surface exposed to the solar radiation. However, the high-rise building the vertical surfaces are the largest area directly exposed to the sunlight. Therefore, the roof insulation is less effect than the outer walls.

The quality of building envelope insulation is highly subject to the level of the apartment. High-class apartments (cases of A1, A2, A3, A4, A5) equip high-performance glazing (e.g. Low-E, double layers) while the medium-class apartments (cases of A6, A7, A8, A9, A10) use common or lower performance of glazing. There is no specific insulation in the brick wall (200mm brick wall). The roof is generally applied the insulation materials.

In short, the ten cases is likely weak consistent with this strategy since the application of insulated wall, and glazing is not mandatory yet. However, this strategy needs to be enhanced for creating the more quality and energy saving space.

- *C4.2.Ha Provision of insulation on building envelope (e.g. walls and roof)*
- *C4.2.Hb Provision of two-layer roof*
- *C4.2.Hc Use of thermal insulation on the east and west facing external walls*
- *C4.2.Hd Select windows and exterior glazing assemblies with thermally broken frames and insulated spacers, and with appropriate low-e coating*

#### 4.4.3.5 Climatically Responsive Landscape (C5)

***(Step-1) C5.1.V Plan the landscaping to work with the site microclimate (e.g. shading, ventilation, and daylighting)***

This strategy is not used in five cases of townhouse. However, this strategy is used in the ten cases of HAB though the performance is poor.

#### 4.4.3.6 Solar Heat Reflectance (C6)

This is the new term appeared in the contemporary houses of HCMC when the new construction materials and painting are popular. Today, the residents and builders are the wide ranks of options on choosing the diversified colors and material characteristics, those do not exist in the vernacular houses. Together with that, it opens a possibility of reducing the solar heat absorption by maximize the reflectance of the surface or making rough surface for increasingly shading itself.

As seen from the five cases of townhouse and ten cases of HAB in HCMC, it is natural that the residents, designers, or builders apply the light color and rough surface for the outer envelopes of the buildings because the heat absorption associated with surface colors is evidently perceived. Although the color of the building may be subject to the common aesthetic, however, this sense is clearly formed during a long time of responding to the living environment.

Especially in HAB in HCMC, four sides of the buildings are always exposed to the solar radiation. Of which, the east and west sides are the most exposed sides since the period of the exposure lasts throughout the year. Therefore, the light color surfaces are put in a higher priority for the east and west facades.

Most of the cases both townhouses and HAB use concrete flat roof that has varied options to choose the roofing materials. However, aside from that, the roof of the house sometimes depends on the materials roof tiles sources as the townhouses T4 case with the grey roof tiles.

The light color is not only applied to the building envelopes but also be found in the hardscapes in the cases of HAB. The walkway, yards, and playgrounds of HAB cases are often tiled by white grey stone, white brown brick.

In short, the strategies associated with this term found in both townhouses cases and HAB cases are as following:

- *C6.1.T Provision of light color textures and rough textures for building external facades*
- *C6.1.Ha Use of cool paints on the east and west facing external walls*
- *C6.2.T Provision of light color and rough textures for building roofing materials*

- *C6.3.H Use light-colored and heat-reflective hardscapes*

### 4.4.4 Exploitation of Renewable Energy (D)

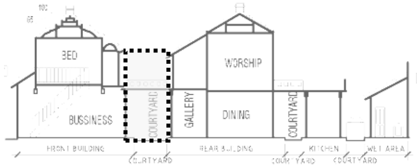
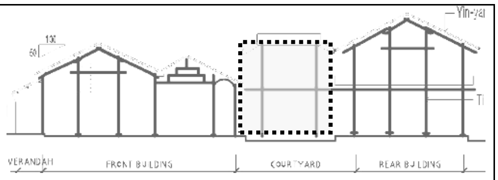
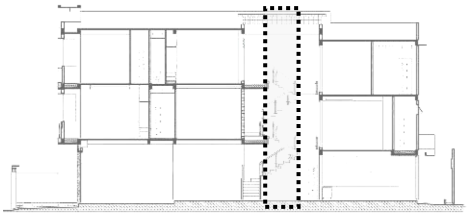
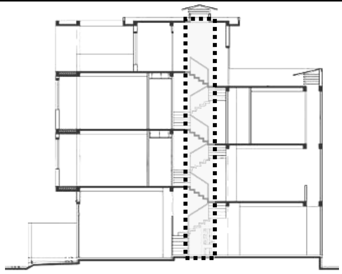
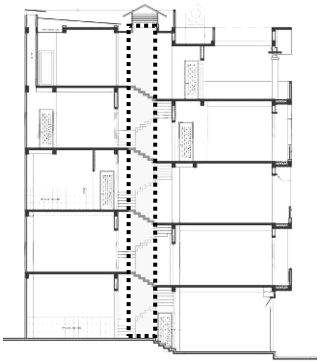
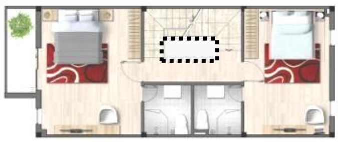
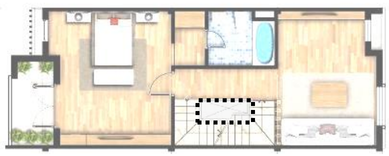
#### 4.4.4.1 Space composition (D1)

***(Step-1) D1.1.V Incorporate courtyard as a place to exploit energy from nature in forms of daylighting, air movement and solar heat***

(For townhouses)

The five cases share the same features in the mechanisms to enhance the natural ventilation and the daylighting in inner space. As long as the townhouses dominate in length, they adopt the traditional strategies by which the void space (courtyard) is incorporated into the interior spaces for collecting daylighting and air circulation. However, the five cases illustrate the ‘void’ as the ‘well’ rather than the inner yard as do in the urban vernacular houses. Though the ‘well’ increases the chances of sunlight illuminating into interior space, the daylighting effects likely do not work on the lower floors due to the height of the houses in the housing in the old urban area (Table 4-9). In addition, since air temperature in HCMC is hot year round, the solar heat function is prevented rather than enhanced in the five cases of townhouse.

Table 4-9 Courtyard in vernacular urban houses and skywell in contemporary townhouses[194]

| | |
|---|---|
|  **A9** |  **A10** |
|  **T3** |  **T2** |
|  **T1** |  **T4**<br> **T5** |

Therefore, the strategy D1.1.V should be revised to D1.1.T as below for townhouses.

*(Townhouses) D1.1.T Incorporate skywell as a place to exploit energy from nature in forms of daylighting and air movement.*

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[194] Drawings of townhouse cases are extracted from various sources. See Appendix C

(For HAB)

The courtyard has dual functions in vernacular houses, a place to exploit energy from nature in the form of daylighting, air movement and, at the same time, a social space. In the ten cases, the needs of ‘courtyard’ as the sources of ventilation and daylighting is weak because there are abundant of light and ventilation. Only in the case A5 with the intention to put many apartment units on a floor, the ‘courtyard-like’ solution is used to create ‘light well’ for enhancing natural ventilation and lighting. Regarding the social function of the courtyard, the application of common space to the apartment unit is impossible due to the economic reason. In conclusion, only the climatic function of the ‘courtyard’ can be applied to the HAB. The strategy here is same as the townhouses. However, since the use of skywell is not promoted due to its polluted noise and air issues, the strategy should be revised that adding the ‘if necessary’ to the strategy content. Thus, the strategy for HAB in HCMC should be:

- *D1.1.H If necessary, incorporate skywell as a place to exploit energy from nature in forms of daylighting and air movement*

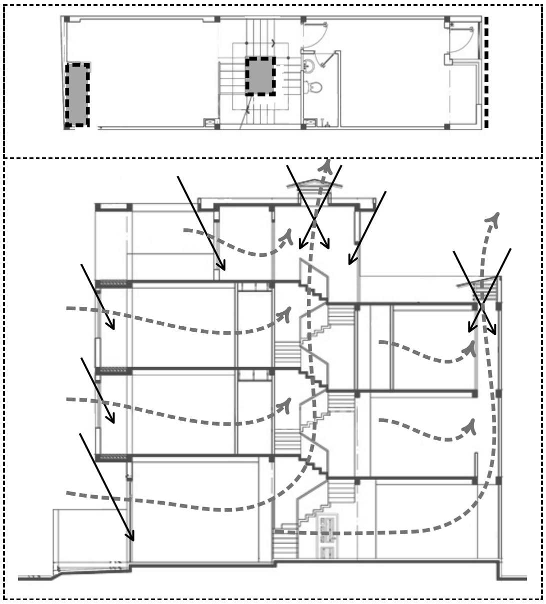
#### 4.4.4.2 Natural ventilation (D2)

***(Step-1) D2.1.V Arrange the openings in opposite sides to enhance the cross ventilation***

(For townhouses)

The contemporary townhouses are mostly similar the urban vernacular houses. However, the closed back side and the over-height of the townhouse cases make this strategy poorer performance than urban vernacular cases. The strategy D2.1.V is, therefore, applicable for townhouses

Table 4-10 Openings in opposite sides in the case T2[195]



(For HAB)

In vernacular houses, natural ventilation is adopted to enhance the indoor air quality and comfort. The rural and urban vernacular houses often use the courtyard to enhance the cross and stack ventilation effects. Since an apartment unit has limited height, the cross ventilation is dominant natural ventilation strategy. In order to ensure the true cross ventilation, the living space must maintain a reasonably unobstructed air flow between the windows or vents on opposite sides of the building. Table 4-11 indicates the analysis of the true cross ventilation potentials in the five typical cases of the ten HAB cases by determining two

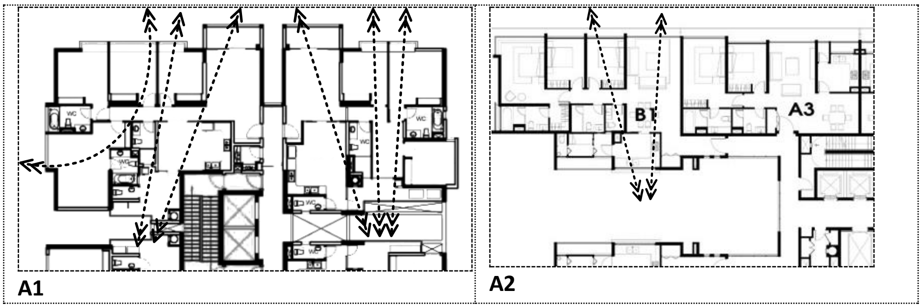
[195] Drawings of townhouse cases are extracted from various sources. See Appendix C

opposite windows or vents with the assumption that the main entrance of dwelling unit is close, and all the interior doors and windows are open.[196]

The analysis shows that the cross ventilation potentials depends on the awareness of designers and the economic reasons. Of all the five cases, the A1 case reveals high performance in cross ventilation potentials. The cases of A2, A3, and A8 have high potentials for cross ventilation, but the design makes middle units weak ventilation potentials. However, this cases can be supported by local prevailing wind from rivers or regional prevailing wind. The case A6 compresses many units on a floor due to economic issues, which causes weak ventilation in many units. Also, the quality of ventilated air is not good because it come from a narrow 'skywell' that contains many smells, polluted air. In summary, the cross ventilation has high potentials to apply in the designing apartment units. The D2.1.V should be revised for matching with HAB, as following:

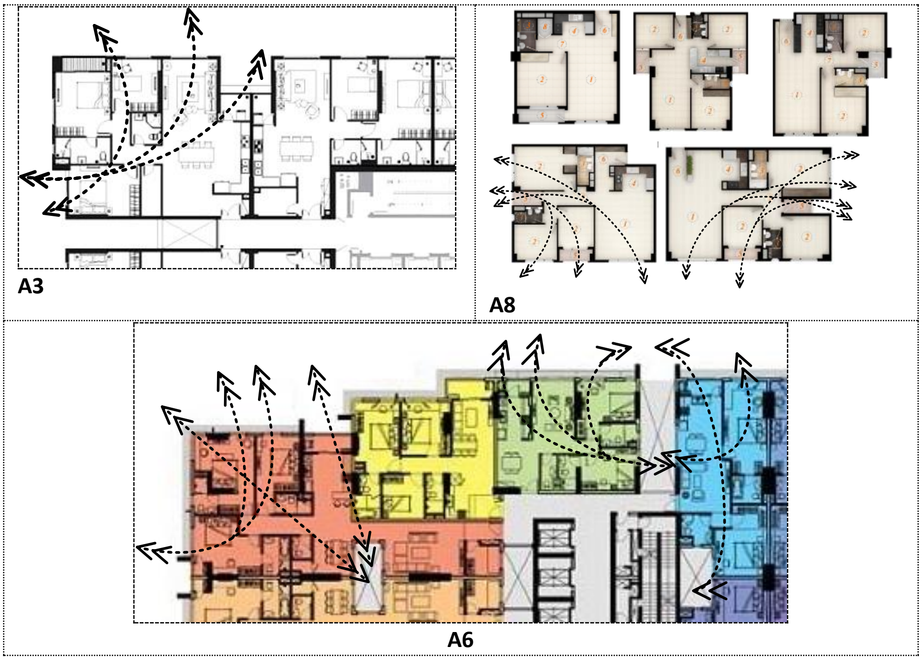
- *D2.1.H In each apartment unit, arrange the openings in opposite sides and interior doors to facilitate the cross ventilation*

Table 4-11 Analysis of cross ventilation potentials[197]




[196] This is the method used for assessment in BCA Green Mark Scheme

[197] Apartment plan drawings of cases are extracted from various sources. See Appendix B




***(Step-1) D2.2.V Use center courtyard for enhancing stack ventilation***

(For townhouses)

The height of the townhouses enhances the stack effects. Among five cases, there is one or two 'skywell' depending on the height of the house, for instances, the cases T1, T3, T4, and T5 have one while the case T2 has two. The 'skywell' is often combined with the stair to become a larger void for enhancing natural ventilation and daylighting. These strategies increase the potentials for effects of natural ventilation and daylighting. Of the five cases, the cases of T4 and T5, typical townhouses in new residential urban, have high performance in term of daylighting and natural ventilation. This is because it is not too long (5m x17m Approx.), reserved front yard and back yard, reasonable height (three floors), which are more similar to urban vernacular houses than the remaining three cases

(Table 4-9).

At this point, the space composition for natural ventilation and daylighting purposes are quite same with the urban vernacular houses in Hanoi or Hoi An town. However, the differences are revealed in the efficiency of the solutions. The first evidence is the ratio of the inner court, and the using area is far higher in the ancient townhouse. The height or number of floors is lesser in the case of an ancient house; the ancient house is often two storey while the contemporary house is three to five. The third discrepancy is the ‘openness’ of space next to the inner court. The ancient house is more open than the modern townhouse, partly because the modern house integrates the toilet adjacent to the bedroom, and the modern houses use mix-mode of ventilation and air-conditioning. As the result, the modern townhouses have the same space composition with ancient one for enhancing the natural ventilation and daylighting but the potentials in the modern townhouses are likely lesser than the ancient ones.

Overall, the natural ventilation and daylighting are the indispensable strategies in the contemporary townhouses, though the performance of the five cases is poorer than vernacular house cases. The dominant strategies are to incorporate the void into interior space as the same strategies with the urban vernacular houses. The first priority of lighting and ventilation is bedroom and living room and the common space is the second priority with an inner yard and void. The strategy is thus revised as following:

*(Townhouses) D2.2.T Enhance stack ventilation by increasing the height of the skywell*

With the same argument in analyzing the strategy D1.1.V, this strategy is applicable to special case A6 of HAB in HCMC, the strategy is thus revised:

- *D2.2.H Enhance stack ventilation by increasing the height of the skywell if necessary*

***(Step-1) D2.3.V Incorporate the slits and openings to doors, windows, walls, and partitions to enhance the air circulation across spaces***

This strategy is not used in the five cases of townhouses.

The slits and openings enhance the potentials of air circulation in interior space. This strategy is evidently applicable to apartment units. However, this strategy is poorly performed in the ten cases of HAB in HCMC. This partly because the dual systems tend to be used, the natural ventilation and the air-conditioning. Thus, it is essential to add the 'controllable' to the content of the strategy D2.3.V for maximizing the ventilation system using. Therefore, the strategy D2.3.V is recomposed as following for HAB:

- *D2.3.H Incorporate the controllable slits and openings to doors, windows, walls, and partitions to enhance the air circulation across spaces*

***(Step-1) D2.4.V Use hipped roof type to enhance the stack ventilation***

This strategy is applicable for detached houses, thus possible to apply to townhouse though it does not exist in the five cases. This strategy evidently could not be applied to HAB.

Besides the above strategies, there are some emerging strategies and issues regarding natural ventilation in townhouse and HAB cases

- *D2.5.T Use operable windows for cross ventilation in combination with* *mechanical ventilation systems (e.g., ceiling/wall-mounted fans, exhaust fans)*

In townhouses and HAB, the mixed mode of ventilation is preferred with the combination of cross natural ventilation with the mechanical ventilation systems. This mixed mode helps enhance the potentials and efficient of natural ventilation in inhabitable space

- *D2.6.T Take into account security, noise and dust concerns when providing natural ventilation*

Natural ventilation often goes with noise, dust and security which has been the problems of contemporary housing in HCMC. This strategy is demanded to raise the attention on these sources of issues. This issue is critical in townhouses cases that are nearby the streets. This issue is also problem of most of the ten cases of HAB

- *D2.7.H All public and circulation spaces and large portion of habitable rooms to be provided with cross and/or stack natural ventilation*

This strategy proceeds with strategy D2.1.H of cross ventilation enhancement with specifying the priority on the public, circulation spaces and large portion of habitable spaces of apartment units. This strategy, thus, is appropriate in term of natural ventilation.

- *D2.8.H Replace air conditioning with natural ventilation including common areas and habitable spaces*

Energy consumption from overuse of air-conditioning has been a problem of majority of residents' habits, also in the ten cases of HAB. This strategy promotes the using natural ventilation habitable spaces, at least in common space. The maximum natural ventilation results in energy saving while maintaining acceptable thermal comfort.

#### 4.4.4.3 Daylighting (D3)

***(Step-1) D3.1.V Maximize opening on main façades for increasing daylighting and natural ventilation***

Maximizing the opening on the main façade may good for daylighting and natural ventilation but at the same time it may be at risk of overheating and glare because of excessive illumination levels in interior space. This is also the problem in most of the ten cases of HAB.

In HAB, the majority of ten cases perform well in providing daylighting to interior space. However, due to lacking of buffer space and insignificant shading devices, the solar light directly irradiating to interior space heats space quickly that brings about the overheating risks.

The strategy D3.1.V, thus, should be revised as following for both townhouses and HAB:

- *D3.1.Ha Selecting appropriate glazed size for daylighting and avoiding excessive illumination levels inside the building*

The overheating issues can be improved by application of double-glazed units with Low-e glass or glass coatings, which can be found in the high-class HAB, cases of A1, A2, A3, A4, and A5. The remained cases do not use any special glazing. Thus, it is necessary to add one more strategy for HAB as following:

- *D3.1.Hb Use appropriate double-glazed units with Low-e glass, or glass* *coatings*

***(Step-1) D3.2.V Use courtyard as diffuse reflecting surface***

Townhouses and apartment building do not have courtyard surface. However, five cases of townhouses and ten cases of HAB adopt similar strategy through using the floor surfaces as reflectors for increasing penetration of daylight (Table 4-12). Therefore, the new strategy is:

- *D3.2.T Use floor surface and light shelves for increasing the penetration of daylight*

Table 4-12 Interior surfaces and daylighting effects in the ten cases of HAB[198]

| A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|
|  |  |  |  |  |
| A6 | A7 | A8 | A9 | A10 |
| - |  | - | - | - |

However, the reflected surfaces often lead to glare. Therefore, it should be accompanied with the new strategy to avoid glare as following:

- *D3.2.Ha Avoid glare in daylighting strategies and use textured/rough surfaces to diffuse the reflected daylight for reducing glare*

***(Step-1) D3.3.V Use vegetation and surrounding facilities as sources of diffusing daylighting***

[198] Interior images of apartment cases are extracted from various sources. See Appendix B

This strategy is not adopted in the five cases of townhouses.

For HAB, the apartment building is often far higher than the landscaping, this strategy often affects apartments in the lower level. The arrangement of building blocks enables sunlight to be reflected for illuminating spaces at the higher level. This strategy can be found in the ten cases. Therefore, the strategy D3.4.V should be recomposed in order to be applicable for HAB, as following:

- *D3.3.H Planning landscape and the building blocks for working as reflectors diffusing daylighting*

In addition, there is an efficient strategy associated with the lighting enhancement through high reflectance of internal finishes found in five cases of townhouses and ten cases of HAB (Table 4-12).

- *D3.4.T Use high reflectance (light color) of internal finishes for lighting penetration enhancement*

In most of the ten cases, daylighting is provided for all public and circulation spaces. Since the strategy of provision of daylighting for public space is necessary, the potential strategy as follow:

- *[D3.5.H] Daylighting for all public and circulation spaces and the large portion of habitable rooms*

#### 4.4.4.4 Occupant Controllability (D4)

***(Step-1) D4.1.V Use flexible occupant-controlled openings (doors and windows) in regularly occupied spaces for natural ventilation and daylighting control***

Controllability of the daylighting and natural ventilation provides the flexibility to control the indoor environment condition to match with the occupants' comfort. In vernacular house, the doors and window system, and shading devices can be manually adjusted to meet the resident demands of comfort. In this sense, the contemporary apartment in the ten cases offers the controllability to the occupant to adjust the doors and windows opening, louvers, curtain, drapes. The controllability of opening is applied in all of the five cases of townhouses and ten cases of HAB.

Therefore, besides the strategy D4.1.V, it needs an accompanied strategy:

- *D4.2.T Provision of interior sunlight control elements (e.g., curtain, drapes, blinds, adjustable louvers)*

### 4.4.5 Water conservation (E)

#### 4.4.5.1 Minimizing water use (E1)

***(Step-1) E1.1.V Landscaping with native and indigenous vegetation***

This strategy could not be found in the five cases of townhouses.

The native vegetation is planned in the ten cases of HAB naturally, but the builder lacks awareness to plan native and indigenous vegetation for water saving.

#### 4.4.5.2 Water Reuse (E2)

***(Step-1) E2.1.V Collecting and storing rainwater for later use***

HCMC has a rainy season with a large amount of rainfalls which often creating the urban inundation. However, rainwater harvesting is out of the scope of the today planning, designing, and constructing the HAB although it had been a strategy in vernacular houses. The rainwater harvesting system needs an initially large investment that would make investors think. Besides, there is a lack of awareness of water conservation in designing and constructing the housing in built environment activities. In all ten cases, there are absolutely no concerns about rainwater collection and reuse. However, this strategy would be significant shortly as a traditionally efficient solutions for urban inundation.

#### 4.4.5.3 Stormwater runoff infiltration (E3)

***(Step-1) E3.1.V Maximize the permeable surfaces***

This strategy is not used in the five cases of townhouse.

For HAB, although the majority of ten cases of HAB performs poorly this strategy. This strategy is universal in reference sources. However, in order to be applicable, this strategy should be recomposed as below:

- *E3.1.H Use permeable/pervious paving materials or open grid pavement system for hardscapes*

Besides, for advancing the permeable surface, some other common strategies can be used, especially, some districts of HCMC, such as District 7 and 2, have many wetlands and open land surface. The two strategies as follows:

- *E3.2.H Use swales, soak-ways, and holding ponds*
- *E3.3.H Design drainage systems that adequately dispose of rainwater and prevent flooding from excessive runoff, size gutters and others to allow for heavy rainfall*

### 4.4.6 Natural Calamity Response (F)

#### 4.4.6.1 Flooding Prevention (F1)

***(Step-1) F1.1.V Locate the building on elevated position***

This strategy is not adopted in the five cases of townhouses.

Since urban flooding has been a critical issue in HCMC as mentioned in Section 2.6, the urban flooding frequently happens in HCMC in every month under the impact of flood-tide and heavy rains. Therefore, this strategy is highly essential for HAB in HCMC.

***(Step-1) F1.2.V Design multi-storey building with the ground storey reserved for flooding situation***

This strategy could be applicable to five cases of townhouses. However, this strategy is certainly unnecessary for the ten cases of HAB in HCMC.

#### 4.4.6.2 Typhoon Prevention (F2)

***(Step-1) F2.1.V Design building form and structure, especially roof shape stable to strong wind (broad and sturdily low building)***

This strategy is not adopted in the five cases of townhouses.

This strategy is applicable to the ten cases of HAB. However, the strategy should be recomposed as following:

- *F2.1.H Planning and design buildings for restriction of wind damage and storm*

#### 4.4.6.3 Earthquake Resistance (F3)

This is the new term that is required for the ten cases of HAB. As the building code of Vietnam, the high-rise building must consider the earthquake in designing the building. The strategy here should be:

- *F3.1.H Design building structures for earthquake resistance*

### 4.4.7 Eco-Friendly Material (G)

#### 4.4.7.1 Local Materials (G1)

***(Step-1) G1.1.V Use materials available in nearby the site***

Using the local materials help reduce the GHG created from transferring the materials from factory to the site. In the context of HCMC, the materials 'nearby the site' could be converted to local or regional materials for contemporary houses. Material nearby the site may be the only option in the vernacular house because of the closed organization of the village and the economic reasons. However, in the current time, the materials sources are abundant, including regional, domestic, and imported sources. It evidences that there is mostly no awareness of using the local and regional material in designing high-rise dwelling in general but rather the sense of pricing. The cheap and acceptable quality material would be accepted. The five cases of townhouses and ten cases of HAB in HCMC would share the same situation. However, due to the reasonable price of the domestic materials, the majority of materials used in the those cases are domestic materials, except high-class quality or high-technology components. Therefore, domestic materials are naturally used, and the using of local/regional materials in the five cases is unmotived. Therefore, this strategy is essential to foster the use of local or regional materials to a higher awareness rather than the price-driven actions. The strategy thus recomposes as below:

- *G1.1.T Use local/regional materials*

#### 4.4.7.2 Reuse and Recycling of Building Materials and Components (G2)

***(Step-1) G2.1.V Reuse the building structural materials***

This strategy is not adopted in five cases of townhouses.

This strategy is also not adopted in the ten cases of HAB. However, this strategy is essential and needs to rewrite as follows:

- *G2.1.H Reuse/renovate a building by maintain existing building structure, walls, floors, and roof*

***(Step-1) G2.2.V Reuse building nonstructural components (e.g. doors, windows, panels)***

***(Step-1) G2.3.V Use reusable, recyclable materials***

***(Step-1) G2.4.V Use the reused, refurbished, and salvaged materials***

The five cases of townhouse do not adopt the three strategies.

These strategies are highly potential in application to the HAB though the degree of recycled materials in the ten cases of HAB is low. There are potentials to reuse and recycle or use the reusable and recyclable materials in built environment in HCMC. However, the is no motive to use it at present, unless the developer needs to attain a certain certification. In short, three strategies are essentials for promoting the saving natural resources.

*(Step-1) G2.5.V Use materials with appropriate durability*

Both five cases of townhouses and ten cases of HAB perform well regarding the durable material. Thus, this strategy is applicable for HAB.

#### 4.4.7.3 Disassemblable Building Components (G3)

*(Step-1) G3.1.V Design for easy disassembling and reassembling of building components*

The structural components in vernacular houses can be disassembled and reassembled thanks to the unique wooden construction. Today, the materials have changed to concrete and steel. Steel structures have many potentials to be disassemblable components, but they are only popular in public and low-rise facilities. Concrete structures could be disassemblable components if they are processed to be fabricated structures. However, There is no fabricated form of the apartment so far in HCMC because the construction technology in Vietnam is still at early stage. The low industrialized apartment housing on one hand makes the building forms diverse and brings in aesthetics but on the other hand, that leads to more energy and resources and emits more greenhouse gas. Therefore, this strategy is inapplicable at the present time because the strategy requires cutting-edge technology that is out of the capacity of Vietnamese construction industry.

#### 4.4.7.4 Rapidly Renewable Material (G4)

*(Step-1) G4.1.V Use natural/organic materials for building structures*

The five cases of townhouse do not adopt this strategy,

This strategy is inapplicable for HAB because of the limited strength of organic materials. Since the high-rise buildings need the high strength materials to bear the great load of the building. The natural or organic materials could not be used in this case.

***(Step-1) G4.2.V Use natural/organic materials for building nonstructural elements***

***(Step-1) G4.3.V Use natural/organic materials for furnishings***

Rapidly renewable materials are often the organic materials that are popular in interior furniture and finishing. Five cases of townhouses and ten cases of HAB fundamentally use wood-based furnishings and finishing. However, the structure materials are totally concrete, brick and steel that are not rapidly renewable materials. Therefore, the two strategies are applicable for both townhouses and HAB.

#### 4.4.7.5 Low-Emitting Materials (G5)

***(Step-1) G5.1.V Use timbers with natural treatment methods***

The timber used in vernacular houses often adopt the natural methods of treatment. Today, many chemicals are largely used for quickly treatment of the wood materials using in furnishings and finishing of a house in both townhouse and HAB cases. This is one problem in HCMC community since designers, engineers, and builder are not aware of the method of treatment the wood materials. Thus, recomposing the strategy G51.V to the chemical concerned treatment is essential. The revised strategy is:

- *G5.1.T Select timbers that use non-toxic methods to treat timber decay, insect attack and other rot problems, avoid toxic chemical treatment of timber where possible*

Aside from timber treatment, the furniture, cabinets, and interior trim, shelving, subflooring are often made of composite wood manufactured and treated from factory, which often used formaldehyde-based resins in production. This also the potential sources of emission that pollutes the indoor air quality and harm occupant health. This issue is also unaware in both townhouses and HAB. Therefore, one supplemental strategy is:

- *G5.1.Ta Reduce formaldehyde emissions in composite and wood-based products (cabinets, interior trim, shelving, subflooring and others)*

## 4.4.8 Occupants' Comfort Perception (H)

### 4.4.8.1 Thermal comfort

***(Step-1) H1.1.V Elevated ground floor for humidity prevention***

Since the ground floor (first floor) in the ten cases of HAB is often elevated to the ground level for preventing living space from humidity and pollutants, this strategy thus has been already applying. Therefore, this strategy is applicable and essential to the contemporary HAB in HCMC.

### 4.4.8.2 Vision comfort

***(Step-1) H2.1.V Provision of views to outdoor environment***

View to outdoor environment is the basic vision comfort that remains unchanged from vernacular houses to contemporary houses. In ten cases of HAB, the majority of living room and bedroom have doors or windows opening directly to the outdoor environment. This strategy is, thus, the essential and well adopted in the HAB in HCMC.

Besides, it is quite common in Vietnamese contemporary living space to have indoor planting in the communal areas for vision comfort, which is popular in both townhouse and apartment living space. Greenery plants in interior space bring about natural connection, aesthetics, and air quality. Thus, a strategy should be added as follow:

- *H2.2.T Use indoor planting beds in communal areas for interior decoration and air quality improvement*

#### 4.4.8.3 Acoustic comfort

The noise has been a critical issue of HCMC urban. The ten cases of HAB often are designed without being aware of the surrounding noise. Therefore, it should add a basic and common strategy for HAB to solve the problem, as follow:

- *H3.1.H Provide an effective level of acoustic insulation within buildings*

### 4.4.9 Waste & Pollution Reduction (I)

This term is a new term that is not be found in the vernacular case. The term added responds to the emerging issues of waste management and polluted air emission today in the compacted city like HCMC. Since the issues of waste and emission have been critical issues of HCMC, this term thus is essential to be mentioned in the proposed guidelines with guiding to reducing the waste and GHG emission. There are often three concerns in this term, including collection of recyclables, alternative transportation, and pollutant sources control.

#### 4.4.9.1 Collection of Recyclables (I1)

In HCMC, since there is no specific requirement for sorting the waste types so far, collection of recyclables is likely strange to the HCMC residents. However, towards the sustainability, the city would stipulate the waste sorting for recycling shortly. For educating the residents, it needs space for gathering, self-sorting waste ready for recycling in each floor and the entire building. Thus, the strategy should be:

- *I1.1.H Provide a centralized and easily accessible area for collection and storage of recyclables on each floor and entire building*

#### 4.4.9.2 Alternative Transportation (I2)

Urban transportation has become one of the extremely critical in HCMC. Paradoxically, HCMC is designed for motorcycles rather than bicycles and city residents nowaday rarely cycle in the city. However, moving by walking and bicycle within a short distance is a sustainable strategy and should be encouraged. Therefore, the strategies for enhancing the alternative transportation in HCMC should be included, as followings:

- *I2.1.H Provide favorable bicycle lanes, secure and easily accessible bicycle storage/parking on the site*
- *I2.2.H Provide favorable public or private walkway and pedestrian-friendly amenities that meet the multiple needs*
- *I2.3.H Locate preferred parking, bicycle parking, pick-up areas, and covered waiting spaces within close proximity of the main building entrances*
- *I.2.4.H Provide limited parking capacity to meet but not exceed minimum local zoning requirements*

### 4.4.9.3 Pollutant Sources Control (I3)

Ten cases of HAB share some strategies to stop the pollutant sources that match with the universal sustainable strategies. One of efficient strategy is using the entryway mats or walk off grilles in entrance areas to prevent dust and contaminants from moving to inside the house. Another strategy is designing the smoking area for smokers in every floor to prevent the building from cigarette smoke. Therefore, the two potential strategies are as follows:

- *I.3.1.H Provide removable entryway mats, walk-off grilles at the interior of all building entrances to capture potential contaminants and dirt*
- *I.3.2.H Prohibit smoking in all common areas of the building except in designated smoking areas*

## 4.5 Summary of Expansion of Strategies in Step-2

By analyzing the ten major cases of HAB and five secondary cases of townhouses in HCMC, strategies from Step-1 have been expanded further in Step-2. The strategies obtained in Step-2 reflect the actual practices and critical issues of contemporary HAB in HCMC. As a result, the strategies have expanded from 40 strategies in Step-1 to 72 strategies, of which 68 strategies are appropriate, and four strategies are inappropriate. All strategies are involved in nine categories. The result of Step-2 is illustrated in Table 4-13.

Table 4-13 Step-2: First expansion of strategies through contemporary houses analysis

| Code & Section | Code & Term | Strategies in Vernacular Houses (V) (Step-1) | Strategies in Townhouses (T) | | Strategies & Issues in Contemporary HAB (H) | | No. |
|---|---|---|---|---|---|---|---|
| **A- Neighborhood Formation** | A1 Community connectivity | A1.1.V Provision of essential services and amenities in walking distance | | | ● | A1.1.Ha Locate a site in walking distance to many community services and amenities | 01 |
| | | | | | ● | A1.1.Hb Locate a site in walking distance to public transit stops (bus stop and urban rail station) | 02 |
| | | A1.2.V Provision of space for community involvement | | | ● | A1.2.H Incorporate space for community involvement within project by providing dedicated community facilities flexible for varied activities (e.g. recreational facilities, meeting room, childcare facilities) | 03 |
| | A2 Collective participation | A2.1.V Involvement of villagers with multiple roles in the process of constructing a house. | | | ● | A.2.1.H Involve local residents in the design process from an early stage through events such as public notification and consultation meeting | 04 |
| **B- Natural Vegetation Preservation** | B1 Vegetation Enhancement | B1.1.V Preserve the site with existing and adapted vegetation | | | ⊙ | Similar to vernacular houses | 05 |
| | | B1.2.V Enhance vegetated open space and biodiversity | | | ⊙ | Similar to vernacular houses | 06 |
| | B2 Land Use Optimization | | | | ▲ | B.2.1.H Optimize the layout and reduce the development footprint to save land and natural resources, and preserve open space | 07 |
| **C- Climatic Response** | C1 Building orientation | C1.1.V Building orientation to the south for taking advantage of solar shading, prevailing winds, and preventing from cold wind | | | ● | C1.1.H Optimizing the building orientation for maximizing the number of apartments facing south for taking advantage of solar shading and prevailing winds | 08 |
| | C2 Buffer space | C2.1.V Incorporate the buffer space as veranda space to at least the main façade of the building for preventing interior space from direct sunlight and heavy rainfall | ● | C2.1.T Incorporate the buffer space as veranda, balcony or loggia space for preventing interior space from direct sunlight and heavy rainfalls | ● | Similar to townhouses | 09 |
| | | | | | ★ | C.2.1.Ha Provide buffer spaces like staircases, lifts, store, toilets, etc., on majority of the west wall | 10 |
| | C3 Shading devices | C3.1.V Incorporating exterior shading devices | ⊙ | Similar to vernacular houses | ⊙ | Similar to vernacular houses | 11 |

| Code & Section | Code & Term | Strategies in Vernacular Houses (V) (Step-1) | | Strategies in Townhouses (T) | | Strategies & Issues in Contemporary HAB (H) | No. |
|---|---|---|---|---|---|---|---|
| | | (e.g. overhangs, screens, and louvers) | | | | | |
| | | C.3.2.V Use occupant-controlled shading devices | ● | C.3.2.T Use an occupant-controlled shading system on all windows, glazed doors and roof lights in regularly occupied spaces | ⊙ | Applicable but weak performance | 12 |
| | C4 Lightweight and insulated envelope | C4.1.V Use lightweight structures for building envelope | | | ⊗ | Applicable | 13 |
| | | C4.2.V Use insulated roof and two-layer roof | | | ● | C4.2.Ha Provision of insulation on building envelope (e.g. walls and roof) | 14 |
| | | | | | ▲ | C4.2.Hb Provision of two-layer roof | 15 |
| | | | | | ★ | C4.2.Hc Use of thermal insulation on the east and west facing external walls | 16 |
| | | | | | ★ | C4.2.Hd Select windows and exterior glazing assemblies with thermally broken frames and insulated spacers, and with appropriate low-e coating | 17 |
| | C5 Climatically responsive landscape | C5.1.V Plan the landscaping to work with the site microclimate (e.g. shading, ventilation, and daylighting) | | | ⊙ | Similar to vernacular houses | 18 |
| | C6 Solar Heat Reflectance | | ▲ | C6.1.T Provision of light color textures and rough textures for building external facades | ▲ | Similar to townhouses | 19 |
| | | | | | ★ | C6.1.Ha Use of cool paints on the east and west facing external walls | 20 |
| | | | ▲ | C6.2.T Provision of light color and rough textures for building roofing materials | ▲ | Similar to townhouses | 21 |
| | | | | | ▲ | C6.3.H Use light-colored and heat-reflective hardscapes | 22 |
| **D- Exploitation of Renewable Energy** | D1 Space composition | D1.1.V Incorporate courtyard as a place to exploit energy from nature in forms of daylighting, air movement and solar heat | ● | D1.1.T Incorporate skywell as a place to exploit energy from nature in forms of daylighting and air movement | ● | D1.1.H If necessary, incorporate skywell as a place to exploit energy from nature in forms of daylighting and air movement | 23 |
| | D2 Natural ventilation | D2.1.V Arrange the openings in opposite | ⊙ | Similar to vernacular houses | ● | D2.1.H In each apartment unit, arrange the openings in | 24 |

| Code & Section | Code & Term | Strategies in Vernacular Houses (V) (Step-1) | | Strategies in Townhouses (T) | | Strategies & Issues in Contemporary HAB (H) | No. |
|---|---|---|---|---|---|---|---|
| | | sides to enhance the cross ventilation | | | | opposite sides and interior doors to facilitate the cross ventilation | |
| | | D2.2.V Use center courtyard for enhancing stack ventilation | ⊙ | D2.2.T Enhance stack ventilation by increasing the height of the skywell | ● | D2.2.H Enhance stack ventilation by increasing the height of the skywell if necessary | 25 |
| | | D2.3.V Incorporate the slits and openings to doors, windows, walls, and partitions to enhance the air circulation across spaces | | | ● | D2.3.H Incorporate the controllable slits and openings to doors, windows, walls, and partitions to enhance the air circulation across spaces | 26 |
| | | D2.4.V Use hipped roof type to enhance the stack ventilation | ⊙ | Similar to vernacular houses | × | Inapplicability | 27 |
| | | | ▲ | D2.5.T Use operable windows for cross ventilation in combination with mechanical ventilation systems (e.g., ceiling/wall-mounted fans, exhaust fans) | ▲ | Similar to townhouses | 28 |
| | | | ★ | D2.6.T Take into account security, noise and dust concerns when providing natural ventilation | ★ | Similar to townhouses | 29 |
| | | | | | ▲ | D2.7.H All public and circulation spaces and large portion of habitable rooms to be provided with cross and/or stack natural ventilation | 30 |
| | | | | | ★ | D2.8.H Replace air conditioning with natural ventilation including common areas and habitable spaces | 31 |
| | D3 Daylighting | D3.1.V Maximize opening on main façades for increasing daylighting and natural ventilation | | | ★ | D3.1.Ha Selecting appropriate glazed size for daylighting and avoiding excessive illumination levels inside the building | 32 |
| | | | | | ▲ | D3.1.Hb Use appropriate double-glazed units with Low-e glass, or glass coatings | 33 |
| | | D3.2.V Use courtyard as diffuse reflecting surface | ● | D3.2.T Use floor surface and light shelves for increasing the penetration of daylight | ● | Similar to townhouses | 34 |

| Code & Section | Code & Term | Strategies in Vernacular Houses (V) (Step-1) | | Strategies in Townhouses (T) | | Strategies & Issues in Contemporary HAB (H) | No. |
|---|---|---|---|---|---|---|---|
| | | | | | ★ | D3.2.Ha Avoid glare in daylighting strategies and use textured/rough surfaces to diffuse the reflected daylight for reducing glare | 35 |
| | | D3.3.V Use vegetation and surrounding facilities as sources of diffusing daylighting | | | ● | D3.3.H Planning landscape and the building blocks for working as reflectors diffusing daylighting | 36 |
| | | | ▲ | D3.4.T Use high reflectance (light color) of internal finishes for lighting penetration enhancement | ▲ | Similar to townhouse cases | 37 |
| | | | | | ▲ | D3.5.H Daylighting for all public and circulation spaces and the large portion of habitable rooms | 38 |
| | D4 Occupant Controllability | D4.1.V Use flexible occupant-controlled openings (doors and windows) in regularly occupied spaces for natural ventilation and daylighting control | ○ | Similar to vernacular houses | ○ | Similar to vernacular houses | 39 |
| | | | ▲ | D4.2.T Provision of interior sunlight control elements (e.g., curtain, drapes, blinds, adjustable louvers) | ○ | Similar to townhouses | 40 |
| **E- Water Conservation** | E1 Minimizing water use | E1.1.V Landscaping with native and indigenous vegetation | | | ⊙ | Similar to vernacular houses cases | 41 |
| | E2 Water reuse | E2.1.V Collecting and storing rainwater for later use | | | ⊗ | Applicable | 42 |
| | E3 Stormwater runoff infiltration | E3.1.V Maximize the permeable surfaces | | | ⊗ | E3.1.H Use permeable/pervious paving materials or open grid pavement system for hardscapes | 43 |
| | | | | | ⊗ | E3.2.H Use swales, soak-ways, and holding ponds | 44 |
| | | | | | ▲ | E3.3.H Design drainage systems that adequately dispose of rainwater and prevent flooding from excessive runoff, size gutters and others to allow for heavy rainfall | 45 |
| **F- Natural Calamity Response** | F1 Flooding prevention | F1.1.V Locate the building on elevated position | | | ○ | Similar to vernacular houses | 46 |
| | | F1.2.V Design multi-storey building with the ground storey reserved for flooding | ○ | Similar to vernacular houses | × | Inapplicable | 47 |

| Code & Section | Code & Term | Strategies in Vernacular Houses (V) (Step-1) | Strategies in Townhouses (T) | | Strategies & Issues in Contemporary HAB (H) | | No. |
|---|---|---|---|---|---|---|---|
| | | situation | | | | | |
| | F2 Typhoon prevention | F2.1.V Design building form and structure, especially roof shape stable to strong wind, (broad and sturdily low building) | | | ● | F2.1.H Planning and design buildings for restriction of wind damage and storm | 48 |
| | F3 Earthquake resistance | | | | ▲ | F3.1.H Design building structures for earthquake resistance | 49 |
| **G- Eco-Friendly Material** | G1 Local materials | G1.1.V Use materials available in nearby the site | ● | G1.1.T Use local/regional materials | ● | Similar to townhouses | 50 |
| | G2 Reuse and recycling of building materials and components | G2.1.V Reuse the building structural materials | | | ⊗ | G2.1.H Reuse/renovate a building by maintain existing building structure, walls, floors, and roof | 51 |
| | | G2.2.V Reuse building nonstructural components (e.g. doors, windows, panels) | | | ⦿ | Applicable but little awareness | 52 |
| | | G2.3.V Use reusable, recyclable materials | | | ⦿ | Applicable but little awareness | 53 |
| | | G2.4.V Use the reused, refurbished, and salvaged materials | | | ⦿ | Applicable but little awareness | 54 |
| | | G2.5.V Use materials with appropriate durability | ○ | Similar to vernacular houses | ○ | Similar to vernacular houses | 55 |
| | G3 Disassemblable building components | G3.1.V Design for easy disassembling and reassembling of building components | | | × | Inapplicable | 56 |
| | G4 Rapidly renewable materials | G4.1.V Use natural/organic materials for building structures | | | × | Inapplicable | 57 |
| | | G4.2.V Use natural/organic materials for building nonstructural elements | ⦿ | Similar to vernacular houses but little awareness | ⦿ | Similar to vernacular houses but little awareness | 58 |
| | | G4.3.V Use natural/organic materials for furnishings | ○ | Similar to vernacular houses | ○ | Similar to vernacular houses | 59 |
| | G5 Low-Emitting Materials | G5.1.V Use timbers with natural treatment methods | ★ | G5.1.T Select timbers that use non-toxic methods to treat timber decay, insect attack and other rot problems, avoid toxic chemical treatment of timber where possible | ★ | Similar to townhouses | 60 |

| Code & Section | Code & Term | Strategies in Vernacular Houses (V) (Step-1) | | Strategies in Townhouses (T) | | Strategies & Issues in Contemporary HAB (H) | No. |
|---|---|---|---|---|---|---|---|
| | | | ★ | G5.1.Ta Reduce formaldehyde emissions in composite and wood-based products (cabinets, interior trim, shelving, subflooring and others) | ★ | Similar to townhouses | 61 |
| **H- Occupants' Comfort Perception** | H1 Thermal comfort | H1.1.V Elevated ground floor for humidity prevention | | | ○ | Similar to vernacular houses | 62 |
| | H2 Vision comfort | H2.1.V Provision of views to outdoor environment | ○ | Similar to vernacular houses | ○ | Similar to vernacular houses | 63 |
| | | | | H2.2.T Use indoor planting beds in communal areas for interior decoration and air quality improvement | ○ | Similar to strategy of townhouses cases | 64 |
| | H3 Acoustic comfort | | | | ★ | H3.1.H Provide an effective level of acoustic insulation within buildings | 65 |
| **I- Waste & Pollution Reduction** | I1 Collection of Recyclables | | | | ★ | I1.1.H Provide a centralized and easily accessible area for collection and storage of recyclables on each floor and entire building | 66 |
| | I2 Alternative Transportation | | | | ★ | I2.1.H Provide favorable bicycle lanes, secure and easily accessible bicycle storage/parking on the site | 67 |
| | | | | | ★ | I2.2.H Provide favorable public or private walkway and pedestrian-friendly amenities that meet the multiple needs | 68 |
| | | | | | ★ | I2.3.H Locate preferred parking, bicycle parking, pick-up areas, and covered waiting spaces within close proximity of the main building entrances | 69 |
| | | | | | ★ | I.2.4.H Provide limited parking capacity to meet but not exceed minimum local zoning requirements | 70 |
| | I3 Pollutant Sources Control | | | | ▲ | I.3.1.H Provide removable entryway mats, walk-off grilles at the interior of all building entrances to capture potential contaminants and dirt | 71 |
| | | | | | ★ | I.3.2.H Prohibit smoking in all common areas of the building except in designated smoking areas | 72 |

Note: ○ - The strategy is similar to the previously available strategy; ● - The strategy is similar to the previously available strategy but needs to be revised for proper applicability; ⊗ - The previously

| Code & Section | Code & Term | Strategies in Vernacular Houses (V) (Step-1) | Strategies in Townhouses (T) | Strategies & Issues in Contemporary HAB (H) | No. |
|---|---|---|---|---|---|
| available strategy is applicable but not to be well applied in contemporary HAB (revised if necessary); × - The previously available strategy is inapplicable Contemporary HAB; ▲ - new strategy of contemporary HAB that do not exist in vernacular houses; ⊙ - The strategy is similar previously available strategy but weak performance or little awareness; ★ - The present issue of contemporary house that needs to deal with | | | | | |

## 4.6 Summary

This chapter conducted the Step-2 for further expanding the strategies gained in Step-1. This chapter has investigated holistically and systematically the Vietnamese contemporary houses with the highlight on HAB in HCMC. 40 inherent strategies drawn from vernacular houses in Step-1 has further expanded in Step-2 to 70 strategies through analyzing contemporary houses with ten major case studies of HAB and five secondary case studies of townhouses in HCMC. This chapter has resulted in 70 strategies involved in nine categories applicable to design guidelines for sustainable HAB in HCM based on the exploration of actual conditions of HCMC. For updating the cutting-edge strategies for HAB, it is necessary to proceed Step-3 to expand further the strategies gained from Step-2 by analyzing the globally prominent design guidelines and assessment methods for sustainable houses and HAB. The next chapter, Chapter Five, will conduct the Step-3 as the second expansion of the strategies.

# Chapter Five: Step-3: Second Expansion of Strategies through Analysis of Selected Guidelines



This chapter proceeds with Step-3, the second expansion of strategies attained in Step-1 and Step-2 through comparatively analyzing the selected guidelines for updating the cutting-edge strategies. Nine selected sustainable design guidelines are involved in sustainable building, housing, HAB, and buildings in the tropical zone. The comparative analysis also includes seven assessment methods described in Section 2.3.3 as the supplemental reference.

The Step-3 finalizes the most potential strategies for HAB in HCMC. The result of this chapter contributes the content element of design guidelines framework in Chapter Six.

## 5.1 Reasons for Second Expansion of Strategies

The inherent strategies drawn from vernacular houses in Step-1 has further expanded in Step-2 through analyzing contemporary houses to extend and make strategies applicable to sustainable HAB in HCMC. The list of strategies gained from Step-2 derives fundamentally from considering the actual practices and issues of HAB in HCMC with reference to vernacular houses. The strategies need to refer further the prominent assessment methods and design guidelines for sustainable housing and HAB to upgrade the strategies. Developed countries, specifically North American and Europe, have developed many high-quality sustainable design guidelines for sustainable houses and HAB which could be essential reference sources. Besides, assessment methods and sustainable design guidelines in regional countries are also valuable references since they share many similarities in entirely climatic, environmental and social issues. Therefore, this chapter proceeds a final step, Step-3, to update the cutting-edge strategies of sustainability in HAB design through analyzing the nine selected guidelines together with the reference of the previous seven selected assessment methods in Section 2.3.3.

## 5.2 Research Method and Data Selection

### 5.2.1 Research Method

The research in Step-3 primarily adopts the comparative analysis. The strategies for comparative analysis comprise those gained from Step-2 and those from selected design guidelines and assessment methods. The analysis process conducts on mutually incorporating two processes, including the quantitatively and qualitatively comparative analysis.

### 5.2.2 Methods of Data Analysis

There are two groups of strategies for comparative analysis, including the prior strategies coded with the character V, H, T which gained from Step-2 and newly referred strategies coded with the character G which comprise nine selected design guidelines and previous seven selected assessment methods in Chapter 2. The combination of the two groups leads to strategies that fall into three cases A, B, and C (Figure 5-1). Strategies of Case A involve those of prior strategies that appear in the newly referred strategies, which are indicated as intersected area in Figure 5-1. Strategies of Case B include those of prior strategies that do not match with any of the newly referred strategies, which are indicated as solid-filled area. Strategies of Case C include those of the newly referred strategies that do not match any of the prior strategies, which are indicated as pattern-filled area.

The strategies of the each case (A, B, or C) have different methods of analysis. Of the three cases, the strategies of the Case C are more concerned than those of the Case A & B since the prior strategies have been analyzed in Step-2. The strategies of Case C are quantitatively and qualitatively argued about their applicability to sustainable HAB in HCMC through actual contexts of the ten cases of HAB presented in Chapter Four. The result of argument may be applicable, inapplicable or revised strategies. Strategies of the Case A & B are analyzed merely in quantitative aspect for reviewing and arguing the popular extent of them in the newly referred strategies.

Finally, all the strategies are finalized through summarizing the analysis in which the applicable, inapplicable or revised strategies are presented. The inapplicable strategies are deleted and the remained strategies are the final strategies applicable to sustainable HAB in HCMC.

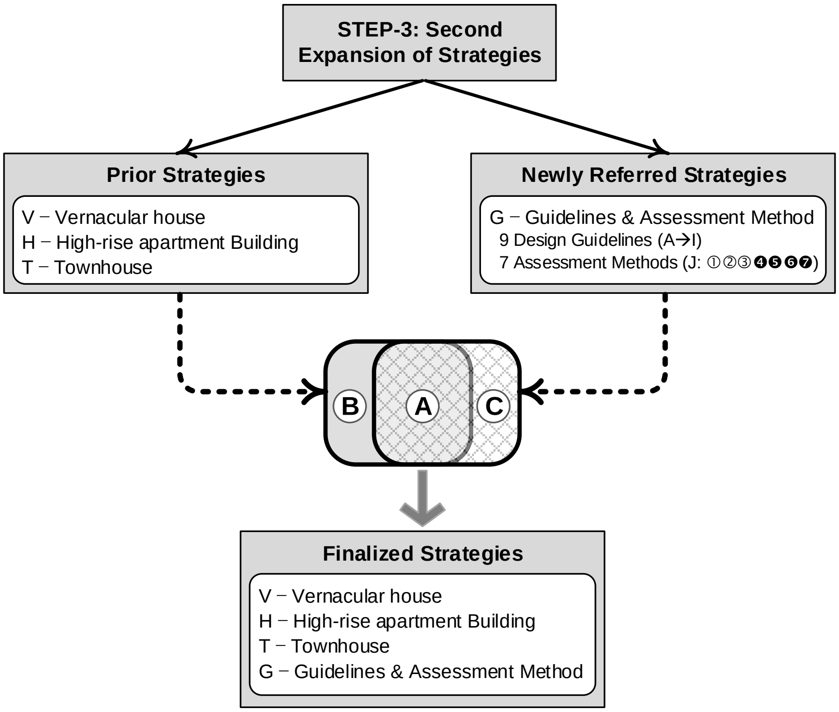



Figure 5-1 Analysis diagram of Step-3

### 5.2.3 Description of Guidelines Selection

Nine guidelines are selected and conducted the analysis. The selection of design guidelines highlights fundamentally on the sustainable HAB in tropical humid climate. Many design guidelines, however, cover the varied scale of sustainable houses rather than merely focus on the sustainable HAB. The coverage of selected guidelines, thus, is extended to a wider area that is associated with the main concern.  The nine guidelines (A-I) are selected with coverage fallen into four terms, including sustainable building, tropical climate, housing, high-rise apartments (Table 5-1). In addition, for those having coverage out of the sustainable HAB, only strategies designed for sustainable HAB are chosen. Five of the nine selected guidelines are conducted in-depth analysis in Section 6.2.3. All criteria of seven selected assessment methods indicated in Table 2-14 in Section 2.3.3.4 are presented as the tenth system with sign 'J' (Table 5-1).

Table 5-1 List of selected guidelines for analysis

| No. | Sign | Guidelines Title | Scope | | | |
|---|---|---|---|---|---|---|
| | | | **General Building** | **Housing** | **High-rise Apartment** | **Tropical Zone** |
| 1 | **A** | The State of Minnesota Sustainable Building Guidelines (Version 2.2)[199] | ✓ | ○ | ○ | |
| 2 | **B** | Designing for Sustainability in the Highlands – The highland council[200] | ✓ | ○ | | |
| 3 | **C** | City of Cape Town Smart Building Handbook[201] | ✓ | ○ | ○ | |
| 4 | **D** | Sustainable Housing Design Guide for Scotland[202] | | ✓ | | |

[199] Downloaded from [*http://www.b3mn.org/guidelines/downloads_v2_2/B3GuidelinesVersion2.2.pdf*] on 07th Jun 2015

[200] Downloaded from [*http://cairngorms.co.uk/resource/docs/publications/01052009/CNPA.Paper.1290.General%20housing%20land%20supply%20-%20objector%20ref%20387%20-%20part%204%20-%20written.pdf*] on 07th Jun 2015

[201] Downloaded from [*https://www.capetown.gov.za/en/EnvironmentalResourceManagement/Documents/Smart-Building-Handbook_2012-06.pdf*] on 07th Jun 2015

| No. | Sign | Guidelines Title | Scope | | | |
|---|---|---|---|---|---|---|
| | | | General Building | Housing | High-rise Apartment | Tropical Zone |
| 5 | **E** | Hugh L. Carey Battery Park City Authority Residential Environmental Guidelines[203] | | ○ | ✓ | |
| 6 | **F** | SeaGreen – Greening Seattle's Affordable Housing[204] | | ✓ | ○ | |
| 7 | **G** | San Mateo Countywide Guide – Sustainable Buildings[205] | | ○ | ✓ | |
| 8 | **H** | Multifamily Green Building Guidelines[206] | | ○ | ✓ | |
| 9 | **I** | Eco-housing Guidelines for Tropical Regions[207] | | ✓ | | ✓ |
| 10 | **J** | Criteria from seven selected assessment methods (In Section 2.3.3.4) | | ○ | ○ | ○ |
| Note: [✓] : the primary scope; [○] : included scope | | | | | | |

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202 Downloaded from [*http://www.gov.scot/Resource/Doc/1125/0085460.pdf*] on 07th Jun 2015

203 Downloaded from [*http://www.batteryparkcity.org/pdf_n/BPCA_GreenGuidelines.pdf*] on 07th Jun 2015

204 Downloaded from [*http://www.seattle.gov/housing/seagreen/SeaGreen.pdf*] on 07th Jun 2015

205 Downloaded from [*http://www.recycleworks.org/pdf/GB-guide-2-23.pdf*] on 07th Jun 2015

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207 Downloaded from [*http://www.rrcap.ait.asia/Publications/eco-housing-unep.pdf*] on 07th Jun 2015

## 5.3 Comparative Analysis and Findings

### 5.3.1 Expansion of Strategies Process

For analyzing logically, all the criteria and strategies in selected guidelines and assessment methods are reclassified to match with the topic categories and strategies of the prior strategies (those gained from Step-2). As a result, the topic areas and strategies gained from Step-2 (those of Case A and B) with additional new strategies (those of Case C) which are marked with shade filled. All compared elements are presented in Table 5-2.

Table 5-2 Step-3: Expansion of strategies

| No. | Code | Strategy | References | | | | | | | | | | Assessment System References | Case of Analysis | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | D | E | F | G | H | I | J | | | |
| **A- Neighborhood Formation** | | | | | | | | | | | | | | | |
| | | **A1 Community Connectivity** | | | | | | | | | | | | | |
| 01 | A1.1.Ha | Locate a site in walking distance to many community services and amenities | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ❺, ❻, ❼ | **A** | |
| 02 | A1.1.Hb | Locate a site in walking distance to public transit stops (bus stop and urban rail station) | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ❺, ❻, ❼ | **A** | |
| 03 | A1.2.H | Incorporate space for community involvement within project by providing dedicated community facilities flexible for varied activities (e.g. recreational facilities, meeting room, childcare facilities, gardens) | - | ✓ | - | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ❼ | **A** | |
| 04 | **A1.3.G** | Include a range of different housing types and sizes to accommodate residents of differing age, income, ethnicity and physical ability | - | ✓ | - | ✓ | - | - | - | ✓ | - | | | **C** | |
| | | **A2 Collective Participation** | | | | | | | | | | | | | |
| 05 | A.2.1.H | Involve local residents in the design process from an early stage through events such as public notification and consultation meeting | ✓ | ✓ | - | ✓ | ✓ | - | - | ✓ | ✓ | ✓ | ③, ❻, ❼ | **A** | |
| 06 | **A2.2.G** | Create an integrated approach to the design process by involving key design team members, users, occupants and operators | ✓ | - | - | ✓ | - | - | - | - | ✓ | | ❻, ❼ | **C** | |
| **B- Natural Vegetation Preservation** | | | | | | | | | | | | | | | |
| | | **B1 Vegetation Enhancement** | | | | | | | | | | | | | |
| 07 | B1.1.V | Preserve the site with existing and adapted vegetation | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ②, ③, ❹, ❺, ❻, ❼ | **A** | |
| 08 | B1.2.V | Enhance vegetated open space and biodiversity | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | ①, ②, ③, ❻, ❼ | **A** | |
| | | **B2 Land Use Optimization** | | | | | | | | | | | | | |
| 09 | B2.1.H | Optimize the layout and reduce the development footprint to save land and natural resources, and preserve open space | ✓ | ✓ | - | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ② | **A** | |

| No. | Code | Strategy | References | | | | | | | | | | Assessment System References | Case of Analysis | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | D | E | F | G | H | I | J | | | |
| 10 | **B2.2.G** | In site selection, avoid building on environmentally, culturally, and socially sensitive sites. | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ | ✓ | ✓ | ①, ②, ③, ❺, ❻, ❼ | **C** | |
| 11 | **B2.3.G** | Rehabilitate a brownfield or previously occupied site | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | ✓ | ✓ | ✓ | ①, ②, ❺, ❻, ❼ | **C** | |
| 12 | **B2.4.G** | Reuse and refurbish site with existing buildings | - | ✓ | - | ✓ | - | - | ✓ | ✓ | | ✓ | ❺ | **C** | |
| **C- Climatic Response** | | | | | | | | | | | | | | | |
| | | **C1 Building Orientation** | | | | | | | | | | | | | |
| 13 | C1.1.H | Optimizing the building orientation for maximizing the number of apartments facing south for taking advantage of solar shading and prevailing winds | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ❼ | **A** | |
| | | **C2 Buffer Space** | | | | | | | | | | | | | |
| 14 | C2.1.T | Incorporate the buffer space as veranda, balcony or loggia space for preventing interior space from direct sunlight and heavy rainfalls | - | - | - | - | - | - | - | - | - | - | | **B** | |
| 15 | C2.1.Ha | Provide buffer spaces like staircases, lifts, store, toilets, etc., on majority of the west wall | - | - | - | - | - | - | - | - | ✓ | | | **A** | |
| | | **C3 Shading Devices** | | | | | | | | | | | | | |
| 16 | C3.1.V | Incorporating exterior shading devices (e.g. overhangs, screens, and louvers) | - | ✓ | - | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ❺ | **A** | |
| 17 | C3.2.T | Install an occupant-controlled shading system on all windows, glazed doors and roof lights in regularly occupied spaces | ✓ | - | - | ✓ | - | - | ✓ | ✓ | - | ✓ | ❻ | **A** | |
| | | **C4 Lightweight and Insulated Envelope** | | | | | | | | | | | | | |
| 18 | C4.1.V | Use lightweight structures for building envelope | - | - | - | - | - | - | - | - | ✓ | - | | **A** | |
| 19 | C4.2.Ha | Provision of thermal insulation on building envelope (e.g. walls and roof) | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ③, ❹, ❺, ❻, ❼ | **A** | |
| 20 | C4.2.Hb | Provision of two-layer roof | - | - | - | - | - | - | - | - | - | - | | **B** | |
| 21 | C4.2.Hc | Use of thermal insulation on the east and west facing external walls | - | - | - | - | - | - | - | - | - | ✓ | ❹ | **A** | |
| 22 | C4.2.Hd | Select windows and exterior glazing assemblies with thermally broken frames and insulated spacers, and with appropriate low-e coating | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ❺ | **A** | |

| No. | Code | Strategy | References | | | | | | | | | | Assessment System References | Case of Analysis | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | D | E | F | G | H | I | J | | | |
| 23 | **C4.3.G** | Stop air leakage at doors, windows, wall/slab junctions, mechanical openings, and other assemblies penetrating the building envelope for air, thermal, and water barriers | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ❻, ❼ | **C** | |
| 24 | **C4.4.G** | Provision of vertical greenery system on building facades abutting the living, dining and bedrooms areas of dwelling units | - | - | - | - | - | - | - | - | - | ✓ | ❹ | **C** | |
| 25 | **C4.5.G** | Install a vegetated roof on large portion of roof area | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ③, ❹, ❺, ❻, ❼ | **C** | |
| | **C5 Climatically Responsive Landscape** | | | | | | | | | | | | | | |
| 26 | C5.1.H | Plan the landscaping to work with the site microclimate (e.g. shading, ventilation, and daylighting) | - | ✓ | - | - | - | ✓ | - | - | - | - | | **A** | |
| | **C6 Solar Heat Reflectance** | | | | | | | | | | | | | | |
| 27 | C6.1.T | Provision of light color textures and rough textures for building external facades | - | - | - | - | - | - | - | - | ✓ | | | **A** | |
| 28 | C6.1.Ha | Use of cool paints on the east and west facing external walls | - | - | - | - | - | - | - | - | - | ✓ | ❹ | **A** | |
| 29 | C6.2.T | Provision of light color and rough textures for building roofing materials | ✓ | - | ✓ | - | ✓ | - | ✓ | ✓ | ✓ | ✓ | ①, ③, ❺, ❼ | **A** | |
| 30 | C6.3.H | Use light-colored and heat-reflective hardscapes | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ③, ❺, ❻, ❼ | **A** | |
| 31 | **C6.4.G** | Provide shade from a tree canopy, solar panels structures or solar reflective architectural structures | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ❺, ❻, ❼ | **C** | |
| **D- Exploitation of Renewable Energy** | | | | | | | | | | | | | | | |
| | **D1 Space composition** | | | | | | | | | | | | | | |
| 32 | D1.1.H | If necessary, incorporate skywell as a place to exploit energy from nature in forms of daylighting and air movement | - | - | - | - | - | - | - | - | - | - | | **B** | |
| | **D2 Natural Ventilation** | | | | | | | | | | | | | | |
| 33 | D2.1.H | In each apartment unit, arrange the openings in opposite sides and interior doors to facilitate the cross ventilation | - | - | - | - | - | - | - | - | - | - | | **B** | |
| 34 | D2.2.H | Enhance stack ventilation by increasing the height of the skywell if necessary | - | - | - | - | - | - | - | - | - | - | | **B** | |
| 35 | D2.3.H | Incorporate the controllable slits and openings to doors, windows, walls, and | - | - | - | - | - | - | - | - | - | - | | **B** | |

| No. | Code | Strategy | References | | | | | | | | | | Assessment System References | Case of Analysis | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | D | E | F | G | H | I | J | | | |
| | | partitions to enhance the air circulation across spaces | | | | | | | | | | | | | |
| 36 | ~~D2.4.V~~ | ~~Use hipped roof type to enhance the stack ventilation~~ | - | - | - | - | - | - | - | - | - | - | | B | Inapplicable as analysis in Step-2 |
| 37 | D2.5.T | Use operable windows for cross ventilation in combination with mechanical ventilation systems (e.g., ceiling/wall-mounted fans, exhaust fans) | - | - | - | - | - | ✓ | ✓ | ✓ | ✓ | | | A | |
| 38 | D2.6.T | Take into account security, noise and dust concerns when providing natural ventilation | - | - | - | - | - | - | - | ✓ | - | | | A | |
| 39 | D2.7.H | All public and circulation spaces and large portion of habitable rooms to be provided with cross and/or stack natural ventilation | - | ✓ | - | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ③, ❹, ❺, ❻ | A | |
| 40 | D2.8.H | Replace air conditioning with natural ventilation including common areas and habitable spaces | - | - | ✓ | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | ❼ | A | |
| 41 | **D2.9.G** | Design car-parking facilities with natural ventilation or mechanical ventilation with demand controls through sensor | - | - | - | - | - | - | - | ✓ | - | | | C | |
| | | **D3 Daylighting** | | | | | | | | | | | | | |
| 42 | D3.1.Ha | Selecting appropriate glazed size for daylighting and avoiding excessive illumination levels inside the building | - | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ❺ | A | |
| 43 | D3.1.Hb | Use appropriate double-glazed units with Low-e glass, or glass coatings | - | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ❺ | A | |
| 44 | D3.2.T | Use floor surface and light shelves for increasing the penetration of daylight | - | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | | A | |
| 45 | D3.2.Ha | Avoid glare in daylighting strategies and use textured/rough surfaces to diffuse the reflected daylight for reducing glare | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ③, ❻ | A | |
| 46 | D3.3.H | Planning landscape and the building blocks for working as reflectors diffusing daylighting | - | ✓ | - | - | - | - | - | - | - | - | | A | |
| 47 | D3.4.T | Use high reflectance (light color) of internal finishes for lighting penetration enhancement | - | - | - | ✓ | - | ✓ | - | ✓ | ✓ | | | A | |
| 48 | D3.5.H | Daylighting for all public and circulation spaces and the large portion of habitable rooms | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ❺, ❼ | A | |
| 49 | **D3.6.G** | Increase minimum size of habitable rooms, | - | - | - | - | ✓ | - | - | - | - | ✓ | ③ | C | |

| No. | Code | Strategy | References | | | | | | | | | | Assessment System References | Case of Analysis | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | D | E | F | G | H | I | J | | | |
| | | increase floor-to-ceiling heights and decrease distance of habitable spaces from windows | | | | | | | | | | | | | |
| 50 | **D3.7.G** | Planning interior partitions and furniture that avoids blocking daylight | - | - | - | - | - | ✓ | - | - | - | - | | C | |
| | | **D4 Occupant Controllability** | | | | | | | | | | | | | |
| 51 | D4.1.V | Use flexible occupant-controlled openings (doors and windows) in regularly occupied spaces for natural ventilation and daylighting control | ✓ | ✓ | - | ✓ | ✓ | - | ✓ | - | - | ✓ | ①, ❻ | A | |
| 52 | D4.2.T | Provision of interior sunlight control elements (e.g., curtain, drapes, blinds, adjustable louvers) | - | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | | | A | |
| | | **D5 Using Renewable Energy** | | | | | | | | | | | | | |
| 53 | **D5.1.G** | Install on-site renewable energy generation systems (solar photovoltaic, wind turbines, biomass) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ②, ③, ❹, ❺, ❻, ❼ | C | |
| 54 | **D5.2.G** | Purchase power from energy providers that utilize renewable sources to generate power. | - | - | - | - | ✓ | ✓ | - | - | - | ✓ | ①, ② | C | |
| 55 | **D5.3.G** | Use solar water heating system for supplementing common water heating needs | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ③, ❼ | C | |
| 56 | **D5.4.G** | Use solar hot-water systems for space heating | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | ✓ | ✓ | ✓ | ❺ | C | |
| 57 | **D5.5.G** | Use geothermal systems, cogeneration, or other alternatives for heating and cooling | ✓ | ✓ | - | ✓ | - | - | ✓ | ✓ | - | ✓ | ③ | C | |
| **E - Water Conservation** | | | | | | | | | | | | | | | |
| | | **E1 Minimizing Water Use** | | | | | | | | | | | | | |
| 58 | E1.1.V | Landscaping with native and indigenous vegetation | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ③, ❹, ❺, ❼ | A | |
| 59 | **E1.2.G** | Water efficient irrigation systems | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ①, ③, ❹, ❻, ❼ | C | |
| 60 | **E1.3.G** | Cluster plants with similar water needs ("water-use" zones) | - | - | - | - | - | ✓ | - | ✓ | - | - | | C | |
| 61 | **E1.4.G** | Use water-conserving plumbing fittings and fixtures (e.g. faucets, showerheads, water closets, and urinals) and water-saving appliances (e.g. dishwasher and washing machine) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ②, ③, ❹, ❺, ❻, ❼ | C | |
| 62 | **E1.5.G** | Use site-reclaimed water (non-potable water) for landscape irrigation, or toilet flushing, or cooling tower | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ❺, ❻, ❼ | C | |

| No. | Code | Strategy | References | | | | | | | | | | Assessment System References | Case of Analysis | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | D | E | F | G | H | I | J | | | |
| | | **E2 Water Reuse** | | | | | | | | | | | | | |
| 63 | E2.1.V | Collecting and storing rainwater for later use | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ②, ③, ❺, ❻, ❼ | **A** | |
| 64 | **E2.2.G** | Use ecology-based treatment (wetland treatment) processes (i.e. ultrafiltration) for sewage treatment or reclaimed water treatment if site' space allows | - | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | | | **C** | |
| 65 | **E2.3.G** | Grey/black water treatment, recycling and reuse for non-portable purposes (landscape irrigation and flushing toilets and urinals) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ②, ❺, ❻, ❼ | **C** | |
| | | **E3 Stormwater Runoff Infiltration** | | | | | | | | | | | | | |
| 66 | E3.1.H | Use permeable/pervious paving materials or open grid pavement system for hardscapes | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ②, ③, ❺, ❼ | **A** | |
| 67 | E3.2.H | Use swales, soak-ways, and holding ponds | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ②, ③, ❺, ❼ | **A** | |
| 68 | E3.3.H | Design drainage systems that adequately dispose of rainwater and prevent flooding from excessive runoff, size gutters and others to allow for heavy rainfall | - | ✓ | - | - | - | - | - | - | - | - | | **A** | |
| **F- Natural Calamity Response** | | | | | | | | | | | | | | | |
| | | **F1 Flooding Prevention** | | | | | | | | | | | | | |
| 69 | F1.1.V | Locate the building on elevated position | - | ✓ | ✓ | ✓ | - | - | - | - | ✓ | ✓ | ②, ❻, ❼ | **A** | |
| 70 | ~~F1.2.V~~ | ~~Design multi-storey building with the ground storey reserved for flooding situation~~ | - | - | - | - | - | - | - | - | - | - | | **A** | Inapplicable as analysis in Step-2 |
| | | **F2 Typhoon Prevention** | | | | | | | | | | | | | |
| 71 | F2.1.H | Planning and design buildings for restriction of wind damage and storm | - | ✓ | - | ✓ | - | - | - | - | - | ✓ | ③, ❼ | **A** | |
| | | **F3 Earthquake Resistance** | | | | | | | | | | | | | |
| 72 | F3.1.H | Design building structures for earthquake resistance | - | - | - | - | - | - | - | - | - | ✓ | ③, ❼ | **A** | |
| **G- Eco-Friendly Material** | | | | | | | | | | | | | | | |
| | | **G1 Local Materials** | | | | | | | | | | | | | |
| 73 | G1.1.T | Use local/regional materials | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ③, ❹, ❺, ❼ | **A** | |
| | | **G2 Reuse and recycling of materials and components** | | | | | | | | | | | | | |
| 74 | G2.1.H | Reuse/renovate a building by maintain existing building structure, walls, floors, and roof roof | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | - | ✓ | ✓ | ①, ②, ③, ❺, ❻, ❼ | **A** | |
| 75 | G2.2.V | Reuse building nonstructural components (e.g. doors, windows, panels) | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | - | ✓ | ✓ | ①, ②, ③, ❺, ❻, ❼ | **A** | |

| No. | Code | Strategy | References | | | | | | | | | | Assessment System References | Case of Analysis | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | D | E | F | G | H | I | J | | | |
| 76 | G2.3.V | Use reusable, recyclable materials | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ③, ❻ | A | |
| 77 | G2.4.V | Use the reused, refurbished, and salvaged materials | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ②, ③, ❹, ❺, ❻, ❼ | A | |
| 78 | G2.5.V | Use materials with appropriate durability | ✓ | ✓ | - | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | ③ | A | |
| 79 | **G2.6.G** | Use recycled materials or materials with recycled content (e.g., recycled-content drywall, acoustical ceiling tiles, insulation, latex paint, landscape elements) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ②, ③, ❹, ❺, ❻, ❼ | C | |
| 80 | **G2.7.G** | Design and select materials for simple and self-evident care and maintenance | - | ✓ | - | ✓ | - | - | - | - | - | | ③ | C | |
| 81 | **G2.8.G** | Use certified wood/timber | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ❺, ❻, ❼ | C | |
| **G3 Disassemblable Building Components** | | | | | | | | | | | | | | | |
| 82 | ~~G3.1.V~~ | ~~Design for easy disassembling and reassembling of building components~~ | - | ✓ | - | ✓ | - | - | - | ✓ | ✓ | ✓ | ③ | A | Inapplicable as analysis in Step-2 |
| 83 | **G3.2.G** | Inform early building assembly material choices using life cycle assessment of material alternatives | ✓ | ✓ | - | ✓ | - | - | - | ✓ | - | | | C | |
| **G4 Rapidly Renewable Materials** | | | | | | | | | | | | | | | |
| 84 | ~~G4.1.V~~ | ~~Use natural/organic materials for building structures~~ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ①, ❻, ❼ | A | Inapplicable as analysis in Step-2 |
| 85 | G4.2.V | Use natural/organic materials for building nonstructural elements | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ①, ❻, ❼ | A | |
| 86 | G4.3.V | Use natural/organic materials for furnishings | ✓ | ✓ | ✓ | ✓ | ✓ | - | | ✓ | ✓ | ✓ | ①, ❻, ❼ | A | |
| **G5 Low-Emitting Materials** | | | | | | | | | | | | | | | |
| 87 | G5.1.T | Select timbers that use non-toxic methods to treat timber decay, insect attack and other rot problems, avoid toxic chemical treatment of timber where possible | - | ✓ | - | ✓ | - | ✓ | - | - | - | - | | A | |
| 88 | G5.1.Ta | Reduce formaldehyde emissions in composite and wood-based products (cabinets, interior trim, shelving, subflooring and others) | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ❺, ❼ | A | |
| 89 | **G5.2.G** | Use recycled-content, formaldehyde-free fiberglass insulation, cellulose insulation, or other green insulation products | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ❺ | C | |
| 90 | **G5.4.G** | Specify low and zero-VOC interior paints, stains and other coatings | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ❺, ❻, ❼ | C | |
| 91 | **G5.5.G** | Use flooring systems ( e.g. carpet systems, | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ❺, ❻, ❼ | C | |

| No. | Code | Strategy | References | | | | | | | | | | Assessment System References | Case of Analysis | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | D | E | F | G | H | I | J | | | |
| | | concrete, wood, tile floor finishes) that emit low levels of VOCs | | | | | | | | | | | | | |
| | | **G6 Low Embodied Energy Materials** | | | | | | | | | | | | | |
| 92 | **G6.1.G** | Minimize the use of highly processed materials such as metals, concretes and plastics, alternately use low embodied energy materials (e.g., certified timber, raw materials) | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | - | ✓ | | | **C** | |
| 93 | **G6.2.G** | Use non-baked materials for non-structural walls | - | - | - | - | - | - | - | - | - | ✓ | ❼ | **C** | |
| 94 | **G6.3.G** | Design for flexibility and adaptability to future changes in building use (e.g., layout, building structures) | - | ✓ | - | ✓ | - | ✓ | - | ✓ | ✓ | ✓ | ②; ③ | **C** | |
| **H- Occupants' Comfort Perception** | | | | | | | | | | | | | | | |
| | | **H1 Thermal Comfort** | | | | | | | | | | | | | |
| 95 | H1.1.V | Elevated ground floor for humidity prevention | - | - | - | - | - | - | - | - | - | - | | **B** | |
| 96 | **H1.2.G** | Proper indoor ventilation rate for mechanically ventilated spaces (at least meet the local building code) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ①, ❺, ❼ | **C** | |
| | | **H2 Vision Comfort** | | | | | | | | | | | | | |
| 97 | H2.1.V | Provision of views to the outdoor environment | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ①, ❺, ❻ | **A** | |
| 98 | H2.2.T | Use indoor planting beds in communal areas for interior decoration and air quality improvement | - | - | - | ✓ | - | - | - | - | - | | | **A** | |
| | | **H3 Acoustic Comfort** | | | | | | | | | | | | | |
| 99 | H3.1.T | Provide an effective level of acoustic insulation within buildings | ✓ | - | ✓ | ✓ | - | - | - | ✓ | ✓ | ✓ | ②, ③, ❹, ❺, ❼ | **A** | |
| 100 | **H3.2.G** | Noise pollution reducing | ✓ | ✓ | - | ✓ | - | - | - | ✓ | ✓ | | | **C** | |
| 101 | **H3.3.G** | Reduce vibration in buildings | ✓ | - | - | ✓ | - | - | - | ✓ | ✓ | | | **C** | |
| 102 | **H3.4.G** | Positive soundscapes | - | ✓ | - | ✓ | - | - | - | - | - | | | **C** | |
| **I- Waste & Pollution Reduction** | | | | | | | | | | | | | | | |
| | | **I1 Collection of Recyclables** | | | | | | | | | | | | | |
| 103 | I1.1.H | Provide a centralized and easily accessible space for collection and storage of recyclables on each floor and for entire building | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ❺, ❻, ❼ | **A** | |
| 104 | **I1.2.G** | Recycle/compost landscape and/or organic | - | ✓ | ✓ | ✓ | - | - | - | ✓ | ✓ | ✓ | ❺ | **C** | |

| No. | Code | Strategy | References | | | | | | | | | | Assessment System References | Case of Analysis | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | D | E | F | G | H | I | J | | | |
| | | waste and incorporate compost to promote healthy topsoil in landscaping | | | | | | | | | | | | | |
| **I2 Alternative Transportation** | | | | | | | | | | | | | | | |
| 105 | I2.1.H | Provide favorable bicycle lanes and secure and easily accessible bicycle storage/parking on the site | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ①, ❺, ❻ | **A** | |
| 106 | I2.2.H | Provide favorable public or private walkway and pedestrian-friendly amenities that meet the multiple needs | - | ✓ | - | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ❺, ❻ | **A** | |
| 107 | I2.3.H | Locate preferred parking, bicycle parking, pick-up areas, and covered waiting spaces within close proximity of the main building entrances | ✓ | ✓ | - | ✓ | - | ✓ | ✓ | - | ✓ | ✓ | ❻ | **A** | |
| 108 | I.2.4.H | Provide limited parking capacity to meet but not exceed minimum local zoning requirements | ✓ | ✓ | - | ✓ | - | ✓ | - | ✓ | - | ✓ | ①, ❻ | **A** | |
| 109 | **I.2.5.G** | Provide an amount of preferred parking spots for high-performance hybrid vehicles (low-emitting and fuel efficient models) | ✓ | - | - | - | ✓ | - | - | - | - | ✓ | ①, ❻ | **C** | |
| 110 | **I.2.6.G** | Provide public transport information and assistance for residents including routes and schedules in an obvious and accessible location | - | - | - | | - | - | - | ✓ | - | ✓ | ❼ | **C** | |
| **I3 Pollutant Sources Control** | | | | | | | | | | | | | | | |
| 111 | I.3.1.H | Provide removable entryway mats, walk-off grilles at the interior of all building entrances to capture potential contaminants and dirt | - | - | - | - | ✓ | - | - | ✓ | - | ✓ | ①, ❻ | **A** | |
| 112 | I.3.2.H | Prohibit smoking in all common areas of the building except in designated smoking areas | ✓ | - | - | - | - | ✓ | - | ✓ | ✓ | ✓ | ①, ❻, ❼ | **A** | |

### 5.3.2 Analysis and Findings

This section conducts quantitatively and qualitatively the analysis based on the results presented in Table 5-2.

#### 5.3.2.1 Neighborhood Formation (A)

**a. Community Connectivity (A1)**

Case A involves three strategies, including A1.1.Ha, A1.1.Hb, and A1.2.H. Of which, A1.1.Ha and A1.1.Hb are well presented in both guidelines and assessment methods while the A1.2.H are mostly highlighted in selected guidelines.

Case C includes one strategy A1.3.G.

*[A1.3.G] Include a range of different housing types and sizes to accommodate residents of differing age, income, ethnicity and physical ability*

This strategy encourages the community connectivity by diversifying housing types and the residents. This strategy is not a universal strategy since only referred in three guidelines. Regards to HCMC context, since the residential projects in HCMC are small scale and disconnected due to the planning fashion. The application of this strategy is likely weak. The scale of this strategy indicates either the macro planning such as a mixture of high-rise and low-rise apartment buildings, townhouses and villas, and micro scale of apartment units such as the varied sizes of apartment units. This strategy should be encouraged in the context of losing the traditionally social connection in many neighborhoods in HCMC.

**b. Collective Participation (A2)**

Case A have only one strategy A2.1.H. This strategy is well presented in the guidelines while merely presented in three assessment methods.

Case C have only one strategy A2.2.G.

*[A2.2.G] Create an integrated approach to the design process by involving key design team members, users, occupants and operators*

This strategy highlights the implementing integrated design or the collective participation in the design process. The integrated approach has been a critical problem of the designing fashion, generally in Vietnam and particularly in HCMC. The actual works show that the architects, civil engineers, M&E technical engineers are often loosely interaction within a project. In the context of HCMC under constructing many HAB, the integrated design is important for professionals contributing the high-quality buildings. Therefore, this strategy has a high potential in actual practices though its appearance is modest in the guidelines and assessment methods.

### 5.3.2.2 Natural Vegetation Preservation (B)

#### a. Vegetation Enhancement (B1)

Case A includes two strategies, B1.1.V & B1.2.V. The two strategies are greatly presented in the guidelines and assessment methods, which imply that B1.1.V and B1.2.V are the two universal strategies.

#### b. Land Use Optimization (B2)

Case A have one strategy B2.1.H which is universal in the guidelines but only assessment methods reveal it.

Case C involves three strategies, including B2.2.G, B2.3.G, and B2.4.G

*[B2.2.G] In site selection, avoid building on environmentally, culturally, and socially sensitive sites.*

This strategy is universal in the guidelines and assessment methods. This strategy highlights the prevention of using the valuable lands for constructing buildings, such as green/open space, cultural/historical sites, or wetlands. This issue is specifically critical in the context of HCMC when the improper expansion of development has broken down many cultural and historical sites or encroached on wetlands causing flooding in the urban area. This strategy, thus, should be inputted in the proposed framework.

*[B2.3.G] Rehabilitate a brownfield or previously occupied site*

*[B2.4.G] Reuse and refurbish site with existing buildings*

Of the two strategies, B2.3.G and B2.4.G, the B2.3.G is more common and well presented in the guidelines and assessment methods. The two strategies stress the encouragement of using the used or polluted site for constructing the new buildings. The polluted sites need to be treated before using. These two strategies are the solution of the above strategy B.2.2.G. In the context of HCMC having the largely old urban area, the reusing and recovering and improving the old site are critically necessary rather than occupying the brand new areas. By these reasons, the two strategies are necessary for planning and designing HAB in HCMC.

### 5.3.2.3 Climatic Response (C)

#### a. Building Orientation (C1)

Case A has only one strategy C1.1.H which is well presents in the guidelines.

#### b. Buffer Space (C2)

Case A has one strategy C2.1.Ha that is presented in only one guideline for tropical region

Case B has one strategy C2.1.T that derives from Vietnamese vernacular houses and townhouses. It is applicable though not presented in any guidelines or assessment methods.

### c. Shading Devices (C3)

Case A includes two strategies C3.1.V and C3.2.T about using shading devices and occupant controlling of the system which are also quite preferred in the selected guidelines.

### d. Lightweight and Insulated Envelope (C4)

Case A comprises four strategies, including C4.1.V, C4.2.Ha, C4.2.Hc, and C4.2.Hd. C4.2.Ha and C4.2.Hd are well presented in the guidelines while the rest two strategies appear in only one system.

Case B have one strategy C4.2.Hb which derives from Vietnamese vernacular house and revised for enabling to be applicable to HAB.

Case C has three strategies, including C4.3.G, C4.4.G, and C4.5.G.

*[C4.3.G] Stop air leakage at doors, windows, wall/slab junctions, mechanical openings, and other assemblies penetrating the building envelope for air, thermal, and water barriers*

The minimized penetration of air in the building envelope offers the efficiency in controllability of the ventilation and air-conditioning methods in interior space which results in energy efficiency. In the hot climate as HCMC, the leakage of air leads to the heat gain which bring about the losing energy for cooling that amount of heat gain. This strategy, thus, is appropriate for HAB in HCMC.

*[C4.4.G] Provision of vertical greenery system on building facades abutting the living, dining and bedrooms areas of dwelling units*

The provision of vertical greenery system on building facades enhances the insulated envelopes and shading devices while offers more vegetated area to the city. This strategy is appropriate in the context of hot weather and the shortage of greenery area of HCMC.

*[C4.5.G] Install a vegetated roof on large portion of roof area*

This strategy strengthens the strategy C4.2.Hb, the two-layer roof. The provision of vegetated roof offers the insulated roof, reflective surface while enhancing vegetated areas. This strategy is highly applicable to HAB in HCMC.

**e. Climatically Responsive Landscape (C5)**

There is only one strategy C5.1.H of Case A about using landscape supporting the site microclimate. This strategy is appropriate as discussed in the Step-2 although only two of selected guidelines refer this strategy.

**f. Solar Heat Reflectance (C6)**

Case A includes four strategies, C6.1.T, C6.1.Ha, C6.2.T, and C6.3.H, of which the strategies of C6.1.T and C6.1.Ha are low reference in selected guidelines. However, these strategies is necessary and applicable in HCMC as discussed in Step-2.

Case C includes one strategy, C6.4.G.

*[C6.4.G] Provide shade from a tree canopy, solar panels structures or solar*

*reflective architectural structures*

The strategy is necessary for enhancing the reflectance of solar heat, in the climatic context of HCMC. The shading from tree canopy, solar panels or reflective surface will replace common surfaces by reflective surfaces or energy generation surfaces. Therefore, the C6.4.G is appropriate for HCMC.

#### 5.3.2.4 Exploitation of Renewable Energy (D)

**a. Space composition (D1)**

Case B has one strategy D1.1.H. Although no guidelines and assessment methods refers the strategy D1.1.H, since the vernacular houses and contemporary houses show the advantages of the application the skywell, this strategy is applicable. Although the incorporating skywell to high-rise building has many disadvantages such as fire safety, polluted air and noise, this strategy can be acceptable in cases of low-price or social apartment buildings in which the compacted floor plan is often used.

**b. Natural Ventilation (D2)**

Case A includes four strategies, comprising D2.5.T, D2.6.T, D2.7.H, and D2.8.H, of which D2.7.H and D2.8.H are quite presented by the systems.

Case B has four strategies, including D2.1.H, D2.2.H, D2.3.H, and D.2.4.V, in which D.2.4.V is argued to be inapplicable in the Step-2. The former three strategies are not mentioned in the selected guidelines and assessment methods that often mention in general strategies rather than in detailed strategies. However, the three former strategies are applicable in the cases of HCMC high-rise apartment as discussed in the Step-2.

Case C comprises one strategy D2.9.G.

*[D2.9.G] Design car-parking facilities with natural ventilation or mechanical ventilation with demand controls through sensor*

The car-parking facilities are often polluted and high risk of fire in the non-ventilated air. Therefore, the ventilation is necessary. The natural ventilation is the best solution, combined with the mechanical ventilation with the sensor checking the polluted degree and appropriately adjusting the fans.

**c. Daylighting (D3)**

Case A includes seven strategies, including D3.1.Ha, D3.1.Hb, D3.2.T, D3.2.Ha, D3.4.H, D3.5.T, D3.6.H. Of which, D3.1.Ha, D3.1.Hb, D3.2.T, D3.2.Ha, and D3.5.H are well presented in the guidelines while strategies D3.3.H and D3.4.T are not largely referred.

Case C includes two strategies: D3.6.G and D3.7.G.

*[D3.6.G] Increase minimum size of habitable rooms, increase floor-to-ceiling heights and decrease distance of habitable spaces from windows*

*[D3.7.G] Planning interior partitions and furniture that avoids blocking daylight*

Since side windows are the principal daylighting sources of apartment units, penetration of daylighting into interior space can be enhanced by increasing the room size and height, and decreasing the distance of habitable spaces from windows (D3.7.G). Besides, the arrangement of partition in interior space affects the depth of the daylighting. Therefore, the two strategies are applicable for this term.

**d. Occupant Controllability (D4)**

Case A has two strategies that are discussed to be applicable in Step-2. These two are also well referred in the selected guidelines.

**e. Using Renewable Energy (D5)**

There are only strategies in Case C in this term with five strategies, including D5.1.G, D5.2.G, D5.3.G, D5.4.G, and D5.5.G.

*[D5.1.G] Install on-site renewable energy generation systems (solar photovoltaic, wind turbines, biomass)*

*[D5.2.G] Purchase power from energy providers that utilize renewable sources to generate power*

*[D5.3.G] Use solar water heating system for supplementing common water heating needs*

*[D5.4.G] Use solar hot-water systems for space heating*

*[D5.5.G] Use geothermal systems, cogeneration, or other alternatives for water heating and space cooling*

Of the five strategies, only strategy D5.2.G is weakly referred in selected guidelines. Since HCMC has high potentials of solar and wind energy, the exploiting the renewable energy by technology should be promoted. Most of the above strategies are partly adopting in HCMC, such as energy generation systems on-site (photovoltaic and turbines), solar water heating. However, the energy providers utilizing renewable sources do not exist in HCMC's system. Thus, the strategy D5.2.G is inapplicable. The use hot-water systems for space heating is inapplicable because the space heating is not necessary for the condition HCMC. Therefore, the strategy D5.4.G is also inapplicable. Finally, geothermal systems or other high-technology of renewable energy generation should be enhanced to adopt in HCMC for extending the alternatives of renewable energy supplemental for water heating and space cooling in HCMC. Thus, strategy D5.5.G is applicable for the condition of HCMC. In summary, except D5.2.G and D5.4.G are inapplicable the remaining strategies are applicable.

#### 5.3.2.5 Water Conservation (E)

**a. Minimizing Water Use (E1)**

Case A includes one strategy, E1.1.V, that is about landscaping with native and indigenous vegetation. This strategy is discussed to be appropriate in Step-2. All the selected guidelines also well refer this strategy.

Case C includes four new strategies, E1.2.G, E1.3.G, E1.4.G, and E1.5.G.

*[E1.2.G] Water efficient irrigation systems*

*[E1.3.G] Cluster plants with similar water needs ("water-use" zones)*

*[E1.4.G] Use water-conserving plumbing fittings and fixtures (e.g. faucets, showerheads, water closets, and urinals) and water-saving appliances (e.g. dishwasher and washing machine)*

*[E1.5.G] Use site-reclaimed water (non-potable water) for landscape irrigation, or toilet flushing, or cooling tower*

The water use can be reduced by the efficient water systems such as efficient irrigation systems, water-conserving plumbing fittings and fixtures, and water-saving appliances, which are provided in strategies E1.2.G and E1.4.G. These are the basic strategies referred in most of the selected guidelines and assessment methods. These two strategies are appropriate to HCMC since they are easy to be adopted and have been adopted in some cases of built apartment buildings. Regarding water used for landscaping, the use of water can be enhanced further by clustering plants with similar water needs. The water used could be saved further by using the grey water reclaiming systems in buildings that provide reclaimed water for the non-portable water demands of landscape irrigation, toilet flushing and cooling tower. This strategy requires reclaiming technologies that are new to the context of HCMC now, but it is popular in the developed world. Since its technology is quite simple, HAB in HCMC can apply this technology shortly. In short, all four strategies are appropriate to HCMC context in term of minimizing water use.

**b. Water Reuse (E2)**

Case A has one strategy, E2.1.V, that is well applied in the selected guidelines.

Case C has two new strategies, E2.2.G and E2.3.G.

*[E2.2.G] Use ecology-based treatment (wetland treatment) processes (i.e. ultrafiltration) for sewage treatment or reclaimed water treatment if site' space allows*

This strategy is greatly used in selected systems, focusing on treating the grey water by the ecology-based methods. This strategy is often applied in the large scale projects with the enough site area for locating a wetland area for treatment. As the apartment in HCMC's projects are getting bigger, this strategy has a high potential to apply, especially, when HCMC topography is a low-level area with many wetlands such as District 2, 7, 9, Binh Chanh, and Nha Be provinces. Therefore, this strategy has a high potential for sustainable HAB in HCMC.

*[E2.3.G] Grey/black water treatment, recycling and reuse for non-portable purposes (landscape irrigation and flushing toilets and urinals)*

This strategy proceeds the previous strategy, the E2.2.G strategy, highlighting on the using reclaimed water on the secondary water demands such as landscape irrigation, flushing toilets ad urinals. This strategy requires separate piping systems from the portable water piping system. Although this strategy is popular in the developed world through wide reference in selected systems, it has not applied yet in the ten cases and most of the HAB in HCMC. However, as the previous strategy, this strategy has a high potential for application in HAB in HCMC.

#### c. Stormwater Runoff Infiltration (E3)

This term only includes there strategies of Case A, E3.1.H, E3.2.H, and E3.3.H, which are discussed to be applicable in the Step-2. In this review, the result of guidelines reference shows that except the E3.3.H being referred by only one system, the remaining is widely referred.

### 5.3.2.6 Natural Calamity Response (F)

#### a. Flooding Prevention (F1)

Only two strategies of Case A are included in this term, F1.1.H and F.1.2.V, of which, the latter is inapplicable as resulted from Step-2. The former is quite mentioned in the selected guidelines.

#### b. Typhoon Prevention (F2)

Only one strategy of Case A, F2.1.H, is included, which is essential as discussed in Step-2 though weak referred in selected guidelines.

#### c. Earthquake Resistance (F3)

Only one strategy of Case A, F3.1.H, is included, which is essential for HAB in HCMC as discussed in Step-2 though only one set of guidelines mentions it.

### 5.3.2.7 Eco-Friendly Material (G)

#### a. Local Materials (G1)

There is only one strategy of Case A, G1.1.H, which is the applicable strategy analyzed in Step-2. This is a universal strategy as being indicated in all selected guidelines and assessment systems.

#### b. Reuse and Recycling of Materials and Components (G2)

Case A includes five strategies that are analyzed to be applicable in Step-2, G2.1.H, G2.2.V, G2.3.V, G2.4.V, and G2.5.V. The majority of selected guidelines and assessment methods use these strategies.

Case C includes three new strategies, G2.6.G, G2.7.G, and G2.8.G.

*[G2.6.G] Use recycled materials or materials with recycled content (e.g., recycled-content drywall, acoustical ceiling tiles, insulation, latex paint, landscape elements)*

This strategy is the most fundamental criterion since all the selected guidelines and assessment methods use it. This strategy is about the selecting materials with the high priority on the recycled products, it is, therefore, subject to the availability of suppliers. HCMC today have diversified materials and this strategy is appropriate guidance for designers. Thus, this strategy is highly applicable for designing HAB in HCMC.

*[G2.7.G] Design and select materials for simple and self-evident care and maintenance*

This is not a popular strategy since only two guidelines and an assessment method adopt this strategy as seen from Table 5-2. Since HAB is a high concentration residence, the design that requires less, maintenance or self-maintenance is critical for saving the labor of management and also strengthening the durability of the materials. This application results in great effects in resource and energy saving. This strategy is merely associated with the designing activities that is possible to implement in the context of HCMC. Therefore, this strategy is applicable for the proposed guidelines.

*[G2.8.G] Use certified wood/timber*

Most of the selected assessment methods and guidelines used this strategy. The certified wood or timber ensures that the wooden materials come from the planted forest with sustainable management which is far sustainable than the wood or timber from the old rain forest. In the ten cases of HAB in HCMC, a large amount of wood and timber is used in interior furnishings and finishing. However, the source of wood is often exploited from the rain forests rather than from certified sources. Therefore, this strategy is necessary for a sustainable HAB in HCMC.

**c. Disassemblable Building Components (G3)**

Case A has one strategy, G3.1.V, that is analyzed to be inapplicable to HAB in HCMC in the Step-2.

Case C has one strategy, G3.2.G.

*[G3.2.G] Inform early building assembly material choices using life cycle assessment of material alternatives*

This strategy highlights the awareness of selecting materials with concerns on its assemblability. Same as the strategy G3.1.V, the assemblability of materials is out of the capacity of HCMC built industry since the majority of HAB in HCMC is merely constructed based on the basic construction technology with on-site concrete casting rather than manufacturing in the factory and fabricating on site. This strategy, thus, is inapplicable to the context of HCMC though four selected guidelines have used it.

**d. Rapidly Renewable Materials (G4)**

The term includes three strategies of Case A, G4.1.V, G4.2.V, and G4.3.V, which are well referred in selected guidelines systems. Of the three strategies, G4.1.V is inappropriate, and the two remained strategies are applicable as discussed in Step-2.

**e. Low-Emitting Materials (G5)**

Case A includes two strategies, G5.1.T and G5.1.Ta. These strategies are discussed to be applicable in Step-2.

Case C includes three new strategies, G5.2.G, G5.4.G, and G5.5.G.

*[G5.2.G] Use recycled-content, formaldehyde-free fiberglass insulation, cellulose insulation, or other green insulation products*

*[G5.4.G] Specify low and zero-VOC interior paints, stains and other coatings*

*[G5.5.G] Use flooring systems (e.g. carpet systems, concrete, wood, tile floor finishes) that emit low levels of VOCs*

All three new strategies are about the popular potentials of emission in materials, such as VOCs and formaldehyde, which are widely required in the selected guidelines and assessment systems. Therefore, these strategies should apply to the HAB in HCMC.

**f. Low Embodied Energy Materials (G6)**

There are only three new strategies of Case C in this term, including G6.1.G, G6.2.G, and G6.3.G.

*[G6.1.G] Minimize the use of highly processed materials such as metals, concretes and plastics, alternately use low embodied energy materials (e.g., certified timber, raw materials)*

*[G6.2.G] Use non-baked materials for non-structural walls*

*[G6.3.G] Design for flexibility and adaptability to future changes in building use (e.g., layout, building structures)*

Of the three new strategies, the G6.1.G and G6.3.G are fundamental criteria and well referred in selected guidelines systems. These two strategies are thus revealed high potentials to be applied to HAB in HCMC. The remained strategy, G6.3.G, is originated from the building code of Vietnam, thus, should be applied. In short, three strategies are appropriate.

#### 5.3.2.8 Occupants' Comfort Perception (H)

**a. Thermal Comfort**

Case B includes one strategy, H1.1.V. The H1.1.V has been argued to be applicable in the Step-2 though no referred guidelines use this strategy.

Case C include one strategy, H1.2.G.

*[H1.2.G] Proper indoor ventilation rate for mechanically ventilated spaces (at least meet the local building code)*

This strategy ensures the minimum thermal comfort of interior space and promotes the natural ventilation and energy saving by maintaining the air circulation. In the hot climate of HCMC city, this strategy is highly essential.

**b. Vision Comfort**

Only two strategies of Case A in this term, H2.1.V and H2.2.T. The H2.1.V strategy is highly referred while the H2.2.T is only referred by one guideline. However, the H2.2.T strategy is essential based on the analysis in Step-2.

**c. Acoustic Comfort**

Case A has one strategy, H3.1.T, that is well referred in the selected guidelines.

Case C has three strategies, H3.2.G, H3.3.G, and H3.4.G.

*[H3.2.G] Noise pollution reducing*

*[H3.3.G] Reduce vibration in buildings*

*[H3.4.G] Positive soundscapes*

Approximately half of referred guidelines use the two former while only two guidelines mention the latter. However, since the noise has been a critical problem due to the high density, crowded private motorcycles in the context of HCMC, the noise pollution reduction, and positive soundscapes are extremely demanded. The vibration in buildings is also essential in the context that the buildings built in

HCMC are less aware of the noise caused by building structures.

#### 5.3.2.9 Waste & Pollution Reduction (I)

**a. Collection of Recyclables (I1)**

Case A has one strategy, I1.1.H, that is discussed in the Step-2. This strategy is well referred in the selected guidelines.

Case C has one strategy, I1.2.G.

*[I1.2.G] Recycle/compost landscape and/or organic waste and incorporate compost to promote healthy topsoil in landscaping*

This strategy impresses about reducing the landscaping and organic wastes by composting it to be fertilizer enrich topsoil directly on the site. This strategy is quite popular since appeared in five guidelines and assessment tools. In the context of HAB in HCMC, this strategy often requires a specific equipment in order to ensure safe composting process, which often emit awful smell. In the context of HCMC today, it is impossible to apply this strategy due to the incompliance of technology and financial status.

**b. Alternative Transportation (I2)**

Case A includes four strategies, I2.1.H, I2.2.H, I2.3.H, and I2.4.H, that are analyzed in Step-2. The four strategies are appeared to be popular in the selected guidelines strategies.

Case C includes two new strategies, I2.5.G and I2.6.G.

*[I2.5.G] Provide an amount of preferred parking spots for high-performance hybrid vehicles (low-emitting and fuel efficient models)*

The strategy I2.5.G highlights the provision some parking lots reserved for high-performance hybrid vehicles to promote the using of clean vehicles. This is an essential method and easily to implement, especially promoting the awareness of the GHG emission from vehicles. However, the context of HCMC is that the motorcycle is the dominant private vehicles, and the high-performance vehicle is so expensive for the common people. This strategy thus should add the priority to the sharing vehicles or bus, and discounting the parking price rather than only preferred parking lot. Therefore, the new I2.5.G strategy should be '*Provide an amount of preferred parking spots for buses, sharing vehicles, and high-performance hybrid vehicles (low-emitting and fuel efficient models) with discounted rate.*'

*[I2.6.G] Provide public transport information and assistance for residents including routes and schedules in an obvious and accessible location*

Although less selected guidelines refer this strategy, it is well fixed with the context of HCMC. Since HCMC do not have the urban rail transport, the bus system is the only public transport option. The less attention on the bus system is partly because of the inconvenience of the service. If every residential building provides full and quickly updated information, the public transportation would promote the using of the services. Therefore, this strategy is necessary for HAB in HCMC.

**c. Pollutant Sources Control (I3)**

There are only two strategies of Case A, I3.1.H and I3.2.H strategies. Though less than half of referred guidelines use this two strategies, as the discussion in the Step-2, these two strategies are essential for HAB in HCMC.

## 5.4 Finalized Strategies in Step-3

This section finalizes strategies based on the above analysis and findings. As a result, Step-3 brings about 112 strategies in total, of which 104 strategies are appropriate while eight strategies are inappropriate to design guidelines for sustainable HAB in HCMC. All strategies are involved in nine categories. The result is indicated in Table 5-3.

Table 5-3 Finalized strategies of Step-3

| No. | Code | Strategy | Status |
|---|---|---|---|
| **A- Neighborhood Formation** | | | |
| **A1 Community Connectivity** | | | |
| 01 | A1.1.Ha | Locate a site in walking distance to many community services and amenities | O |
| 02 | A1.1.Hb | Locate a site in walking distance to public transit stops (bus stop and urban rail station) | O |
| 03 | A1.2.H | Incorporate space for community involvement within project by providing dedicated community facilities flexible for varied activities (e.g. recreational facilities, meeting room, childcare facilities, gardens) | O |
| 04 | A1.3.G | Include a range of different housing types and sizes to accommodate residents of differing age, income, ethnicity and physical ability | O |
| **A2 Collective Participation** | | | |
| 05 | A.2.1.H | Involve local residents in the design process from an early stage through events such as public notification and consultation meeting | O |
| 06 | A2.2.G | Create an integrated approach to the design process by involving key design team members, users, occupants and operators | O |
| **B- Natural Vegetation Preservation** | | | |
| **B1 Vegetation Enhancement** | | | |
| 07 | B1.1.V | Preserve the site with existing and adapted vegetation | O |
| 08 | B1.2.V | Enhance vegetated open space and biodiversity | O |
| **B2 Land Use Optimization** | | | |
| 09 | B2.1.H | Optimize the layout and reduce the development footprint to save land and natural resources, and preserve open space | O |
| 10 | B2.2.G | In site selection, avoid building on environmentally, culturally, and socially sensitive sites. | O |
| 11 | B2.3.G | Rehabilitate a brownfield or previously occupied site | O |
| 12 | B2.4.G | Reuse and refurbish site with existing buildings | O |
| **C- Climatic Response** | | | |
| **C1 Building Orientation** | | | |
| 13 | C1.1.H | Optimizing the building orientation for maximizing the number of apartments facing south for taking advantage of solar shading and prevailing winds | O |
| **C2 Buffer Space** | | | |
| 14 | C2.1.T | Incorporate the buffer space as veranda, balcony or loggia space for preventing interior space from direct sunlight and heavy rainfalls | O |
| 15 | C2.1.Ha | Provide buffer spaces like staircases, lifts, store, toilets, etc., on majority of the west wall | O |
| **C3 Shading Devices** | | | |
| 16 | C3.1.V | Incorporating exterior shading devices (e.g. overhangs, screens, and louvers) | O |
| 17 | C3.2.T | Install an occupant-controlled shading system on all windows, glazed doors and roof lights in regularly occupied spaces | O |
| **C4 Lightweight and Insulated Envelope** | | | |
| 18 | C4.1.V | Use lightweight structures for building envelope | O |
| 19 | C4.2.Ha | Provision of thermal insulation on building envelope (e.g. walls and roof) | O |

| No. | Code | Strategy | Status |
|---|---|---|---|
| 20 | C4.2.Hb | Provision of two-layer roof | O |
| 21 | C4.2.Hc | Use of thermal insulation or cool paints on the east and west facing external walls | O |
| 22 | C4.2.Hd | Select windows and exterior glazing assemblies with thermally broken frames and insulated spacers, and with appropriate low-e coating | O |
| 23 | C4.3.G | Stop air leakage at doors, windows, wall/slab junctions, mechanical openings, and other assemblies penetrating the building envelope for air, thermal, and water barriers | O |
| 24 | C4.4.G | Provision of vertical greenery system on building facades abutting the living, dining and bedrooms areas of dwelling units | O |
| 25 | C4.5.G | Install a vegetated roof on large portion of roof area | O |
| **C5 Climatically Responsive Landscape** | | | |
| 26 | C5.1.V | Plan the landscaping to work with the site microclimate (e.g. shading, ventilation, and daylighting) | O |
| **C6 Solar Heat Reflectance** | | | |
| 27 | C6.1.T | Provision of light color textures and rough textures for building external facades | O |
| 28 | C6.1.Ha | Use of cool paints on the east and west facing external walls | O |
| 29 | C6.2.T | Provision of light color and rough textures for building roofing materials | O |
| 30 | C6.3.H | Use light-colored and heat-reflective hardscapes | O |
| 31 | C6.4.G | Provide shade from a tree canopy, solar panels structures or solar reflective architectural structures | O |
| **D- Exploitation of Renewable Energy** | | | |
| **D1 Space composition** | | | |
| 32 | D1.1.H | If necessary, incorporate skywell as a place to exploit energy from nature in forms of daylighting and air movement | O |
| **D2 Natural Ventilation** | | | |
| 33 | D2.1.H | In each apartment unit, arrange the openings in opposite sides and interior doors to facilitate the cross ventilation | O |
| 34 | D2.2.H | Enhance stack ventilation by increasing the height of the skywell if necessary | O |
| 35 | D2.3.H | Incorporate the controllable slits and openings to doors, windows, walls, and partitions to enhance the air circulation across spaces | O |
| 36 | D2.4.V | Use hipped roof type to enhance the stack ventilation | × |
| 37 | D2.5.T | Use operable windows for cross ventilation in combination with mechanical ventilation systems (e.g., ceiling/wall-mounted fans, exhaust fans) | O |
| 38 | D2.6.T | Take into account security, noise and dust concerns when providing natural ventilation | O |
| 39 | D2.7.H | All public and circulation spaces and large portion of habitable rooms to be provided with cross and/or stack natural ventilation | O |
| 40 | D2.8.H | Replace air conditioning with natural ventilation including common areas and habitable spaces | O |
| 41 | D2.9.G | Design car-parking facilities with natural ventilation or mechanical ventilation with demand controls through sensor | O |
| **D3 Daylighting** | | | |
| 42 | D3.1.Ha | Selecting appropriate glazed size for daylighting and avoiding excessive illumination levels inside the building | O |
| 43 | D3.1.Hb | Use appropriate double-glazed units with Low-e glass, or glass coatings | O |
| 44 | D3.2.T | Use floor surface and light shelves for increasing the penetration of daylight | O |
| 45 | D3.2.Ha | Avoid glare in daylighting strategies and use textured/rough surfaces to diffuse the reflected daylight for reducing glare | O |
| 46 | D3.3.H | Planning landscape and the building blocks for working as reflectors diffusing daylighting | O |
| 47 | D3.4.T | Use high reflectance (light color) of internal finishes for lighting penetration enhancement | O |
| 48 | D3.5.H | Daylighting for all public and circulation spaces and the large portion of habitable rooms | O |
| 49 | D3.6.G | Increase minimum size of habitable rooms, increase floor-to-ceiling heights and decrease distance of habitable spaces from windows | O |
| 50 | D3.7.G | Planning interior partitions and furniture that avoids blocking daylight | O |
| **D4 Occupant Controllability** | | | |
| 51 | D4.1.V | Use flexible occupant-controlled openings (doors and windows) in regularly occupied spaces for natural ventilation and daylighting control | O |
| 52 | D4.2.T | Provision of interior sunlight control elements (e.g., curtain, drapes, blinds, adjustable louvers) | O |
| **D5 Using Renewable Energy** | | | |
| 53 | D5.1.G | Install on-site renewable energy generation systems (solar photovoltaic, wind turbines, biomass) | O |

| No. | Code | Strategy | Status |
|---|---|---|---|
| 54 | D5.2.G | Purchase power from energy providers that utilize renewable sources to generate power. | × |
| 55 | D5.3.G | Use solar water heating system for supplementing common water heating needs | O |
| 56 | D5.4.G | Use solar hot-water systems for space heating | × |
| 57 | D5.5.G | Use geothermal systems, cogeneration, or other alternatives for water heating and space cooling | O |
| **E - Water Conservation** | | | |
| **E1 Minimizing Water Use** | | | |
| 58 | E1.1.V | Landscaping with native and indigenous vegetation | O |
| 59 | E1.2.G | Water efficient irrigation systems | O |
| 60 | E1.3.G | Cluster plants with similar water needs ("water-use" zones) | O |
| 61 | E1.4.G | Use water-conserving plumbing fittings and fixtures (e.g. faucets, showerheads, water closets, and urinals) and water-saving appliances (e.g. dishwasher and washing machine) | O |
| 62 | E1.5.G | Use site-reclaimed water (non-potable water) for landscape irrigation, or toilet flushing, or cooling tower | O |
| **E2 Water Reuse** | | | |
| 63 | E2.1.V | Collecting and storing rainwater for later use | O |
| 64 | E2.2.G | Use ecology-based treatment (wetland treatment) processes (i.e. ultrafiltration) for sewage treatment or reclaimed water treatment if site' space allows | O |
| 65 | E2.3.G | Grey/black water treatment, recycling and reuse for non-portable purposes (landscape irrigation and flushing toilets and urinals) | O |
| **E3 Stormwater Runoff Infiltration** | | | |
| 66 | F1.4.G | Design drainage systems that adequately dispose of rainwater and prevent flooding from excessive runoff, size gutters and other rainwater goods to allow for higher rainfall | O |
| 67 | E3.1.H | Use permeable/pervious paving materials or open grid pavement system for hardscapes | O |
| 68 | E3.2.H | Use swales, soak-ways, and holding ponds | O |
| **F- Natural Calamity Response** | | | |
| **F1 Flooding Prevention** | | | |
| 69 | F1.1.V | Locate the building on elevated position | O |
| 70 | F1.2.V | Design multi-storey building with the ground storey reserved for flooding situation | × |
| **F2 Typhoon Prevention** | | | |
| 71 | F2.1.H | Planning and design buildings for restriction of wind damage and storm | O |
| **F3 Earthquake Resistance** | | | |
| 72 | F3.1.H | Design building structures for earthquake resistance | O |
| **G- Eco-Friendly Material** | | | |
| **G1 Local Materials** | | | |
| 73 | G1.1.T | Use local/regional materials | O |
| **G2 Reuse and Recycling of Materials and Components** | | | |
| 74 | G2.1.H | Reuse/renovate a building by maintain existing building structure, walls, floors, and roof | O |
| 75 | G2.2.V | Reuse building nonstructural components (e.g. doors, windows, panels) | O |
| 76 | G2.3.V | Use reusable, recyclable materials | O |
| 77 | G2.4.V | Use the reused, refurbished, and salvaged materials | O |
| 78 | G2.5.V | Use materials with appropriate durability | O |
| 79 | G2.6.G | Use recycled materials or materials with recycled content (e.g., recycled-content drywall, acoustical ceiling tiles, insulation, latex paint, landscape elements) | O |
| 80 | G2.7.G | Design and select materials for simple and self-evident care and maintenance | O |
| 81 | G2.8.G | Use certified wood/timber | O |
| **G3 Disassemblable Building Components** | | | |
| 82 | G3.1.V | Design for easy disassembling and reassembling of building components | × |
| 83 | G3.2.G | Inform early building assembly material choices using life cycle assessment of material alternatives | × |
| **G4 Rapidly Renewable Materials** | | | |
| 84 | G4.1.V | Use natural/organic materials for building structures | × |
| 85 | G4.2.V | Use natural/organic materials for building nonstructural elements | O |
| 86 | G4.3.V | Use natural/organic materials for furnishings | O |
| **G5 Low-Emitting Materials** | | | |
| 87 | G5.1.T | Select timbers that use non-toxic methods to treat timber decay, insect attack and other rot problems, avoid toxic chemical treatment of timber where possible | O |

| No. | Code | Strategy | Status |
|---|---|---|---|
| 88 | G5.1.Ta | Reduce formaldehyde emissions in composite and wood-based products (cabinets, interior trim, shelving, subflooring and others) | O |
| 89 | G5.2.G | Use recycled-content, formaldehyde-free fiberglass insulation, cellulose insulation, or other green insulation products | O |
| 90 | G5.4.G | Specify low and zero-VOC interior paints, stains and other coatings | O |
| 91 | G5.5.G | Use flooring systems ( e.g. carpet systems, concrete, wood, tile floor finishes) that emit low levels of VOCs | O |
| **G6 Low Embodied Energy Materials** | | | |
| 92 | G6.1.G | Minimize the use of highly processed materials such as metals, concretes and plastics, alternately use low embodied energy materials (e.g., certified timber, raw materials) | O |
| 93 | G6.2.G | Use non-baked materials for non-structural walls | O |
| 94 | G6.3.G | Design for flexibility and adaptability to future changes in building use (e.g., layout, building structures) | O |
| **H- Occupants' Comfort Perception** | | | |
| **H1 Thermal Comfort** | | | |
| 95 | H1.1.V | Elevated ground floor for humidity prevention | O |
| 96 | H1.2.G | Proper indoor ventilation rate for mechanically ventilated spaces (at least meet the local building code) | O |
| **H2 Vision Comfort** | | | |
| 97 | H2.1.V | Provision of views to the outdoor environment | O |
| 98 | H2.2.T | Use indoor planting beds in communal areas for interior decoration and air quality improvement | O |
| **H3 Acoustic Comfort** | | | |
| 99 | H3.1.T | Provide an effective level of acoustic insulation within buildings | O |
| 100 | H3.2.G | Noise pollution reducing | O |
| 101 | H3.3.G | Reduce vibration in buildings | O |
| 102 | H3.4.G | Positive soundscapes | O |
| **I- Waste & Pollution Reduction** | | | |
| **I1 Collection of Recyclables** | | | |
| 103 | I1.1.H | Provide a centralized and easily accessible space for collection and storage of recyclables on each floor and for entire building | O |
| 104 | I1.2.G | Recycle/compost landscape and/or organic waste and incorporate compost to promote healthy topsoil in landscaping | × |
| **I2 Alternative Transportation** | | | |
| 105 | I2.1.H | Provide favorable bicycle lanes and secure and easily accessible bicycle storage/parking on the site | O |
| 106 | I2.2.H | Provide favorable public or private walkway and pedestrian-friendly amenities that meet the multiple needs | O |
| 107 | I2.3.H | Locate preferred parking, bicycle parking, pick-up areas, and covered waiting spaces within close proximity of the main building entrances | O |
| 108 | I.2.4.H | Provide limited parking capacity to meet but not exceed minimum local zoning requirements | O |
| 109 | I.2.5.G | Provide an amount of preferred parking spots for buses, sharing vehicles, and high-performance hybrid vehicles (low-emitting and fuel efficient models) with discounted rate | O |
| 110 | I.2.6.G | Provide public transport information and assistance for residents including routes and schedules in an obvious and accessible location | O |
| **I3 Pollutant Sources Control** | | | |
| 111 | I.3.1.H | Provide removable entryway mats, walk-off grilles at the interior of all building entrances to capture potential contaminants and dirt | O |
| 112 | I.3.2.H | Prohibit smoking in all common areas of the building except in designated smoking areas | O |

# Chapter Six: Constructing Proposed Framework Applicable to Design Guidelines

6.1 Design Guidelines Identification

6.2 Research on Format of Design Guidelines

6.3 The Proposed Framework for Design Guidelines

6.4 Validation Issue

The major work of this chapter is to construct the proposed framework applicable to design guidelines. After the Chapter Three, Four and Five, the three-step process has resulted in a list of strategies applicable to HAB in HCMC, which would contribute the content of the proposed guidelines. Rather than the content, however, constructing complete design guidelines framework requires the two key elements: the guidelines format and guidelines content. Since the content element has been built, this chapter firstly focuses on building the format element before combining the two elements to become a complete proposed framework. Then, the suggestion of proposed framework applicable to design guidelines proceeds with a discussion of validation issues.

## 6.1 Design Guidelines Identification

### 6.1.1 Scale of Guidelines

The guidelines are the linkage of a flowing process from general goals for future development of particular practices. A design guidelines are often originated from of design objectives, design principles, and design guidelines as can be seen in the diagram in Figure 6-1.[208] The design objectives specify the general goals and inform what a design should achieve. The design principles help linking design objectives to physical outcomes.

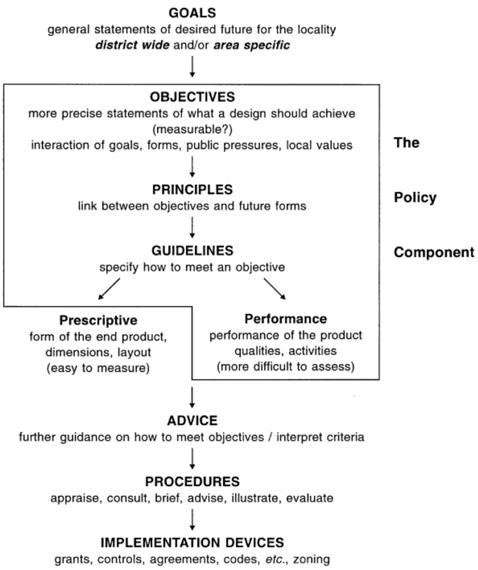


Figure 6-1 Key components of design policy[209]

Most of the design guidelines available for planners, designers and builders in

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[208] John Punter, "Design Guidelines in American Cities a Review of Design Policies and Guidance in Five West Coast Cities," (1999): 27.

[209] John Punter and Matthew Carmona, *The Design Dimension of Planning : Theory, Content, and Best Practice for Design Policies*, 1st ed. (London ; New York: E & FN Spon, 1997), 94.

developed countries fall into a hierarchy appropriate to the goals and objectives of a certain scale of design practices. The design guidelines hierarchy is ranging from macro extent including the national and regional levels to micro extent including the scale of the municipality, sub-areas of neighborhoods, and specific sites.[210] In this dissertation, the guidelines for sustainable HAB in HCMC are studied on the level of municipality/ district.

Table 6-1 Hierarchy of design guidelines[211]

| | |
|---|---|
| **National** | ***National planning guidance***<br>Circulars, Guidance Notes, National Codes (UK, F, N, FRG) |
| **Regional** | ***Regional Planning Guidance***<br>Regional plans (N, FRG), Regional strategies, land-use allocations, landscape plans (FRG), regional vernacular guidance (UK, F)<br>***Sub-regional guidance***<br>City-region plans, General plans, Structure plans,(UK, N, F, FRG), local vernacular guidance (UK, F, FRG) |
| **Municipality/District** | ***Local guidance***<br>Local plans, District plans (UK, F, FRG, N)<br>Comprehensive plans, Green plans (FRG)<br>Design goals, objectives, principles, policies<br>Zoning controls, Design codes – general, Development standards, Street classifications, highway standards |
| **Neighborhood** | ***Sub-area guidance***<br>Community plans, neighborhood guidelines, zoning ordinances<br>***Large sites:*** Area Strategies, Development Frameworks, Master Plans (subdivision plans)<br>***Small sites:*** Design briefs (UK), Building plans (N, FRG)<br>***Design detail:*** Design codes (detailed), signage/ street furniture, Planting standards |
| Note: UK: United Kingdom; F: France; N: Netherlands; FRG: Federal Republic of Germany. | |

While the guidelines is quite popular in the North America, Europe, and Oceania playing role as efficient tools of municipal assistance and management, Vietnam like other Asian countries, especially the developing countries tends to

[210] Punter, "Design Guidelines in American Cities a Review of Design Policies and Guidance in Five West Coast Cities," 25.

[211] Ibid., 26.

use unfriendly codes, standards rather than develop the guidelines for a certain purpose of management.[212]

### 6.1.2 Elements Constituting Design Guidelines

Complete design guidelines are constituted of two key elements: the guidelines format and guidelines content (Figure 6-2). The format element shows the structural, compositional, or organizational direction that make guidelines activate smoothly and efficiently. The content element is the strategies, criteria, credits, or topic areas that assist in implementing actions for the quality of a building design.

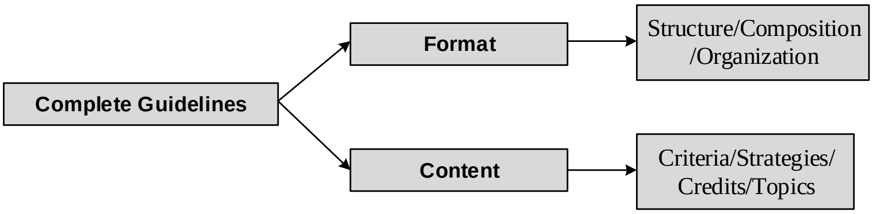


Figure 6-2 Two key elements of design guidelines

### 6.1.3 Classification of guidelines

A majority of scholars working on design guidelines classify the guidelines' strategies into two types: the prescriptive and performance guidelines (Figure 6-1).[213] Prescriptive guidelines prescribe the procedure involving a set of actions that must be carried out to fulfill a certain criteria or credit. The prescriptive strategies highlight evaluating the prescribed processes rather than measuring their

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[212] The trend is evident during searching typical guidelines for analysis and being revealed in the Table 6-2.

[213] Carmody, Weber, and Jacobson, "Design Guidelines for Sustainable Housing," 31.; Punter, "Design Guidelines in American Cities a Review of Design Policies and Guidance in Five West Coast Cities," 202.

outcomes. In contrast, performance guidelines require a particular level of performance that can be measured in specific numbers/amounts to attain the criteria or credits. The performance guidelines pay attention to the measurable outcomes without prescribing a set of actions for practitioners. The two basic types of guidelines are created on the basis of the two types of indicators: prescriptive indicator and performance indicator. [214] Prescriptive indicator determines prescribed terms while performance indicator reveals the performed outcomes and ways outcomes to be measured.

Each type of prescriptive and performance guidelines has its individual advances depending on the intention when adopting it. Developers, contractors, and administrators may prefer prescriptive guidelines because it is quite simple tasks to follow the list of actions. Meanwhile, designers and engineers would prefer to performance guidelines because by adopting them they have more options for creative actions to achieve the desired outcomes. Additionally, by measuring the outcomes of the strategy's decision, designers will have a real sense of strategies, their effects for improving a building's performance.[215]

Aside from the above two types, some scholars classify the design guidelines into three types with the two previous basic types and the additional advisory guidelines.[216] Advisory guidelines are suggestive ideas that advise the practitioners to refer the optimum alternatives. This type of guidelines is more discretionary than the two previous guidelines. The different between advisory guidelines and the two

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[214] Carmody, Weber, and Jacobson, "Design Guidelines for Sustainable Housing," 31.

[215] Ibid.

[216] Jon Lang classify the design guidelines for urban design into three types: prescriptive, performance and advisory. In Jon T. Lang, *Urban Design : A Typology of Procedures and Products* (Oxford; Burlington, MA: Elsevier/Architectural Press, 2005), 205.

types of prescriptive and performance guidelines is that the prescriptive and performance guidelines can be adopted into law to become the mandatory guidelines while the advisory guidelines are no legal requirements to comply with.[217]

In actual practices, the three types of guidelines are often incorporated to deliver the guidelines that provide the most efficient instruments with enlarged options for practitioners.

[217] Ibid.

## 6.2 Research on Format of Design Guidelines

### 6.2.1 Research Method

The research on format element is conducted through two major processes. The first process comparatively analyzes the formats of 34 available sustainable design guidelines worldwide. The result of the first process offers a practical perspective on available guidelines' formats. The second process conducts the in-depth analysis on the formats of the five selected guidelines. The second process brings about the valuable insights such as the background of making guidelines, guidelines organization and process. The combination of the two processes supports the suggestion on the format for the proposed design guidelines applicable to HAB in HCMC, the second element of the desired framework. Both qualitative and quantitative analysis are adopted to the two processes for analyzing the whole aspects of the guidelines' format.

### 6.2.2 Comparative Analysis of Format of Design Guidelines

#### 6.2.2.1 Guidelines Models Selection and Analysis Settings

To make design guidelines worked, the guidelines are composed of various components that effectively assist the users in attaining good practices. In this research, 34 existing sustainable building guidelines worldwide are investigated to find the most prominent structures. In term of building type, the guidelines are selected with the priority on sustainable building, new building, multi-family dwellings, and high-rise housing. Besides, most of the selected guidelines are applicable for regional and municipal scale. The list of 34 guidelines and its relative information are presented in Table 6-2.

The synthesizing the reading and understanding the 34 guidelines brings about analyzing method that comparing the 34 guidelines across the six major components including guidelines introduction, category base, criteria explanation, compulsory extent, guiding language, and others. Each major component is constituted of many minor attributes, items, and categories, which are argued in each debate of guidelines component.

### 6.2.2.2 Components Division of Guidelines Format

#### a. Guidelines Introduction

The guidelines introduction often includes the explanation of the objectives/intents, 'how to use' and primary approaches or principles. The guidelines intents indicate evidently the purpose and the coverage of the guidelines. The 'how to use' is adopted to teach the user the best way to use the guidelines since the guidelines have individual structure and contents. Finally, the principles show how the guidelines writers approach the issues of sustainability that controls the contents of the guidelines (Figure 6-3).

Buildings are responsible for between 40% and 60% of greenhouse gas emissions in the city, and are thus a major contributor towards global **climate change**. The urgency of reducing greenhouse gas emissions and other environmental impacts is therefore driving the change to a more sustainable built environment. However, green buildings offer a range of other benefits as well, including:

- reduced operational costs;
- reduced resource consumption;

**1.3 How to use this handbook**

This handbook provides information to achieve resource-efficient buildings in the following three ways:

1. By stepping through the construction process, from site selection and design to construction and operation, highlighting considerations and opportunities at each stage
2. By providing checklists for stakeholders at

Figure 6-3 'Guidelines introduction' component[218]

#### b. Category Base

[218] City of Cape Town Smart Building Handbook: A Guide to Green Building in Cape Town, (City of Cape Town: City of Cape Town, 2012), https://www.capetown.gov.za/en/MediaReleases/Pages/CityproducesSmartBuildingHandbooktoencouragesustainablepractices.aspx. 5.

The sustainable building guidelines cover a variety of criteria in regards to ecology, society and economy. How to classify those criteria favorable for practitioners to implement the guidelines is also a question. Of all surveying guidelines, the criteria are often categorized in three ways including process-based, sustainable issues based and building components based.

The process-based category is the classification based on the process of the planning, design, construction, operation, and maintenance, referring to the building life cycle. Guidelines with process-based category results in the logic sense of applicants that it is easy to define the role of actors during the design and construction process following the ‘step by step’ rule.

The sustainable issues based category, on another hand, make sense of comprehensive view of all aspects of sustainability in built environment such as energy efficiency, water, waste, materials, indoor environmental quality. It is favorable for managers to assess the extent of the building performance in regards of sustainability.

The building components based classification is associated with the building components such as floors, walls, roofs, or building elements such as structure, finishes, and furnishings. This category is favorable for the designers and engineers to deal with individual issues of the buildings (Figure 6-4).


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**Introduction**
i Creating High-Performance Green Buildings

**Green Design Systems**
D2 Green Team Building & Goal Setting
D4 Site
D8 Enclosure
D12 Mechanical
D16 Interiors
D20 Materials

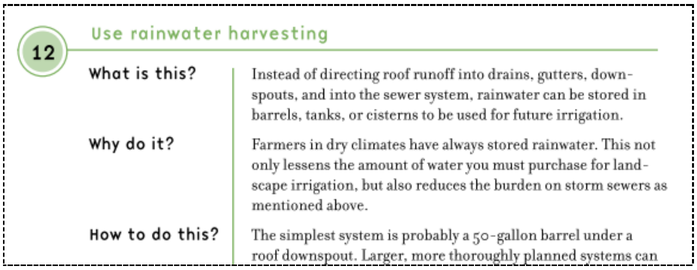
**Green Design Process**
P3 The Green Design and Construction Process
P5 Design Optimization
P7 Construction Documents and Specifications
P9 Bidding and Construction
P11 Building Commissioning
P13 Operations and Maintenance

DESIGN systems
DESIGN process

Figure 6-4 Guidelines composed with process-based and building components based category[219]

## c. Criteria Explanation

In each criterion, the guidelines often have a short explanation to clarify the meaning and intent. The explanation often answers the questions ‘What is this?’ and ‘Why do it?’ (Figure 6-5).


12 Use rainwater harvesting

**What is this?** Instead of directing roof runoff into drains, gutters, downspouts, and into the sewer system, rainwater can be stored in barrels, tanks, or cisterns to be used for future irrigation.

**Why do it?** Farmers in dry climates have always stored rainwater. This not only lessens the amount of water you must purchase for landscape irrigation, but also reduces the burden on storm sewers as mentioned above.

**How to do this?** The simplest system is probably a 50-gallon barrel under a roof downspout. Larger, more thoroughly planned systems can

Figure 6-5 An example of ‘criteria explanation’ component of guidelines[220]

## d. Compulsory Extent

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[219] Guidelines for Creating High-Performance Green Buildings: A Document for Decision Makers, (Pennsylvania: Commonwealth of Pennsylvania, 1999), http://www.tcrpc-pa.org/Planning-Toolkit/Building-Stock/Documents/High%20Performance%20Green%20Buildings.pdf.

[220] San Mateo Countywide Guide: Sustainable Buildings, (County of San Mateo: County of San Mateo, 2004), http://www.recycleworks.org/pdf/GB-guide-2-23.pdf. 20.

The guidelines are designed to serve a particular purpose according to which the guidelines define the extent to which the practitioners must fulfill. There are often two extents including requirement and recommendation, respective with the mandatory and voluntary guidelines (Figure 6-6).

**Required Performance Criteria**

A. Radon is best controlled using source prevention techniques rather than ventilation. For New Buildings Path, if construction is to occur in one of the 68 Minnesota counties considered "Zone 1" by the US EPA, guidance contained in the EPA document, "Radon Prevention in the Design and Construction of Schools and other Large Buildings", must be followed. Major Renovations located in these 68 counties whose exterior envelopes have more than 40% of their surface areas in contact with the ground must follow the same EPA guidance.

B. Ventilation Baseline: meet current ASHRAE ventilation standard 62.1 for commercial and institutional buildings (as of the writing of this guideline ASHRAE 62.1-2010 Updates are scheduled to be issued every three years thereafter.)

**Recommended Performance Criteria**

C. Ventilation Performance Validation: in addition to required ventilation baseline criteria above, design the ventilation system so that $CO_2$ concentrations can be monitored continuously in all continuously occupied spaces. Continuously occupied spaces are those intended for human occupancy excluding spaces intended for other purposes such as storage rooms or equipment

Figure 6-6 Requirement and recommendation extent of guidelines' criteria[221]

## e. Guiding Language

To assist the practitioners in delivering the sustainability, the guidelines must be adopted many efficient 'language' to implement the guidance functions, including criteria specification, detailed strategies, reference data cited, illustrated figure, checklist, case study, questionnaires, and cost implication.

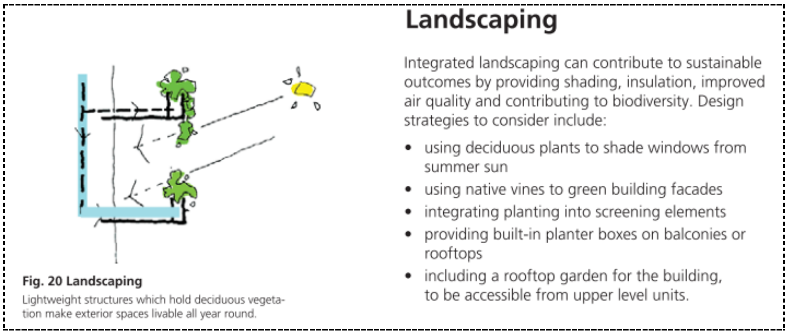
The criteria specification describes the core content while the detailed strategies expand the criteria into individual strategies favorable to implement.

Reference data cited support some criteria that require reference remote data.

221 Minnesota Sustainable Building Guidelines: For New Buildings and Major Renovations, (Minnesota: University of Minnesota, 2013), accessed June 07, 2015, http://www.b3mn.org/guidelines/downloads_v2_2/B3GuidelinesVersion2.2.pdf.

It often happens with the performance criteria when it needs to compare the number with standard data.

The illustrated figures assist readers easily to imagine the strategies of the particular guidelines. The illustrated figure is also used to support the criteria that words cannot adequately describe (Figure 6-7).


**Landscaping**

Integrated landscaping can contribute to sustainable outcomes by providing shading, insulation, improved air quality and contributing to biodiversity. Design strategies to consider include:

- using deciduous plants to shade windows from summer sun
- using native vines to green building facades
- integrating planting into screening elements
- providing built-in planter boxes on balconies or rooftops
- including a rooftop garden for the building, to be accessible from upper level units.

**Fig. 20 Landscaping**
Lightweight structures which hold deciduous vegetation make exterior spaces livable all year round.

Figure 6-7 An example of 'illustrated figure' guiding language[222]

A checklist is a tool that enables users to address all the aspects of a particular issue and allows managers to understand the performance extent that might be achieved. In terms of sustainability, the checklist enables designers, builders, contractors to recognize the impacts of new projects on ecology, society and economy easily.

The checklist is often provided a framework to assist all practitioners to carry out the constructing projects in a prescriptive procedure towards sustainability, systematically and comprehensively. The checklist is composed of a set of everyday sense prompts for practitioners, e.g. client, designers, engineers,

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[222] Yarra City Council, Sustainable Design Guidelines: Apartment Development, (Yarra: Yarra City Council, 2005), http://www.yarracity.vic.gov.au/Planning--Building/Studies-Strategies-and-Guidelines/Sustainable-Design-Guidelines/. 17.

maintenance staffs. Although it is hard for a checklist to be produced to cover comprehensively all the aspects of sustainability, the contents of checklists assuredly involve the vast majority of fundamental issues' requirements. It is possible that some checklists are highly required; some are recommended subject to the priority level of criteria and the practitioners and the characteristics of an individual project. However, the checklist has been formed in such a way to ensure a logical 'matrix' style access to each topic.[223]

The principal discrepancy between an assessment tool or rating system and checklist tool is based on the purpose of developers. The assessment tool is a system designed for evaluation of a particular scoring system, meanwhile the checklist is an assistant tool that helps practitioners acknowledging the extent to which their projects have covered within the scopes of the environment, community and economy. Different from assessment methods, the checklist may also be an efficient tool to foster the social participation and community engagement since different actors can share the same checklist tool (Figure 6-8).

| | ✓ | No. | Item | Applicable Building Types |
|---|---|---|---|---|
| COMMUNITY PLANNING | | | **Goal: Create a more sustainable community** | |
| | | 1 | Build mixed-use developments and provide public amenities such as open space | c m |
| | | 2 | Cluster development to minimize paving and utilities, and to preserve open space | c m |
| | | 3 | Reuse a brownfield or previously occupied site | c m |
| | | 4 | Design for easy pedestrian, bicycle, and transit access | c t m |
| PE | | | **Goal: Respect your site** | |
| | | 5 | Design and landscape to create comfortable micro-climates and reduce heat island effects | c m s |
| | | 6 | Optimize building orientation for heat gain, shading, daylighting, and natural ventilation | c m s |
| | | 7 | Reduce building footprint - smaller is better | c m s |

Figure 6-8 An example of 'checklist' guiding language[224]

Case-study helps the practitioners to acknowledge the criteria in a realistic

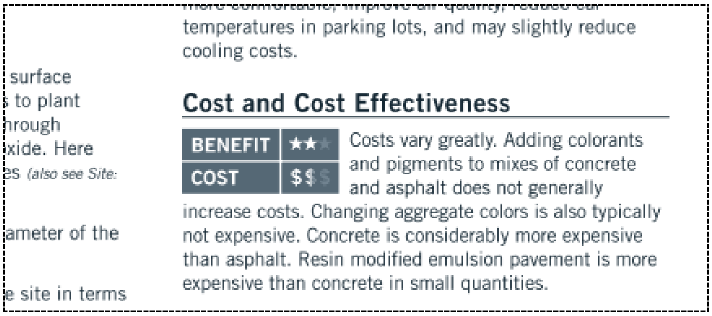
[223] Sustainable Design Guide, (Edinburgh: The City of Edinburgh Council).

[224] *San Mateo Countywide Guide: Sustainable Buildings*. 7.

way. The good case-study could contribute to simulate the case and fulfill the criteria.

The questionnaire is like, in a certain aspect, a checklist. The questionnaire method is referred to prescriptive criteria.

Cost implication is a particular aspect of sustainable building guidelines when the life cycle cost plays an important role in the whole building. The cost implication highlights the effects of the criteria on costing regarding the life cycle of the building (Figure 6-9).


temperatures in parking lots, and may slightly reduce cooling costs.

**Cost and Cost Effectiveness**

| | |
|---|---|
| BENEFIT | ★★★ |
| COST | $$$ |

Costs vary greatly. Adding colorants and pigments to mixes of concrete and asphalt does not generally increase costs. Changing aggregate colors is also typically not expensive. Concrete is considerably more expensive than asphalt. Resin modified emulsion pavement is more expensive than concrete in small quantities.

Figure 6-9 An example of 'cost implication' guiding language[225]

### f. Others

Besides the popular 'language', the guidelines is also adopted some other secondary manners including user consideration, further reference, relevant code, tools, and points.

User consideration regards to the participator in implementing the criteria. There are many actors involving in a building project, ranging from homeowners, professionals such as architects, engineers, quantity surveyors, and facilities

225 Multifamily Green Building Guidelines, (Alameda County: Build it green, Green Building in Alameda County, 2008), http://www.ci.campbell.ca.us/DocumentCenter/. 58.

managers, developers, contractors, and tenants. Each actor plays a particular role in all design and construction process. Thus, there should be appropriate guidelines for each. In addition, the principle of sustainability requires integrated approach in practices. The cooperation of many individuals from a variety of fields is necessary to bring in comprehensive practices.

Further reference is a component to provide the further information favorable for those willing to study advanced guidelines or related knowledge.

The guidelines themselves are not an alternative to code or standard but rather merely assist the practitioners in delivering sustainability. Code relevant component helps the user to make a cross-reference for accessing the relating official documents such as legislation, policies, building code and standard. This component increases the practical features of the guidelines.

Some guidelines links to available tools to aid the practitioners in calculating or designing works, for example, the case of The State of Minnesota Sustainable Building Guidelines.

Point-based assessment is adopted in some guidelines though most of the guidelines are voluntary. The point-based guidelines are often associated with a rating tool.

#### 6.2.2.3 Result and Discussion

The comparative analysis of formats of 34 guidelines are revealed in Table 6-2. The result of the analysis is illustrated in Figure 6-10. Figure 6-10 shows a tendency of composing the guidelines for sustainable buildings in the group of 34 guidelines worldwide. Accordingly, the majority of guidelines' format uses the prescriptive, performance and advisory types of guidelines. In introduction part, objective/intent and ‘How to use’ are the key items that over two-third of the group has indicated. The approach/principle of composing guidelines is also an option when it appears in over half of guidelines.

Regarding criteria for guidelines, over two-third of guidelines classifies the criteria based on sustainable issues while less than one-third adopts the other methods. Voluntary guidelines are preferred when the guidelines criteria are largely provided in recommendation compulsory. Explaining about criteria and reason for applying it is an option when one-third of the guidelines do not use that.

Regarding guiding language, some of ‘language’ preferred to use for composing the guidelines are criteria specification, detailed strategies, illustrated figure. Besides, checklist and further reference are also favorable items. The reference data cited, case study, cost implication, and relevant code are only applied for those having a specific intention in composing guidelines.

Table 6-2 Comparative analysis of formats of design guidelines for sustainable building

| No. | Applied Location | | Guidelines Information | | | | Type of Guidelines | | | Introduction | | | Category Base | | | Criteria Explanation | | Compulsory Extent | | Guiding Language | | | | | | | | Others | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Country | Region / City / County | Publisher | Guidelines Title | Publishing Year: Latest (Previous) | Pages | Prescriptive | Performance | Advisory | Objective / Intent | How to Use | Approach / Principle | Process-based | Sustainable Issues | Building Components | What is this? | Why do it? | Requirement | Recommendation | Criteria Specification | Detailed Strategies | Reference Data Cited | Illustrated Figure | Checklist | Case Study | Questionnaire | Cost Implication | User Consideration | Further Reference | Relevant Code | Tools | Point |
| **01** | United States | | US DOE / EPA | Sustainable Building Technical Manual[226] | 1996 | 292 | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | - | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | ✓ | - | ✓ | - |
| **02** | | | DOE | Greening Federal Facilities[227] | 2001 | 211 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | ✓ | - | ✓ | - | - | - |
| **03** | | Triangle J Council of Governments | | High Performance Guidelines: Triangle Region Public Facilities[228] | 2001 | 150 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | - | - | ✓ | - | - | ✓ |
| **04** | | Stanford University | | Stanford's Guidelines for Sustainable Buildings[229] | ? | 38 | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | - | ✓ | ✓ | ✓ | - | - | - | - | - | - | - | ✓ | - | - | |

[226] Sustainable Building Technical Manual, (US DOE / EPA), http://smartcommunities.ncat.org/pdf/sbt.pdf.

[227] Greening Federal Facilities, (DOE), http://www.nrel.gov/docs/fy01osti/29267.pdf.

[228] High Performance Guidelines: Triangle Region Public Facilities, (Triangle J Council of Governments, 2001), http://infohouse.p2ric.org/ref/05/04061/04061.pdf.

[229] Stanford's Guidelines for Sustainable Buildings, (Stanford University), http://sustainable.stanford.edu/sites/sem.stanford.edu/files/documents/Stanford_sustainable_guidelines.pdf.

| No. | Applied Location | | Guidelines Information | | | | Type of Guidelines | | | Introduction | | | Category Base | | | Criteria Explanation | | Compulsory Extent | | Guiding Language | | | | | | | | Others | | | | |
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| **05** | | Commonwealth of Pennsylvania | | Guidelines for Creating High-Performance Green Buildings[230] | 1999 | 47 | ✓ | - | - | ✓ | - | - | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | - | - | ✓ | - | - | - |
| **06** | | | NAHB | NAHB Model Green Home Building Guidelines[231] | 2006 | 157 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | - | ✓ | - | - | ✓ |
| **07** | | Minnesota | | The State of Minnesota Sustainable Building Guidelines V 2.2[232] | 2013 (04,06,09) | 270 | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | - | - | - | - | ✓ | ✓ | ✓ | - |
| **08** | | New York | | High Performance Building Guidelines[233] | 1999 | 146 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - |
| **09** | | Seattle | | SeaGreen – Greening Seattle's Affordable Housing[234] | 2002 | 145 | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | - | - | ✓ | - | ✓ | - | - | - |
| **10** | | Alameda | | Multifamily Green Building Guidelines[235] | 2008 (04) | 261 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | - | ✓ | - | ✓ | - | ✓ | ✓ | - | - |
| **11** | | San Mateo | | San Mateo Countywide Guide – Sustainable Buildings[236] | 2004 | 64 | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | - | - | ✓ | ✓ | - | - | - | ✓ | - | - | - | - |

[230]*Guidelines for Creating High-Performance Green Buildings: A Document for Decision Makers*.

[231] NAHB Model Green Home Building Guidelines, (NAHB, 2006), http://www.energysaver1.com/yahoo_site_admin/assets/docs/nahb_guidelines.353123249.pdf.; NAHB: National Association of Home Builders

[232] Minnesota Sustainable Building Guidelines: For New Buildings and Major Renovations.

[233] Department of Design and Construction., High Performance Building Guidelines, (New York: City of New York Dept. of Design and Construction, 1999), http://www.nyc.gov/html/ddc/downloads/pdf/guidelines.pdf.

[234] Katie Hong and Greg Nickels, Seagreen : Greening Seattle's Affordable Housing, (Seattle, WA: Office of Housing City of Seattle, 2002), http://www.seattle.gov/housing/seagreen/SeaGreen.pdf.

[235] *Multifamily Green Building Guidelines*.

| No. | Applied Location | | Guidelines Information | | | | Type of Guidelines | | | Introduction | | | Category Base | | | Criteria Explanation | | Compulsory Extent | | Guiding Language | | | | | | | | Others | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| **12** | | Santa Barbara | TSP | Santa Barbara County Green Building Guidelines[237] | 2001 | 222 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | ✓ | - | - | - |
| **13** | | Santa Monica | | Santa Monica Residential – Green Building Guide[238] | 1999 | 52 | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | - | - | ✓ | ✓ | ✓ | - | - | - |
| **14** | | Santa Monica | | City of Santa Monica Green Building Design & Construction Guidelines[239] | 1999 | 269 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | - | ✓ | ✓ | - | - |
| **15** | | Oakland | | Oakland Sustainable Design Guide[240] | 2001 | 92 | ✓ | ✓ | - | - | - | - | - | ✓ | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | - | - | - | - | - | - | - | ✓ |
| **16** | | Contra Costa County | Build It Green | New Home Construction Green Building Guidelines[241] | 2007 (05,00) | 58 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | - | - | - | - | - | - | - | ✓ |

236 *San Mateo Countywide Guide: Sustainable Buildings*.

237 Santa Barbara County Green Building Guidelines, (Santa Barbara: TSP, 2001), http://constructiondurable.com/docs/GBGuidelines.pdf.

238 Santa Monica Residential – Green Building Guide, (Santa Monica, 1999), http://www.smgov.net/uploadedFiles/Departments/OSE/Categories/Green_Building/Residential_GB_Guidelines.pdf.

239 City of Santa Monica Green Building Design & Construction Guidelines, (Santa Monica, 1999), http://infohouse.p2ric.org/ref/11/10279.pdf.

240 Oakland Sustainable Design Guide, (Oakland, 2001), http://www.ibrarian.net/navon/page.jsp?paperid=2733542&searchTerm=oakland+sustainable+design.

241 New Home Construction Green Building Guidelines, (Contra Costa County: Build It Green, 2007), http://www.co.contra-costa.ca.us/depart/cd/recycle/gbg/GBG-NewHomes_ContraCosta.pdf.

| No. | Applied Location | | Guidelines Information | | | | | Type of Guidelines | | | Introduction | | | Category Base | | | Criteria Explanation | | Compulsory Extent | | Guiding Language | | | | | | | | Others | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| **17** | | HCBP City | | Hund L. Carey Battery Park City Authority Residential Environmental Guidelines[242] | 2005 (00) | 92 | ✓ | ✓ | ✓ | - | - | - | - | ✓ | - | - | ✓ | ✓ | - | ✓ | ✓ | - | - | - | - | - | ✓ | - | - | - | - | - |
| **18** | Canada | Ottawa | | Urban Design Guidelines for High-Rise Housing[243] | 2009 | 38 | ✓ | ✓ | ✓ | ✓ | - | - | - | - | ✓ | - | - | - | ✓ | ✓ | ✓ | - | ✓ | - | - | - | - | - | - | - | - | - |
| **19** | UK | Scotland | Communities Scotland | Sustainable Housing Design Guide for Scotland[244] | 2007 | 323 | ✓ | ✓ | ✓ | - | ✓ | - | - | ✓ | - | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | - | - | ✓ | ✓ | - | - |
| **20** | | Edinburgh | Council | Edinburgh Design Guidance[245] | 2013 | 100 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | - | ✓ | ✓ | - | - |
| **21** | | Highland | Council | Designing for Sustainability in the Highlands[246] | 2006 (04) | 86 | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | - | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | - | - | ✓ | - | - | - |
| **22** | | Highland | Council | Sustainable Design Guide - Supplementary Guidance[247] | 2013 | 50 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | - | - | - | - | ✓ | ✓ | - | - |

[242] Hugh L. Carey Battery Park City Authority, Hugh L. Carey Battery Park City Authority Residential Environmental Guidelines (2005), http://www.batteryparkcity.org/pdf_n/BPCA_GreenGuidelines.pdf.

[243] Ottawa City Council, Urban Design Guidelines for High-Rise Housing, (Ottawa, 2009), http://documents.ottawa.ca/sites/documents.ottawa.ca/files/documents/con049399.pdf.

[244] Fionn Stevenson et al., Sustainable Housing Design Guide for Scotland, (Scotland: Communities Scotland, 2000), http://www.gov.scot/Resource/Doc/1125/0085460.pdf.

[245] Edinburgh Design Guidance, (Edinburgh: Edinburgh Council, 2013), http://www.edinburgh.gov.uk/downloads/file/2975/edinburgh_design_guidance.

[246] Designing for Sustainability in the Highlands, (Highland: Highland Council, 2006), http://cairngorms.co.uk/resource/docs/publications/01052009/CNPA.Paper.1290.General%20housing%20land%20supply%20-%20objector%20ref%20387%20-%20part%204%20-%20written.pdf.

| No. | Applied Location | | Guidelines Information | | | | Type of Guidelines | | | Introduction | | | Category Base | | | Criteria Explanation | | Compulsory Extent | | Guiding Language | | | | | | | | Others | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| **23** | Germany | | BMUB | Guideline for Sustainable Building[248] | 2014 | 172 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | - | - | ✓ | ✓ | ✓ | - | ✓ | - | - | - | - | - | - | ✓ | - | - |
| **24** | Australia | - | Commonwealth of Australia | Your Home Technical Manual[249] | 2010 (08,05,04,01) | 353 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | ✓ | - | - | - |
| **25** | | South Australia | South Australia | Design Guidelines for Sustainable Housing and Liveable Neighbourhoods – Apartment Design[250] | 2014 | 40 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | - | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | - | - | - | - | - | - | - | - | - |
| **26** | | Victoria | | Guidelines for Higher Density Residential Development[251] | 2004 | 62 | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | ✓ | - | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | - | - | - | - | - | - | - | - | - |
| **27** | | Cairns Region | Regional | Cool Homes: Smart Design for the Tropics[252] | 2014 | 31 | ✓ | ✓ | ✓ | ✓ | - | - | - | ✓ | - | ✓ | - | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | - | - | - | - | ✓ | - | - | - |

247 Sustainable Design Guide - Supplementary Guidance, (Highland: Highland Council, 2013), http://www.highland.gov.uk/downloads/file/3019/highland_council_sustainable_design_guide.

248 *Guideline for Sustainable Building*.

249 Your Home Technical Manual: Australia's Guide to Environmentally Sustainable Homes, (Australia: Commonwealth of Australia, 2010), http://www.todayshomes.com.au/f.ashx/Your-Home-Technical-Manual.pdf.

250 Design Guidelines for Sustainable Housing and Liveable Neighbourhoods – Apartment Design, (South Australia, 2014), http://dcsi.sa.gov.au/__data/assets/pdf_file/0019/6382/Design-Guide-1_3.pdf.

251 Guidelines for Higher Density Residential Development, (Victoria, 2004), http://www.dtpli.vic.gov.au/planning/urban-design-and-development/urban-design-guidelines/higher-density-residential-development.

252 Cool Homes: Smart Design for the Tropics, (Cairns Region: Regional Council, 2014), http://www.cairns.qld.gov.au/__data/assets/pdf_file/0006/100698/Cool-Homes.pdf.

| No. | Applied Location | | Guidelines Information | | | | Type of Guidelines | | | Introduction | | | Category Base | | | Criteria Explanation | | Compulsory Extent | | Guiding Language | | | | | | | | Others | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Country | Region / City / County | Publisher | Guidelines Title | Publishing Year: Latest (Previous) | Pages | Prescriptive | Performance | Advisory | Objective / Intent | How to Use | Approach / Principle | Process-based | Sustainable Issues | Building Components | What is this? | Why do it? | Requirement | Recommendation | Criteria Specification | Detailed Strategies | Reference Data Cited | Illustrated Figure | Checklist | Case Study | Questionnaire | Cost Implication | User Consideration | Further Reference | Relevant Code | Tools | Point |
| | | | Council | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 28 | | Yarra | City Council | Sustainable Design Guidelines: Apartment Development[253] | 2005 | 20 | ✓ | ✓ | ✓ | ✓ | - | - | - | ✓ | - | - | - | - | ✓ | ✓ | ✓ | - | ✓ | - | - | - | - | - | - | - | - | - |
| 29 | New Zealand | | CCANZ | Apartment Design Guide[254] | 2013 | 52 | ✓ | ✓ | ✓ | ✓ | - | - | - | ✓ | - | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | - | - | - | - | - | - |
| 30 | South Africa | Cape Town | | City of Cape Town Smart Building Handbook[255] | 2012 | 40 | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | - | ✓ | ✓ | - | - | ✓ | ✓ | - | ✓ | - | ✓ | - | - | - | - |
| 31 | South Asia | Bhutan | | Bhutan Green Building Guidelines[256] | 2013 | 77 | ✓ | ✓ | - | ✓ | - | - | - | ✓ | - | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | | - | - | - | - | - |
| 32 | | Sri Lanca | | Sustainable Building Design Guideline for Sri Lanka[257] | - | 61 | ✓ | ✓ | - | - | - | - | - | ✓ | - | - | - | - | ✓ | ✓ | - | ✓ | ✓ | - | - | - | - | - | - | - | - | - |

[253] Yarra City Council, *Sustainable Design Guidelines: Apartment Development*..

[254] Apartment Design Guide: Guidelines for the Design of Multi-Storey Apartment Buildings in New Zealand, (New Zealand: Cement & Concrete Association of New Zealand (CCANZ), 2013), http://www.ccanz.org.nz/files/documents/4f553995-3dd0-41cd-8650-4f7d7d4ec11f/CCANZ_Apt_Design_Guide_2014.pdf.

[255] *City of Cape Town Smart Building Handbook: A Guide to Green Building in Cape Town*.

[256] Bhutan Green Building Guidelines (Thimphu: Department of Engineering Services, Ministry of Works and Human Settlements, 2013), http://www.gnhc.gov.bt/wp-content/uploads/2011/05/Final-DRAFT-3-Bhutan-Green-Building-Guidelines-MAY-2013.pdf.

[257] Ravihansa Chandratilake and Shiromal Fernando, Sustainable Building Design Guideline for Sri Lanka, (Green Building Council of Sri Lanka).

| No. | Applied Location | | Guidelines Information | | | | Type of Guidelines | | | Introduction | | | Category Base | | | Criteria Explanation | | Compulsory Extent | | Guiding Language | | | | | | | | Others | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Country | Region / City / County | Publisher | Guidelines Title | Publishing Year: Latest (Previous) | Pages | Prescriptive | Performance | Advisory | Objective / Intent | How to Use | Approach / Principle | Process-based | Sustainable Issues | Building Components | What is this? | Why do it? | Requirement | Recommendation | Criteria Specification | Detailed Strategies | Reference Data Cited | Illustrated Figure | Checklist | Case Study | Questionnaire | Cost Implication | User Consideration | Further Reference | Relevant Code | Tools | Point |
| **33** | Southeast Asia | UNEP SBCI/skat | | After the Tsunami: Sustainable building guidelines for Southeast Asia[258] | 2007 | 69 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | - | ✓ | - | - | - |
| **34** | | UNEP | UNEP | Eco-housing Guidelines for Tropical Regions[259] | 2006 | 126 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | - | - | - | - | - | - |
| NOTE: CCANZ (Cement & Concrete Association of New Zealand); TSP (The Sustainability Project) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

[258] United Nations Environment Programme., *After the Tsunami : Sustainable Building Guidelines for South-East Asia* (Nairobi: UNEP, 2007).

[259] Eco-Housing Guidelines for Tropical Regions, (Bangkok: UNEP, 2006), http://www.rrcap.ait.asia/Publications/eco-housing-unep.pdf.

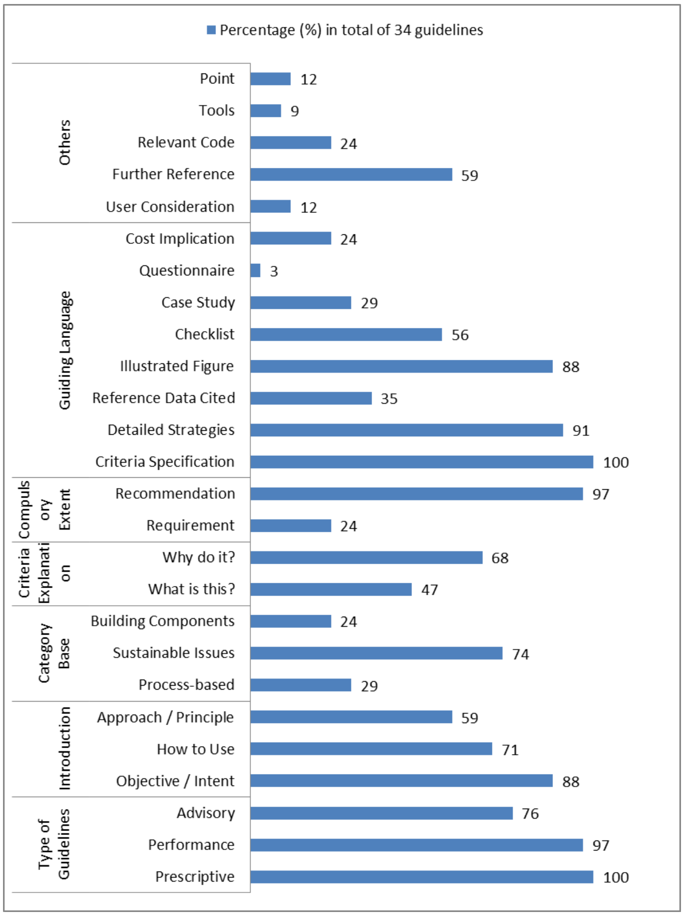



Figure 6-10 Percentage of guidelines components in the total of 34 guidelines

### 6.2.3 In-Depth Analysis of Format of Design Guidelines

The comparative analysis of 34 guidelines has brought about a practical perspective of formatting guidelines. This section contributes more detailed and contextual perspective by analyzing five selected design guidelines for sustainable building. The analysis concentrates on two issues comprising the background of making guidelines, guidelines organization and process.

The five guidelines are selected over the concerns on their specific format and context of making guidelines. Five guidelines include (1) The State of Minnesota Sustainable Building Guidelines, (2) City of Cape Town Smart Building Handbook, (3) Hugh L. Carey Battery Park City Authority Residential Environmental Guidelines, (4) Multifamily Green Building Guidelines, and (5) Eco-housing Guidelines for Tropical Regions.

### 6.2.3.1 The State of Minnesota Sustainable Building Guidelines (B3 Guidelines) Version 2.2[260]

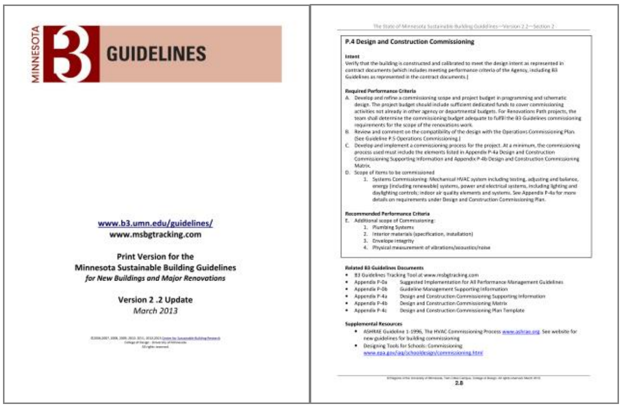
#### a. Guidelines Background

The State of Minnesota Sustainable Building Guidelines, also known as B3 Guidelines[261], was developed to respond to the needs of sustainable building design guidelines mandatory for all new buildings and major renovations, which obtain funding from the governmental bond proceeds fund. In 2000, the Departments of Administration and Commerce, with the support of other agencies, was required by The Minnesota Legislature to build the mandatory guidelines for all new buildings applied from 1 Jan 2004. As a result, the B3 Guidelines Version 1.0 were initially developed in 2004. Since then, the guidelines has consecutively improved and updated. Version 2.0 released in 2006 responded to the various tests of the previous version of pilot projects. In 2008, the scope of guidelines was expanded to apply for all major renovations from 1 Jan 2009 with the publication of the version 2.1 in

[260] Downloaded from [http://www.b3mn.org/guidelines/downloads_v2_2/B3GuidelinesVersion2.2.pdf] on 07 Jun 2015

[261] The name is B3 guidelines because the guidelines are a part of the Buildings, Benchmarks &Beyond (B3) Project. Project management and delivery are led by LHB, Inc. The guideline development process is led by the Center for Sustainable Building Research (CSBR) at the University of Minnesota. Public building benchmarking is led by The Weidt Group.

2009.[262] The present version 2.2 published in 2013 was the latest version with some minor updates (Figure 6-11).


MINNESOTA B3 GUIDELINES

www.b3.umn.edu/guidelines/
www.msbgtracking.com

Print Version for the
Minnesota Sustainable Building Guidelines
*for New Buildings and Major Renovations*

Version 2 .2 Update
*March 2013*

The State of Minnesota Sustainable Building Guidelines—Version 2.2—Section 2

**P.4 Design and Construction Commissioning**

**Intent**
Verify that the building is constructed and calibrated to meet the design intent as represented in contract documents (which includes meeting performance criteria of the Agency, including B3 Guidelines as represented in the contract documents.)

**Required Performance Criteria**
A. Develop and refine a commissioning scope and project budget in programming and schematic design. The project budget should include sufficient dedicated funds to cover commissioning activities not already in other agency or departmental budgets. For Renovations Path projects, the team shall determine the commissioning budget adequate to fulfill the B3 Guidelines commissioning requirements for the scope of the renovations work.
B. Review and comment on the compatibility of the design with the Operations Commissioning Plan. (See Guideline P.5 Operations Commissioning.)
C. Develop and implement a commissioning process for the project. At a minimum, the commissioning process used must include the elements listed in Appendix P-4a Design and Construction Commissioning Supporting Information and Appendix P-4b Design and Construction Commissioning Matrix.
D. Scope of items to be commissioned
1. Systems Commissioning: Mechanical HVAC system including testing, adjusting and balance, energy (including renewable) systems, power and electrical systems, including lighting and daylighting controls; indoor air quality elements and systems. See Appendix P-4a for more details on requirements under Design and Construction Commissioning Plan.

**Recommended Performance Criteria**
E. Additional scope of Commissioning:
1. Plumbing Systems
2. Interior materials (specification, installation)
3. Envelope integrity
4. Physical measurement of vibrations/acoustics/noise

**Related B3 Guidelines Documents**
- B3 Guidelines Tracking Tool at www.msbgtracking.com
- Appendix P-0a Suggested Implementation for All Performance Management Guidelines
- Appendix P-0b Guideline Management Supporting Information
- Appendix P-4a Design and Construction Commissioning Supporting Information
- Appendix P-4b Design and Construction Commissioning Matrix
- Appendix P-4c Design and Construction Commissioning Plan Template

**Supplemental Resources**
- ASHRAE Guideline 1-1996, The HVAC Commissioning Process www.ashrae.org. See website for new guidelines for building commissioning
- Designing Tools for Schools: Commissioning www.epa.gov/iaq/schooldesign/commissioning.html

2.8

Figure 6-11 B3 Guidelines Version 2.2

## b. Guidelines Organization and Process

The guidelines are designed to be accordant with national guiding systems, such as LEED, while maintaining the local values, priorities and requirements. The guidelines system are organized into five environmental topic categories including (1) Performance Management, (2) Site and Water, (3) Energy and Atmosphere, (4) Indoor Environmental Quality and (5) Materials and Waste with 40 subcategories in total.

The guidelines are implemented under a process of four steps including Determine Path and Required Guidelines, Project Planning & Work, Documentation, and Review and Tracking (Table 6-3).

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[262] The major renovations were defined by legislation as at least 10,000 square feet and including the replacement of the mechanical, ventilation, or cooling system of the building or a section of the building.

Table 6-3 B3 Guidelines' Process for Implementation[263]

| Step | Action | In-charge team |
|---|---|---|
| Determine Path and Required Guidelines | Proper path is defined for project, which is either New Buildings Path or Major Renovations Path. The specific guidelines are determined from the B3 Guidelines Compliance Path Table corresponding to the defined path. | Implementers |
| Project Planning & Work | At the start of each phase, the Guide Leader reviews the B3 Guidelines | Guideline Leader |
| Documentation | • Complete the appropriate documentation at the end of each phase via the online B3 Guideline Tracking Tool.<br>• Submit online documentations to Appropriate Agency for compliance review at the end of each phase or annually during operation period. | Work Team<br><br>Guideline Leader |
| Review and Tracking | • Review and determine the reports for approving the level of compliance and variances.<br>• Track the status of compliance, variances, documentation and performance outcomes and summarizes these for the State | The Appropriate Agency<br><br>Center for Sustainable Building Research (CSBR) at the University of Minnesota |

For properly managing the criteria, a master set of guidelines 'B3 Guidelines Compliance Path Table' is made, which reveals the two project status, New Buildings and Major Renovations, and mandatory extent including required and recommended (Figure 6-12).

[263] This table is a summary of the B3 Guidelines' process as the explanation in the guidelines booklet.

## B3 Guidelines COMPLIANCE PATH TABLE

| No. | GUIDELINE | NEW BUILDINGS | MAJOR RENOVATIONS |
|---|---|---|---|
| | PERFORMANCE MANAGEMENT | | |
| P.0 | Guideline Management | Required | Required |
| P.1 | General Project Data | Required | Required |
| P.2 | Planning for Conservation | Required | Required |
| P.3 | Integrated Design Process | Required | Required |
| P.4 | Design and Construction Commissioning | Required | Required |
| P.5 | Operations Commissioning | Required | Required |
| P.6 | Lowest Life Cycle Cost | Recommended | Recommended |
| | SITE AND WATER | | |
| S.1 | Identification and Avoidance of Critical Sites | Required | Documentation Required |
| S.2 | Stormwater Management | Required | Required for Minimum Site Scope (See Guideline) |
| S.3 | Soil Management | Required | Required for Minimum Site Scope (See Guideline) |
| S.4 | Sustainable Vegetation Design | Required | Required for Minimum Site Scope (See Guideline) |

Figure 6-12 B3 Guidelines Compliance Path Table

The entire organizational structure of the B3 Guidelines is summarized in Figure 6-13 and Table 6-4.

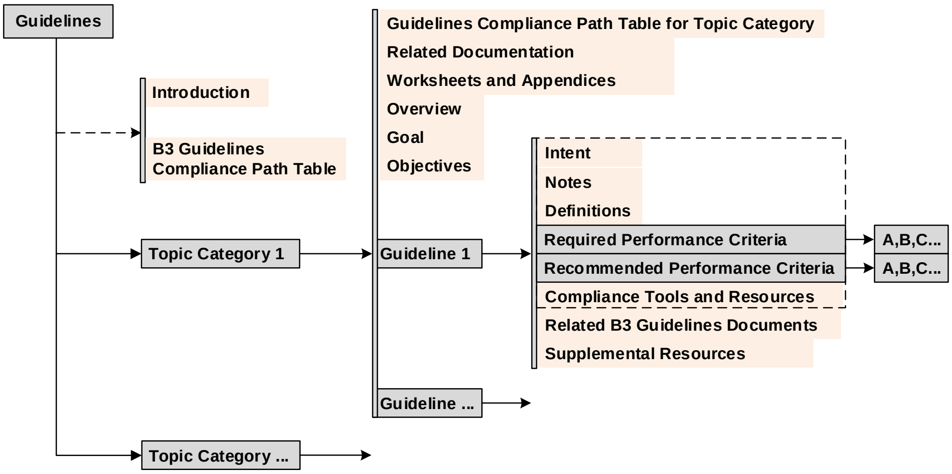


Figure 6-13 Organizational Structure of the B3 Guidelines

Table 6-4 Explanation of organizational structure of the B3 Guidelines

| | | | |
|---|---|---|---|
| **Particular Guidelines Topic Category** | | Guidelines Compliance Path Table | *List all the guidelines in the topic category* |
| | | Related Documentation | *Related guidelines tracking tool* |
| | | Worksheets and Appendices | *Related worksheets and appendices need to be used* |
| | | Overview | *Overview the characteristics of the topic category* |
| | | Goal | *Goal of the topic category section* |
| | | Objectives | *Specific objectives of the topic category* |
| | **Each Guideline of the Category** | Intent | *Describe the main objectives of the guideline* |
| | | Notes | *Related notes in implementation* |
| | | Definitions | *Provide explanation of new conception* |
| | | Required Performance Criteria | *Detail of performance criteria must be achieved in order to fulfill the guideline. (unnecessary in recommended guidelines)* |
| | | Recommended Performance Criteria | *Detail of performance criteria should be achieved in advance to accelerate the outcome of the guideline.* |
| | | Compliance Tools and Resourc es | *Related tools and resources (standards, manuals, survey results, calculated tools, software, and so on) can be used or referred to implement the guideline.* |
| | | Related Guidelines Documents | *Related contents within the guidelines set* |
| | | Supplemental Resources | *Other materials for more reference* |

Basic information and contents of the B3 Guidelines are summarized in the Table 6-5.

Table 6-5 Content summary of the B3 Guidelines

<table>
<tr><th colspan="8">The State of Minnesota Sustainable Building Guidelines (B3 Guidelines)</th></tr>
<tr><td>Country / Region</td><td>US / The State of Minnesota</td><td>Publisher</td><td colspan="4">The State of Minnesota</td></tr>
<tr><td>Pages</td><td>270</td><td>Publishing Year</td><td>2004</td><td>2006</td><td>2009</td><td>2013</td></tr>
<tr><td>Compulsory Extent</td><td>Requirement, Recommendation</td><td>Version</td><td>1.1</td><td>2.0</td><td>2.1</td><td>2.2</td></tr>
<tr><td>Applied Building</td><td colspan="6">All building types</td></tr>
<tr><td>Application</td><td colspan="6">☑ New Buildings ☑ Renovated Buildings</td></tr>
<tr><td>Purpose</td><td colspan="6">Mandatory guidelines for all new buildings and major renovations, which obtain funding from the governmental bond proceeds fund</td></tr>
</table>

<table>
<tr><th colspan="4">Guidelines Content</th></tr>
<tr><th rowspan="2">Topic Category</th><th rowspan="2">Subcategory</th><th colspan="2">Performance Criteria</th></tr>
<tr><th>Required</th><th>Recommended</th></tr>
<tr><td rowspan="7">1. Performance Management</td><td>1.1 Guideline Management</td><td>2</td><td>2</td></tr>
<tr><td>1.2 General Project Data</td><td>4</td><td>-</td></tr>
<tr><td>1.3 Planning for Conservation</td><td>1</td><td>-</td></tr>
<tr><td>1.4 Integrated Design Process</td><td>2</td><td>2</td></tr>
<tr><td>1.5 Design and Construction Commissioning</td><td>4</td><td>1</td></tr>
<tr><td>1.6 Operations Commissioning</td><td>3</td><td>2</td></tr>
<tr><td>1.7 Lowest Life Cycle Cost</td><td>-</td><td>2</td></tr>
</table>

| | | | |
|---|---|---|---|
| 2. Site and Water | 2.1 Identification and Avoidance of Critical Sites | 6 | - |
| | 2.2. Stormwater Management | 3 | - |
| | 2.3 Soil Management | 7 | - |
| | 2.4 Sustainable Vegetation Design | 7 | 1 |
| | 2.5 Light Pollution Reduction | 1 | 3 |
| | 2.6 Erosion and Sedimentation Control during Construction | 7 | - |
| | 2.7 Landscape Water Efficiency | 1 | 1 |
| | 2.8 Building Water Efficiency | 1 | 1 |
| | 2.9 Appropriate Location and Development Pattern | 5 | - |
| | 2.10 Brownfield Redevelopment | 3 | - |
| | 2.11 Heat Island Reduction | 2 | - |
| | 2.12 Transportation Impacts Reduction | 11 | - |
| | 2.13 Wastewater Management | 1 | - |
| | 2.14 Bird Safe Building | 6 | 4 |
| 3. Energy and Atmosphere | 3.1 Energy Efficiency | 4 | - |
| | 3.2 Renewable Energy | 1 | 2 |
| | 3.3. Efficient Equipment and Appliances | 1 | - |
| | 3.4 Atmospheric Protection | 4 | - |
| 4. Indoor Environmental Quality | 4.1 Restrict Environmental Tobacco Smoke | 4 | - |
| | 4.2 Specify Low-emitting Materials | 2 | - |
| | 4.3 Moisture Control | 3 | - |
| | 4.4 Ventilation Design | 2 | 2 |
| | 4.5 Thermal Comfort | 4 | 2 |
| | 4.6 Quality Lighting | 1 | 6 |
| | 4.7 Effective Acoustics | 4 | 4 |
| | 4.8 Reduce Vibration in Buildings | 3 | 4 |
| | 4.9 Daylight | 3 | - |
| | 4.10 View Space and Window Access | - | 3 |
| | 4.11 Personal Control of IEQ Conditions & Impacts | - | 9 |
| | 4.12 Encourage Healthful Physical Activity | - | 4 |
| 5. Materials and Waste | 5.1 Life Cycle Assessment of Materials | 1 | 1 |
| | 5.2 Environmentally Preferable Materials | 3 | 2 |
| | 5.3 Waste Reduction and Management | 3 | 2 |
| **Total** | **40 Subcategories** | **120** | **60** |

### 6.2.3.2 City of Cape Town Smart Building Handbook (2012)[264]

#### a. Guidelines Background

The Smart Building Handbook was developed in 2012 by the City of Cape

264 *City of Cape Town Smart Building Handbook: A Guide to Green Building in Cape Town*.

Town's Environmental Resource Management Department for promoting sustainable building and construction (Figure 6-14). The handbook is developed to provide efficient resources for residents of Cape Town, who are associated with making decisions concerning the built environment. The handbook specifically concerns the wide range of users including homeowners, professionals (architects, engineers, quality surveyors, and facilities managers), developers, contractors, and tenants through the various means, including process-oriented guidelines, and checklists, questionnaires.

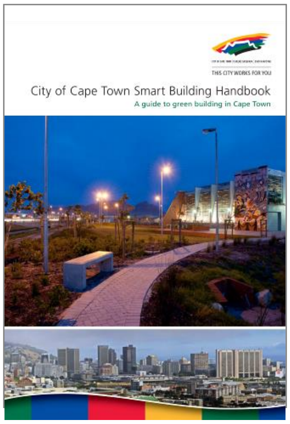


Figure 6-14 City of Cape Town Smart Building Handbook

### b. Guidelines Organization and Process

The guidelines are composed to attain resource-effective buildings in three basic means for serving the multiple purposes of the practitioners. The building professionals can follows working stages of the construction process, from site selection and design to construction and operation. The stakeholders can monitor and manage the projects by using the checklists at each stage of building process. The homeowners, developers and tenants favorably proceed the building project through series of questionnaires that provide the summary of all contents of the guidelines. Besides, this handbook also concerns to the developers and commercial tenants through the instructions on green certifications, benchmarking, and green leasing.[265] The entire organizational structure of the Smart Building Handbook is presented in Figure 6-15.

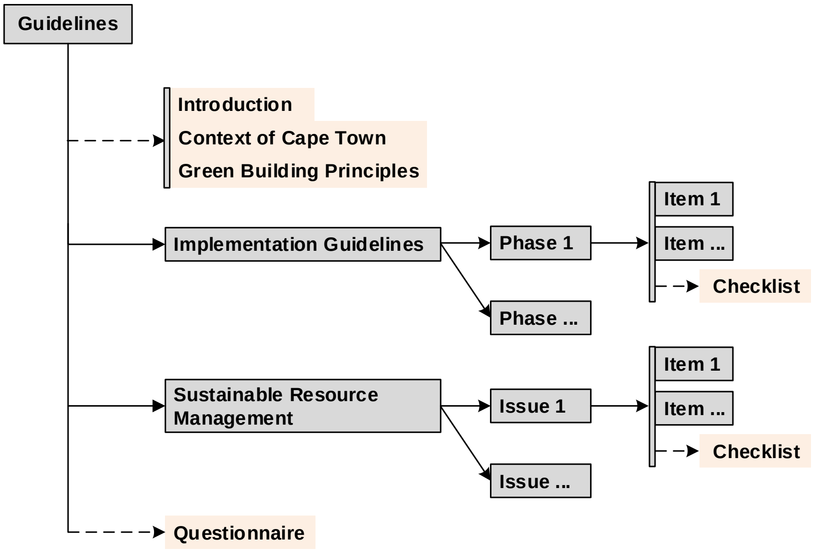


Figure 6-15 Organizational structure of the City of Cape Town Smart Building Handbook

Basic information and contents of the City of Cape Town Smart Building Handbook are summarized in Table 6-6.

Table 6-6 Content Summary of the City of Cape Town Smart Building Handbook

| City of Cape Town Smart Building Hand Book | | | |
|---|---|---|---|
| Country / Region | South Africa | Publisher | The City of Cape Town |
| Pages | 40 | Publishing Year | 2012 |
| Compulsory Extent | Recommendation | Version | - |
| Applied Building | All building types | | |
| Purpose | Resources for citizens of Cape Town in making decisions associated with built | | |

[265] Ibid., 5.

| | | |
|---|---|---|
| | environment | |
| Coverage of Criteria | ☑ Management ☑ Site & Ecology ☑ Energy ☑ Water ☑ IEQ<br>☑ Materials & Resources ☑ Waste & Emissions ☑ Social ☑ Economic ☐ Others | |
| Principles | 1. Be locally appropriate<br>2. Conserve the natural environment<br>3. Use resources efficiently and effectively<br>4. Apply a full life-cycle approach<br>5. Minimize waste<br>6. Use renewable resources | 7. Implement sustainable procurement<br>8. Utilize locally sourced materials and skills<br>9. Maximize the health and well-being of users<br>10. Allow real-time monitoring and evaluation<br>11. Leave a positive legacy |

**Guidelines Framework**

| Main Section | 1st Subsection | Item |
|---|---|---|
| 1. Implementation Guidelines | 1.1 Site selection | 1.1.1 Greyfield and brownfield redevelopment<br>1.1.2 Compact urban development<br>1.1.3 Access to transport networks |
| | 1.2 Design phase | 1.2.1 Establish a knowledgeable team<br>1.2.2 Efficient site planning<br>1.2.3 Efficient building design<br>1.2.4 Passive solar design<br>1.2.5 Orientation and shading<br>1.2.6 Energy-efficient building materials<br>1.2.7 Ceilings and insulation<br>1.2.8 Thermal mass: Heat sinks<br>1.2.9 Natural and traditional building materials and methods<br>1.2.10 Design according to standard sizes of construction materials<br>1.2.11 Integrated planting and roof gardens<br>1.2.12 Economic impact |
| | 1.3 Construction phase | 1.3.1 Soil conservation<br>1.3.2 Recycle construction and demolition waste<br>1.3.3 Use sustainable materials and products<br>1.3.4 Buy local |
| 2. Sustainable Resource Management | 2.1 Energy efficiency | 2.1.1 Passive solar design<br>2.1.2 Insulation<br>2.1.3 Ceilings<br>2.1.4 Air ventilation<br>2.1.5 Tight construction<br>2.1.6 Electricity<br>2.1.7 Lighting<br>2.1.8 On-site generation: Photovoltaic panels and wind generation<br>2.1.9 Water heating |
| | 2.2 Water efficiency | 2.2.1 Stormwater management<br>2.2.2 Water-wise landscaping<br>2.2.3 Rainwater harvesting<br>2.2.4 Plumbing layouts<br>2.2.5 Water-wise installations<br>2.2.6 Grey wastewater systems<br>2.2.7 Water-wise toilets<br>2.2.8 Alternative sanitation options |
| | 2.3 Waste minimization and management | |
| | 2.4 Human health and comfort | 2.4.1 Heating, ventilation and air conditioning (HVAC)<br>2.4.2 Sick building syndrome (SBS)<br>2.4.3 Indoor air quality<br>2.4.4 Allergens<br>2.4.5 Volatile organic compounds (VOCs)<br>2.4.6 Microbial and bacterial growth<br>2.4.7 Fire<br>2.4.8 Visual comfort |

### 6.2.3.3 Hugh L. Carey Battery Park City Authority Residential Environmental Guidelines (2005)[266]

#### a. Guideline Background

The Hugh L. Carey Battery Park City Authority Residential Environmental Guidelines (BPC Guidelines) was initially written in 1999 and published in 2000.[267] So far, the latest updated version of the guidelines was published in 2005, which included several improvements based on lessons learned from *The Solaire*[268], a first residential high-rise building project applied these guidelines, and updated technology, philosophy, and feasibility of sustainable development.

Main goals of this guidelines system are to set up a process for implementing design and construction of environmentally responsible residential buildings. The buildings under these guidelines perform higher quality than current required standards and practices, which contributes a model for healthy and "green" environments for living.

#### b. Guideline Organization and Process

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[266] The Hugh L. Carey Battery Park City Authority Residential Environmental Guidelines are downloaded from web link [http://www.batteryparkcity.org/pdf_n/BPCA_GreenGuidelines.pdf] accessed on 20 Oct 2014.

[267] The Hugh L. Carey Battery Park City Authority Residential Environmental Guidelines were sponsored by the Hugh L. Carey Battery Park City Authority, the New York State Energy Research and Development Authority, and the Carrier Corporation and written by Fox & Fowle Architects, Flack + Kurtz, Green October, the Rocky Mountain Institute, the Carrier Corporation, Barney Skanska USA, the Hugh L. Carey Battery Park City Authority, and the New York State Energy Research and Development Authority.

[268] The Solaire building designed by Pelli Clarke Pelli firm was known as the first "green" residential building in the United States. The building was also the first residential high-rise building in New York City to be certified by the U.S. Green Building Council and has been rated as LEED-NC, v2 – Level: Platinum.

The BPC guidelines are divided into five topic categories, including: (1) Energy Efficiency, (2) Enhanced Indoor Environment Quality (IEQ), (3) Conserving Materials & Resources, (4) Education, Operation & Maintenance, (5) Water Conservation & Site Management. The entire organizational structure of the BPC Guidelines is presented in Figure 6-16 and Table 6-7.

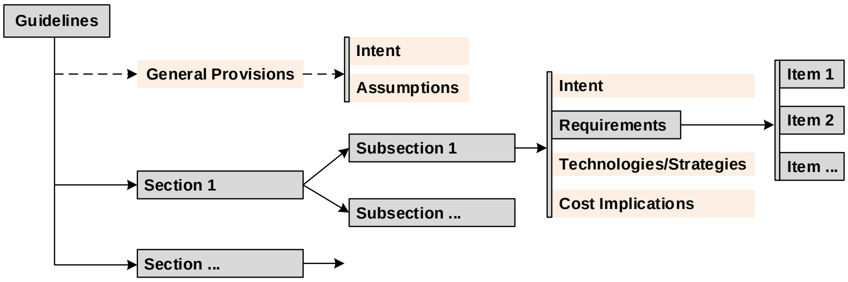


Figure 6-16 Organizational structure of BPC Guidelines

Table 6-7 Explanation of organizational structure of the BPC Guidelines

| | | | |
|---|---|---|---|
| **Particular Guidelines Topic Category** | **General Provisions** | Intent | *Describe the main objectives of the topic category* |
| | | Assumptions | *Explanation of major requirements that will happen in practices to comply with the goals of the topic category* |
| | **Each Guideline of the Category** | Intent | *Describe the main objectives of the particular guideline* |
| | | Requirements | *Detail of specific activities or performance criteria must be achieved in order to fulfill the guideline.* |
| | | Technologies/ Strategies | *Technologies and strategies are recommended to be applied for reaching above requirements* |
| | | Cost Implications | *Describes the effects of above technologies and strategies for achieving this guideline on costs especially initial costs (construction costs)* |

Basic information and contents of the BPC Guidelines are summarized in Table 6-8..

Table 6-8 Content summary of the BPC Guidelines

| **Hugh L. Carey Battery Park City Authority Residential Environmental Guidelines** | | | | | |
|---|---|---|---|---|---|
| Country / Region | US / | | Publisher | | |
| Pages | 92 | | Publishing Year | 2000 | 2005 |
| Compulsory Extent | Requirement, Recommendation | | Version | 1st Edition | Revised Edition |
| Applied Building | Commercial/ Industrial; Multi-family housing; Single-family home | | | | |
| Application | ☑ New Bld | ☑ Renovated Bld | ☑ Low Rise | ☑ High Rise | |
| Purpose | - | | | | |

| **Guidelines Content** | | |
|---|---|---|
| **Topic Category** | **Subcategory** | **No. of Items** |
| 1. Energy efficiency | 1.1 Maximizing energy efficiency | 13 |
| | 1.2 Modeling for energy performance | 3 |
| | 1.3 Renewable Energy & Green Power Sources | 4 |
| 2. Enhanced Indoor Environment Quality (IEQ) | 2.1 Indoor Air Quality (IAQ) | 9 |
| | 2.2 Low-Emitting Materials | 3 |
| | 2.3 Controllability of Systems | 2 |
| | 2.4 Lighting & Daylighting | 2 |
| | 2.5 Indoor Pest Control | 3 |
| | 2.6 Construction IAQ Management | 2 |
| 3. Conserving Materials & Resources | 3.1 Storage & Collection of Recyclables | 3 |
| | 3.2 Construction Waste & Resource Reuse | 2 |
| | 3.3 Recycled Content | 2 |
| | 3.4 Local/Regional Materials | 1 |
| | 3.5 Renewable & Rapidly Renewable Materials | 1 |
| | 3.6 CFC Elimination | 2 |
| | 3.7 Alternative Transportation | 3 |
| | 3.8 Certified Wood | 2 |
| | 3.9 Low-Pollution Fuels | 2 |
| 4. Education, Operations & Maintenance | 4.1 Education | 5 |
| | 4.2 Commissioning | 4 |
| | 4.3 Building Systems Monitoring | 2 |
| | 4.4 Maintenance Accountability | 4 |
| 5. Water Conservation & Site Management | 5.1 Stormwater Management | 4 |
| | 5.2 Water Use Reduction | 3 |
| | 5.3 Innovative Water Technologies | 4 |
| | 5.4 Water Efficient & Responsible Landscaping Practices | 3 |
| | 5.5 Landscape and Roof Design to Reduce “Heat Islands” | 3 |
| | 5.6 Light Pollution Reduction | 2 |
| **Total** | | **93** |

### 6.2.3.4 Multifamily Green Building Guidelines 2008 Edition[269]

#### a. Guideline Background

The guidelines were composed through the cooperation between Green Building in Alameda County and Build It Green organization. These guidelines focus on the multifamily residential buildings in California with specific attention on cost-effective suggestions and reduction of environmental impacts.

#### b. Guideline Organization and Process

The guidelines were developed on the five principles of green building, including (1) plan for livable communities, (2) use energy wisely, (3) improve indoor environmental quality and health, (4) conserve natural resources, (5) conserve water. These guidelines highlight the integrated design in green building with the involvement of various participants, such as owner, occupant, architect, technical engineers, landscape architect, builder & contractor, maintenance & operation team. The entire organizational structure of the Multifamily Green Building Guidelines is presented in Figure 6-17 and Table 6-9.

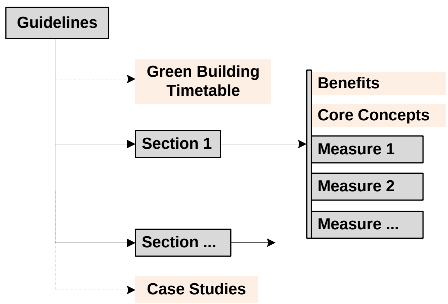


Figure 6-17 Organizational structure of Multifamily Green Building Guidelines

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[269] *Multifamily Green Building Guidelines*.

Table 6-9 Organization of Multifamily Green Building Guidelines

<table>
<tr><th colspan="5">Multifamily Green Building Guidelines 2008 Edition</th></tr>
<tr><td>Country / Region</td><td>US / California</td><td>Publisher</td><td colspan="2">Green Building in Alameda County & Build It Green</td></tr>
<tr><td>Pages</td><td>262</td><td>Publishing Year</td><td>2008</td><td>2004</td></tr>
<tr><td>Compulsory Extent</td><td>Recommendation</td><td>Version</td><td>2008 Edition</td><td>2004 Edition</td></tr>
<tr><td>Applied Building</td><td colspan="4">Multifamily residential building</td></tr>
<tr><td>Application</td><td>☑ New Bld</td><td>☑ Renovated Bld</td><td>☑ Low Rise</td><td>☑ High Rise</td></tr>
<tr><td>Purpose</td><td colspan="4">General education and informational purposes</td></tr>
<tr><td>Principles</td><td colspan="2">1. Plan for livable communities<br>2. Use energy wisely<br>3. Improve indoor environmental quality and health</td><td colspan="2">4. Conserve natural resources<br>5. Conserve water</td></tr>
<tr><th colspan="5">Guidelines Framework</th></tr>
<tr><th>Section</th><th colspan="4">Measure</th></tr>
<tr><td>1. Planning & Design</td><td colspan="2">AA1 Infill sites<br>AA2 Design for walking and bicycling<br>AA3 Alternative transportation<br>AA4 Mixed-use developments<br>AA5 Outdoor gathering places</td><td colspan="2">AA6 Design for safety and vandalism deterrence<br>AA7 Passive solar design, daylighting and natural ventilation<br>AA8 Adaptable buildings<br>AA9 Affordability</td></tr>
<tr><td>2. Site</td><td colspan="2">A1 Protection of soil, vegetation and water during construction<br>A2 C&D waste management<br>A3 Construction environmental quality<br>A4 Recycled aggregate</td><td colspan="2">A5 Cool site<br>B1 Sustainable landscaping<br>B2 Source water efficiency<br>B3 Light pollution reduction</td></tr>
<tr><td>3. Structure</td><td colspan="2">C1 Acoustics: Noise and vibration control<br>C2 Mixed-use design strategies<br>C3 Commissioning<br>D1 Reduced portland cement in concrete<br>D2 Structural pest and rot controls<br>D3 Construction material efficiencies<br>D4 Engineered lumber<br>D5 FSC-certified wood for framing lumber</td><td colspan="2">D6 Raised heel roof trusses<br>D7 Structural insulated panels and other solid wall systems<br>D8 Window replacement<br>E1 Drainage planes and durable siding<br>E2 Sustainable roofing options<br>E3 Vegetated roofs<br>F1 Insulation<br>F2 Quality installation of insulation</td></tr>
<tr><td>4. Systems</td><td colspan="2">G1 Water-efficient fixtures<br>G2 Efficient domestic hot water distribution<br>G3 Water submetering<br>G4 Water heater replacement<br>H0 Heating equipment<br>H1 Radiant hydronic space heating<br>H2 Air conditioning with non-HCFC refrigerants</td><td colspan="2">H3 Advanced ventilation practices<br>H4 Garage ventilation<br>I1 Solar water heating<br>I2 Photovoltaic systems<br>J1 Building performance exceeds Title 24<br>J2 Building diagnostics</td></tr>
<tr><td>5. Finishes & Furnishings</td><td colspan="2">K1 Entryways<br>K2 Recycled paint<br>K3 Low/no-VOC paint and other coatings<br>K4 Low-VOC adhesives and sealants<br>K5 Environmentally preferable materials for interior finish<br>K6 Reduced formaldehyde in interior finishes<br>K7 Durable cabinets<br>K8 Environmentally preferable interior furniture</td><td colspan="2">L1 Environmentally preferable flooring<br>L2 Low-emitting flooring<br>M1 Energy- and water-efficient appliances<br>M2 Central laundry<br>M3 Recycling and waste collection<br>M4 Lighting<br>M5 Elevators<br>M6 Outdoor play structures</td></tr>
<tr><td>6. Operations & Maintenance</td><td colspan="2">N1 Operations and maintenance procedures<br>N2 Transit options</td><td colspan="2">N3 Educational signage<br>N4 Energy monitors</td></tr>
</table>

### 6.2.3.5 Eco-housing Guidelines for Tropical Regions[270]

#### a. Guidelines Background

The Eco-Housing Guidelines for Tropical Regions (EHTR Guidelines) is published by the cooperation of UNEP and UN-Habitat, a cooperation established in 2004 to promote the eco-housing as the efficiently preventive measure in Asia-Pacific region. The guidelines are built from a collection of latest experiences. The provision of this guidelines aims to fill the gap of the shortage the real eco-housing that restrains the adoption of the eco-housing on the larger scale though it has gained the high attention of policy makers in the region.

The guidelines aim to raise the awareness, interest in eco-housing and capacity in the Asia Pacific region. The guidelines are intended to provide the concept of eco-housing to a wide range of users, especially the common practitioners. The guidelines intensively challenge practitioners towards improving the capacity of management, planning, design, construction, and operation the building projects.

#### b. Guidelines Organization and Process

The guidelines grouped into nine topic categories, including: (1) Pre-design guidelines, (2) site planning, (3) material and product selection, (4) sustainable use of energy, (5) water and sanitation, (6) solid waste management, (7) indoor environment quality, (8) construction administration and (9) building commissioning, operation and maintenance. The entire organizational structure of the Eco-housing Guidelines for Tropical Regions is presented in Table 6-10.

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Table 6-10 Organization of Eco-housing Guidelines for Tropical Regions

| **Eco-housing Guidelines for Tropical Regions** | | | | |
|---|---|---|---|---|
| Country / Region | Tropics of Asia Pacific region | Publisher | UNEP RRCAP[271] | |
| Pages | 126 | Publishing Year | 2006 | |
| Compulsory Extent | Recommendation | Version | 1st Edition | |
| Applied Building | Commercial/ Industrial; Multi-family housing; Single-family home | | | |
| Application | ☑ New Bld | ☑ Renovated Bld | ☑ Low Rise | ☐ High Rise |
| Purpose | Promoting eco-housing for the warm and humid climate region in Asia | | | |

| **Guidelines Content** | | |
|---|---|---|
| **Section** | **Subsection** | **No. of Items** |
| 1. Pre-design guidelines | | |
| 2. Site planning | 2.1 Site selection | |
| | 2.2 Site assessment | |
| | 2.3 Site development | 2.3.1 Site layout<br>2.3.2 Landscaping |
| 3. Building Material and products | | |
| 4. Sustainable use of energy | 4.1 Reduction in energy demand | 4.1.1 Building form<br>4.1.2 Landscaping<br>4.1.3 Insulation<br>4.1.4 Thermal mass<br>4.1.5 Natural ventilation<br>4.1.6 Shading and glazing<br>4.1.7 External colours and textures<br>4.1.8 Day lighting |
| | 4.2 Energy efficiency | |
| | 4.3 Renewable energy | |
| 5. Water and sanitation | 5.1 Water supply and use | |
| | 5.2 Sustainable drainage | |
| | 5.3 Waste water treatment and sanitation | |
| 6. Solid waste management | | |
| 7. Indoor environment quality | | |
| 8. Construction administration | | |
| 9. Building commissioning, operationand maintenance | | |
| **Total** | | |

271 United Nations Environment Programme Regional Resource Centre for Asia and The Pacific (UNEP RRCAP)

### 6.2.4 Proposed Format of Design Guidelines applicable to HAB in HCMC

Based on the comparative analysis of 34 guidelines and the in-depth analysis of five selected guidelines, this section argues and suggests the format for design guidelines applicable to sustainable HAB in HCMC. The argument goes over previously analyzed components, discusses and suggests the appropriate items. Seven major items are considered, including intents, approaches and principles of the guidelines, type of guidelines, category base, compulsory extent, guiding language, and others.

#### 6.2.4.1 Intents

The proposed guidelines are intended to be useful sources for those responsible for developing new high-rise apartment projects in HCMC towards sustainability. The guidelines are supporting materials of multiple practitioner groups from developers, building professionals (e.g., architects, engineers).

The guidelines focus on the planning and designing stage of the development. The guidelines provide instructions for planning and designing high-rise apartment projects in HCMC context and takes account of the possible strategies to contribute to the sustainability through economic, environmental and social effects over the short and long term.

#### 6.2.4.2 Approaches and Principles of the Guidelines

The final destination of the proposed guidelines is to achieve a high degree of sustainable development. The fundamental aim is that the HAB built in HCMC must attain a ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs' as defined in Brundtland report (1987). The core contents of proposed guidelines approach the sustainability in a comprehensive view with environmental, social and economic dimensions. The strategies of planning and design are provided on a holistic approach for resources-efficiency. They also encourage the integrated design in which all the participants of the projects share the same vision of sustainability and practising collaborative works for the sustainable target at the appropriate stage of the project. The strategies are also built on the life-cycle awareness. The target is to minimize the life-cycle costs of the projects by application the integrated design and system thinking.

To obtain the full impacts on environmental, economic and social sustainability, the proposed guidelines are going to built on seven fundamental principles, including:

(1) Plan for locally appropriate and livable communities

(2) Design on the life-cycle justification

(3) Give priority to local resources

(4) Conserve the natural resources and environment

(5) Use energy wisely

(6) Minimize waste and emission

(7) Promote health and well-being

#### 6.2.4.3 Type of Guidelines

The prescriptive, performance and advisory guidelines are used in the proposed guidelines to serve the various forms of criteria and detailed strategies.

However, the prescriptive and advisory guidelines are preferred since it is easy to comply for the non-professional users such as owners, developers, contractors, and tenants.

#### 6.2.4.4 Category Base

The proposed guidelines with hundred of designing, constructing and managing strategies need to be classified to facilitate the implementation and management. The proposed guidelines are categorized base on the sustainable issues. The investigation shown on Figure 6-10 indicates that the majority of guidelines are constructed on the sustainable issues-based category. Design strategies grouped on particularly sustainable issues maintain a sense of the logic of solution and its effects and facilitate integrated design process when multidisciplinary practitioners are involved in a particular issue.

#### 6.2.4.5 Compulsory Extent

The recommendation is consistent with the compulsory degree for the proposed guidelines. Unlike building code, the guidelines are developed to encourage the awareness of sustainable development in built-environment in HCMC. The guidelines support the users on suggesting the possible solutions and strategies to achieve a specific impact on the sustainable building. Therefore, the criteria strategies recommend rather than mandate the practitioners to follow the guidelines.

#### 6.2.4.6 Guiding Language

Multiple guiding languages should be used for efficiently transferring the guiding contents to the practical actions. The guidelines must be clear, specific and readable. Based on the result of guidelines survey shown in Figure 6-10, the proposed guidelines should use the following language in composing the guidelines contents, including criteria specification, detailed strategies, reference data cited, illustrated figure, checklist, and case study. The criteria specification and detailed strategies are the basic manners for readers understanding the criteria and strategies. The cited reference data helps readers tracking back to the materials that supporting the content of the guideline as well as provides more sources for advanced users. The illustrated figure makes the guideline more lively and readable. The case study is necessary for evidently sensing the guiding strategies since there are rare examples of sustainable apartment buildings in Vietnam. The checklist is favorable to managers to review the performance of projects as well as supports the integrated design.

The questionnaire and cost implication is not used in the proposed guidelines. The questionnaire is somehow similar to the check-list in practices while the cost implication is likely impossible to apply in the HCMC context because there are insufficient data on the costing. The cost implication might be applicable in the future when HCMC built industry and market are perfectly developed.

#### 6.2.4.7 Others

The user consideration, further reference, and relevant code are supplemental sections of the proposed guidelines. The proposed guidelines are built on the integrated design approach that stresses on the collaboration of multidisciplinary actors. User consideration section guides who is involved in the particular guideline, and scope of an each actor, thus facilitates interaction in teamwork. The further reference supports advanced user to study in depth the interested theme, then expanding the sustainable knowledge. The relevant code is important to assist practitioners tracking back the relevant legislation codes, standards that are equivalent to the guideline strategy. This section makes sense of the connection of the guidelines and the local legislation systems.

The supporting tools and pointing certification are advanced features that are often accompanied by the certification system and assessment team which is inconsistent with the intents of this guidelines system.

## 6.3 The Proposed Framework for Design Guidelines

A complete design guidelines framework is constituted of two elements, format and content. The format element is discussed and suggested in Section 6.2. The content element is the strategies attained in Step-3, Table 5-3. As a result, the proposed framework for design guidelines is established by combining the two elements and presented in Table 6-11.

Table 6-11 Proposed framework for design guidelines

<table>
<tr><th colspan="5">Design Guidelines for Sustainable High-Rise Apartment Buildings in Ho Chi Minh City</th></tr>
<tr><th colspan="5">1. Guidelines Format</th></tr>
<tr><td>Country / Region</td><td colspan="2">Vietnam / Ho Chi Minh City</td><td>Publisher</td><td>-</td></tr>
<tr><td>Pages</td><td colspan="2">-</td><td>Publishing Year</td><td>2016</td></tr>
<tr><td>Applied Building</td><td colspan="4">Apartment Buildings</td></tr>
<tr><td>Application</td><td>☑ New Bld</td><td>☐ Renovated Bld</td><td>☐ Low Rise</td><td>☑ High Rise</td></tr>
<tr><td>Coverage of Development Phase</td><td colspan="4">Planning – Design</td></tr>
<tr><td>Purpose</td><td colspan="4">Useful sources for those responsible for developing new high-rise apartment projects in HCMC towards sustainability</td></tr>
<tr><td>Users</td><td colspan="4">Developers<br>Building professionals (e.g., architects, engineers, and facilities managers)<br>Building contractors</td></tr>
<tr><td>Principles</td><td colspan="4">(1) Plan for locally appropriate and livable communities<br>(2) Design on the life-cycle justification<br>(3) Give priority to local resources<br>(4) Conserve the natural resources and environment<br>(5) Use energy wisely<br>(6) Minimize waste and emission<br>(7) Promote health and well-being</td></tr>
<tr><td>Type of Guidelines</td><td colspan="4">Prescriptive, performance, and advisory guidelines</td></tr>
<tr><td>Introduction</td><td colspan="4">Intent<br>How to Use<br>Approach & Principle</td></tr>
<tr><td>Category Base</td><td colspan="4">Sustainable Issues</td></tr>
<tr><td>Criteria Explanation</td><td colspan="4">What is this?<br>Why do it?</td></tr>
<tr><td>Compulsory Extent</td><td colspan="4">Recommendation</td></tr>
<tr><td>Guiding Language</td><td colspan="4">Criteria specification<br>Detailed strategies<br>Reference data cited<br>Illustrated figure</td></tr>
</table>

| | |
|---|---|
| | Checklist<br>Case study |
| Others | User consideration<br>Further reference<br>Relevant code |

| **2. Guidelines Content** | | |
|---|---|---|
| **No.** | **Code** | **Strategy** |
| **A- Neighborhood Formation** | | |
| **A1 Community Connectivity** | | |
| 01 | A1.1.Ha | Locate a site in walking distance to many community services and amenities |
| 02 | A1.1.Hb | Locate a site in walking distance to public transit stops (bus stop and urban rail station) |
| 03 | A1.2.H | Incorporate space for community involvement within project by providing dedicated community facilities flexible for varied activities (e.g. recreational facilities, meeting room, childcare facilities, gardens) |
| 04 | A1.3.G | Include a range of different housing types and sizes to accommodate residents of differing age, income, ethnicity and physical ability |
| **A2 Collective Participation** | | |
| 05 | A.2.1.H | Involve local residents in the design process from an early stage through events such as public notification and consultation meeting |
| 06 | A2.2.G | Create an integrated approach to the design process by involving key design team members, users, occupants and operators |
| **B- Natural Vegetation Preservation** | | |
| **B1 Vegetation Enhancement** | | |
| 07 | B1.1.V | Preserve the site with existing and adapted vegetation |
| 08 | B1.2.V | Enhance vegetated open space and biodiversity |
| **B2 Land Use Optimization** | | |
| 09 | B2.1.H | Optimize the layout and reduce the development footprint to save land and natural resources, and preserve open space |
| 10 | B2.2.G | In site selection, avoid building on environmentally, culturally, and socially sensitive sites. |
| 11 | B2.3.G | Rehabilitate a brownfield or previously occupied site |
| 12 | B2.4.G | Reuse and refurbish site with existing buildings |
| **C- Climatic Response** | | |
| **C1 Building Orientation** | | |
| 13 | C1.1.H | Optimizing the building orientation for maximizing the number of apartments facing south for taking advantage of solar shading and prevailing winds |
| **C2 Buffer Space** | | |
| 14 | C2.1.T | Incorporate the buffer space as veranda, balcony or loggia space for preventing interior space from direct sunlight and heavy rainfalls |
| 15 | C2.1.Ha | Provide buffer spaces like staircases, lifts, store, toilets, etc., on majority of the west wall |
| **C3 Shading Devices** | | |
| 16 | C3.1.V | Incorporating exterior shading devices (e.g. overhangs, screens, and louvers) |
| 17 | C3.2.T | Install an occupant-controlled shading system on all windows, glazed doors and roof lights in regularly occupied spaces |
| **C4 Lightweight and Insulated Envelope** | | |
| 18 | C4.1.V | Use lightweight structures for building envelope |
| 19 | C4.2.Ha | Provision of thermal insulation on building envelope (e.g. walls and roof) |
| 20 | C4.2.Hb | Provision of two-layer roof |
| 21 | C4.2.Hc | Use of thermal insulation on the east and west facing external walls |
| 22 | C4.2.Hd | Select windows and exterior glazing assemblies with thermally broken frames and insulated spacers, and with appropriate low-e coating |
| 23 | C4.3.G | Stop air leakage at doors, windows, wall/slab junctions, mechanical openings, and other assemblies penetrating the building envelope for air, thermal, and water barriers |
| 24 | C4.4.G | Provision of vertical greenery system on building facades abutting the living, dining and bedrooms areas of dwelling units |
| 25 | C4.5.G | Install a vegetated roof on large portion of roof area |
| **C5 Climatically Responsive Landscape** | | |
| 26 | C5.1.V | Plan the landscaping to work with the site microclimate (e.g. shading, ventilation, and daylighting) |
| **C6 Solar Heat Reflectance** | | |

| | | |
|---|---|---|
| 27 | C6.1.T | Provision of light color textures and rough textures for building external facades |
| 28 | C6.1.Ha | Use of cool paints on the east and west facing external walls |
| 29 | C6.2.T | Provision of light color and rough textures for building roofing materials |
| 30 | C6.3.H | Use light-colored and heat-reflective hardscapes |
| 31 | C6.4.G | Provide shade from a tree canopy, solar panels structures or solar reflective architectural structures |
| **D- Exploitation of Renewable Energy** | | |
| **D1 Space composition** | | |
| 32 | D1.1.H | If necessary, incorporate skywell as a place to exploit energy from nature in forms of daylighting and air movement |
| **D2 Natural Ventilation** | | |
| 33 | D2.1.H | In each apartment unit, arrange the openings in opposite sides and interior doors to facilitate the cross ventilation |
| 34 | D2.2.H | Use light well for enhancing stack ventilation if necessary |
| 35 | D2.3.H | Incorporate the controllable slits and openings to doors, windows, walls, and partitions to enhance the air circulation across spaces |
| 36 | D2.5.T | Use operable windows for cross ventilation in combination with mechanical ventilation systems (e.g., ceiling/wall-mounted fans, exhaust fans) |
| 37 | D2.6.T | Take into account security, noise and dust concerns when providing natural ventilation |
| 38 | D2.7.H | All public and circulation spaces and large portion of habitable rooms to be provided with cross and/or stack natural ventilation |
| 39 | D2.8.H | Replace air conditioning with natural ventilation including common areas and habitable spaces |
| 40 | D2.9.G | Design car-parking facilities with natural ventilation or mechanical ventilation with demand controls through sensor |
| **D3 Daylighting** | | |
| 41 | D3.1.Ha | Selecting appropriate glazed size for daylighting and avoiding excessive illumination levels inside the building |
| 42 | D3.1.Hb | Use appropriate double-glazed units with Low-e glass, or glass coatings |
| 43 | D3.2.T | Use floor surface and light shelves for increasing the penetration of daylight |
| 44 | D3.2.Ha | Avoid glare in daylighting strategies and use textured/rough surfaces to diffuse the reflected daylight for reducing glare |
| 45 | D3.3.H | Planning landscape and the building blocks for working as reflectors diffusing daylighting |
| 46 | D3.4.T | Use high reflectance (light color) of internal finishes for lighting penetration enhancement |
| 47 | D3.5.H | Daylighting for all public and circulation spaces and the large portion of habitable rooms |
| 48 | D3.6.G | Increase minimum size of habitable rooms, increase floor-to-ceiling heights and decrease distance of habitable spaces from windows |
| 49 | D3.7.G | Planning interior partitions and furniture that avoids blocking daylight |
| **D4 Occupant Controllability** | | |
| 50 | D4.1.V | Use flexible occupant-controlled openings (doors and windows) in regularly occupied spaces for natural ventilation and daylighting control |
| 51 | D4.2.T | Provision of interior sunlight control elements (e.g., curtain, drapes, blinds, adjustable louvers) |
| **D5 Using Renewable Energy** | | |
| 52 | D5.1.G | Install on-site renewable energy generation systems (solar photovoltaic, wind turbines, biomass) |
| 53 | D5.3.G | Use solar water heating system for supplementing common water heating needs |
| 54 | D5.5.G | Use geothermal systems, cogeneration, or other alternatives for water heating and space cooling |
| **E - Water Conservation** | | |
| **E1 Minimizing Water Use** | | |
| 55 | E1.1.V | Landscaping with native and indigenous vegetation |
| 56 | E1.2.G | Water efficient irrigation systems |
| 57 | E1.3.G | Cluster plants with similar water needs (“water-use” zones) |
| 58 | E1.4.G | Use water-conserving plumbing fittings and fixtures (e.g. faucets, showerheads, water closets, and urinals) and water-saving appliances (e.g. dishwasher and washing machine) |
| 59 | E1.5.G | Use site-reclaimed water (non-potable water) for landscape irrigation, or toilet flushing, or cooling tower |
| **E2 Water Reuse** | | |
| 60 | E2.1.V | Collecting and storing rainwater for later use |
| 61 | E2.2.G | Use ecology-based treatment (wetland treatment) processes (i.e. ultrafiltration) for sewage treatment or reclaimed water treatment if site’ space allows |
| 62 | E2.3.G | Grey/black water treatment, recycling and reuse for non-portable purposes (landscape irrigation and flushing toilets and urinals) |

| | | |
|---|---|---|
| **E3 Stormwater Runoff Infiltration** | | |
| 63 | F1.4.G | Design drainage systems that adequately dispose of rainwater and prevent flooding from excessive runoff, size gutters and other rainwater goods to allow for higher rainfall |
| 64 | E3.1.H | Use permeable/pervious paving materials or open grid pavement system for hardscapes |
| 65 | E3.2.H | Use swales, soak-ways, and holding ponds |
| **F- Natural Calamity Response** | | |
| **F1 Flooding Prevention** | | |
| 66 | F1.1.V | Locate the building on elevated position |
| **F2 Typhoon Prevention** | | |
| 67 | F2.1.H | Planning and design buildings for restriction of wind damage and storm |
| **F3 Earthquake Resistance** | | |
| 68 | F3.1.H | Design building structures for earthquake resistance |
| **G- Eco-Friendly Material** | | |
| **G1 Local Materials** | | |
| 69 | G1.1.T | Use local/regional materials |
| **G2 Reuse and Recycling of Materials and Components** | | |
| 70 | G2.1.H | Reuse/renovate a building by maintain existing building structure, walls, floors, and roof |
| 71 | G2.2.V | Reuse building nonstructural components (e.g. doors, windows, panels) |
| 72 | G2.3.V | Use reusable, recyclable materials |
| 73 | G2.4.V | Use the reused, refurbished, and salvaged materials |
| 74 | G2.5.V | Use materials with appropriate durability |
| 75 | G2.6.G | Use recycled materials or materials with recycled content (e.g., recycled-content drywall, acoustical ceiling tiles, insulation, latex paint, landscape elements) |
| 76 | G2.7.G | Design and select materials for simple and self-evident care and maintenance |
| 77 | G2.8.G | Use certified wood/timber |
| **G4 Rapidly Renewable Materials** | | |
| 78 | G4.2.V | Use natural/organic materials for building nonstructural elements |
| 79 | G4.3.V | Use natural/organic materials for furnishings |
| **G5 Low-Emitting Materials** | | |
| 80 | G5.1.T | Select timbers that use non-toxic methods to treat timber decay, insect attack and other rot problems, avoid toxic chemical treatment of timber where possible |
| 81 | G5.1.Ta | Reduce formaldehyde emissions in composite and wood-based products (cabinets, interior trim, shelving, subflooring and others) |
| 82 | G5.2.G | Use recycled-content, formaldehyde-free fiberglass insulation, cellulose insulation, or other green insulation products |
| 83 | G5.4.G | Specify low and zero-VOC interior paints, stains and other coatings |
| 84 | G5.5.G | Use flooring systems ( e.g. carpet systems, concrete, wood, tile floor finishes) that emit low levels of VOCs |
| **G6 Low Embodied Energy Materials** | | |
| 85 | G6.1.G | Minimize the use of highly processed materials such as metals, concretes and plastics, alternately use low embodied energy materials (e.g., certified timber, raw materials) |
| 86 | G6.2.G | Use non-baked materials for non-structural walls |
| 87 | G6.3.G | Design for flexibility and adaptability to future changes in building use (e.g., layout, building structures) |
| **H- Occupants' Comfort Perception** | | |
| **H1 Thermal Comfort** | | |
| 88 | H1.1.V | Elevated ground floor for humidity prevention |
| 89 | H1.2.G | Proper indoor ventilation rate for mechanically ventilated spaces (at least meet the local building code) |
| **H2 Vision Comfort** | | |
| 90 | H2.1.V | Provision of views to the outdoor environment |
| 91 | H2.2.T | Use indoor planting beds in communal areas for interior decoration and air quality improvement |
| **H3 Acoustic Comfort** | | |
| 92 | H3.1.T | Provide an effective level of acoustic insulation within buildings |
| 93 | H3.2.G | Noise pollution reducing |
| 94 | H3.3.G | Reduce vibration in buildings |
| 95 | H3.4.G | Positive soundscapes |
| **I- Waste & Pollution Reduction** | | |
| **I1 Collection of Recyclables** | | |
| 96 | I1.1.H | Provide a centralized and easily accessible space for collection and storage of recyclables on each floor and for entire building |

| | | |
|---|---|---|
| **I2 Alternative Transportation** | | |
| 97 | I2.1.H | Provide favorable bicycle lanes and secure and easily accessible bicycle storage/parking on the site |
| 98 | I2.2.H | Provide favorable public or private walkway and pedestrian-friendly amenities that meet the multiple needs |
| 99 | I2.3.H | Locate preferred parking, bicycle parking, pick-up areas, and covered waiting spaces within close proximity of the main building entrances |
| 100 | I.2.4.H | Provide limited parking capacity to meet but not exceed minimum local zoning requirements |
| 101 | I.2.5.G | Provide an amount of preferred parking spots for buses, sharing vehicles, and high-performance hybrid vehicles (low-emitting and fuel efficient models) with discounted rate |
| 102 | I.2.6.G | Provide public transport information and assistance for residents including routes and schedules in an obvious and accessible location |
| **I3 Pollutant Sources Control** | | |
| 103 | I.3.1.H | Provide removable entryway mats, walk-off grilles at the interior of all building entrances to capture potential contaminants and dirt |
| 104 | I.3.2.H | Prohibit smoking in all common areas of the building except in designated smoking areas |

## 6.4 Validation Issue

Presently, the architectural designing activities in HCMC has no much concern over the terms of sustainability. The numbers of ‘green’ buildings designed recently bring about merely formal appearance rather than the real sustainable performance of the building. There is a shortage of guidelines special for sustainable HAB in HCMC. The actual situation is demanding guidelines for sustainable HAB when the HAB becomes the major housing tendency in HCMC. It is essential to develop design guidelines in the context of a shortage of guidance for designing practices in HCMC towards sustainability. The framework is thus the efficient tool that enables practitioners to develop flexibly varied design guidelines for fostering sustainable HAB in HCMC.

This dissertation, therefore, attempts to propose guidelines through referring to the prevalent guidelines in developed countries and incorporating those guidelines into the HAB in HCMC for maximizing connection with local tradition and context. This thesis has proposed a framework applicable to design guidelines for sustainable HAB in HCMC. The proposed framework involves two primary elements of the guidelines: the format and content of guidelines. The format element is built on the basis of comparative analysis of 34 existing design guidelines and in-depth analysis of five typical design guidelines. The content element is constructed through the three-step process, starting with inherent strategies in Vietnamese vernacular houses, expanding through analysis of contemporary houses, and enlarging with reference to selected design guidelines and assessment methods. On the theoretical side, it is evident that the proposed framework is readily applicable to design guidelines for sustainable HAB in

HCMC since it practically touches the original culture of Vietnamese settlement and presents issues of contemporary living in HCMC. This thesis, therefore, contributes the cornerstone for putting the sustainability into practices.

This proposed framework needs to be validated to present its applicability. However, this dissertation does not conduct the validating action because the conditions for testing the validation of proposed framework are weak. Lacking of sustainable awareness of the public potentially becomes an obstacle for testing any guidelines for sustainable building. Since validation is not part of this dissertation, whether the proposed framework is valid in actual application remains a question. The testing validation of proposed framework would be conducted in separate research. It is necessary to conduct the experimental and pilot research to qualify the proposed framework.

# Chapter Seven: Conclusion

Sustainable development has been a global tendency that changes all the conventional thinking. Since the introduction of the term ‘sustainable development’ in 1987, the process of promoting sustainability has made a large step in the developed world. However, Vietnam, like other developing country, is still standing out of the major global course, being facing many environmental, social and economic issues during the process of the modernization and urbanization. These issues are more serious to HCMC, a largest and the most populous city in Vietnam. The building sector is one of the major factor contributing the GHG emission, polluted air, and environmental degradation. HAB has been a major tendency, the developing sustainable HAB in HCMC thus is crucial for sustainable built environment.

This research results in a proposed framework applicable to design guidelines for sustainable HAB in HCMC. Besides, this study brings about some major contribution to the academic research in term of sustainable housing in Vietnam and HCMC. Some important findings as follows:

First, this study gives a general knowledge about sustainable built environment, in particular, the topic areas and the general criteria for sustainable residential buildings. This perspective provides a basic foundation for any works associated with the sustainable residential building.

Second, the thesis has systematically broken down Vietnamese vernacular houses into many aspects and brought about eight sustainability terms, including neighborhood formation, natural vegetation preservation, climatic response, exploitation of renewable energy, water conservation, natural calamity response, eco-friendly material, and occupant's comfort perception.

Third, this research has closely argued the HAB in HCMC through the ten cases of HAB with five secondary cases of townhouses based on the strengthening the inherent strategies of vernacular houses. The insights of analyzing HAB in HCMC involve positive strategies and negative issues which were given strategies as a solution. The work on HAB is the great basis for any associated research on sustainable HAB in HCMC.

Fourth, this research contributes holistic strategies applicable to design guidelines for sustainable HAB in HCMC. The strategies are developed through a three-step process that results in the incorporation of the Vietnamese vernacular inherent strategies, contemporary responsive strategies, and the international high-quality guidelines strategies. The strategies fall into nine categories including neighborhood formation, natural vegetation preservation, climatic response, exploitation of renewable energy, water conservation, natural calamity response, eco-friendly material, occupant's comfort perception, and waste & pollution reduction.

Fifth, this study has brought about the comprehensive perspective of the formats of the guidelines as a result of the comparative of 34 existing guidelines and in-depth analysis of the five guidelines. Many items constituting guidelines format are surveyed. These findings enable guidelines maker to build well-structured guidelines that efficiently operate.

Finally, the proposed framework for design guidelines is the major result of this research, which embeds all findings. This framework can be used as a foundation for developing a number of design guidelines for sustainable HAB in HCMC. Besides, it is also the good reference for any studying on progressing the guidelines. In conclusion, the development of the proposed framework has great potentials in opening large effects on the application in the moment of expanding HAB in HCMC. This will contribute not only the academic knowledge but also practical influences on sustainability in HCMC.

This research, however, remains numbers of limitations. The major limitation is the validation is not included in this research. Lacking of validation makes the proposed framework is still behind convincing the usage of it. The second limitation is that the proposed framework is built on the pre-construction process meanwhile the sustainability regards the whole life of the building. Additionally, this proposed framework pays more attention to the environmental and social issues rather than economic issues in the comprehensive approach to sustainability.

To solve above limitations, the author recommends some further research to stabilize and strengthen this research. The first recommendation is the validating this proposed framework to check if it is valid when applying to designing activities in HCMC. The second suggestion is further research on guidelines for the post-design stage for sustainable HAB in HCMC.

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# Appendices

Appendix A: Vernacular House Case Study Models

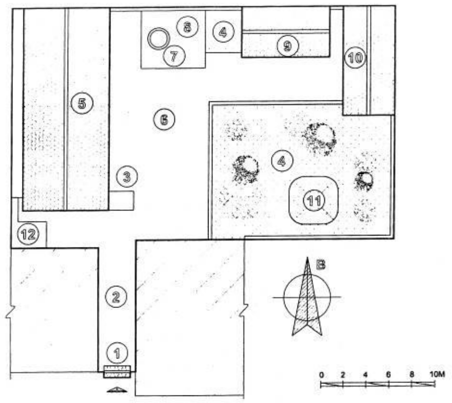
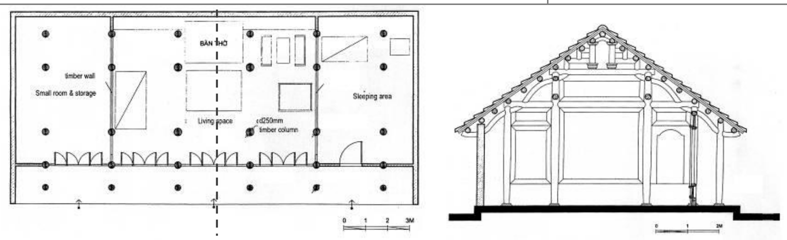
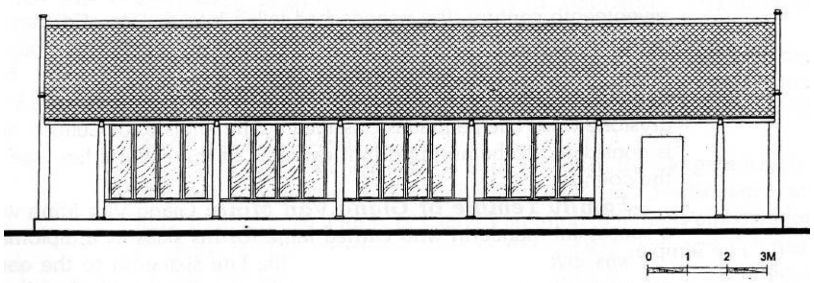
Appendix B: High-Rise Apartment Buildings in HCMC Case Study Models

Appendix C: Townhouses in HCMC Case Study Models

Appendix D: Green Building Assessment Methods Selected for Analysis

## Appendix A: Vernacular House Case Study Models

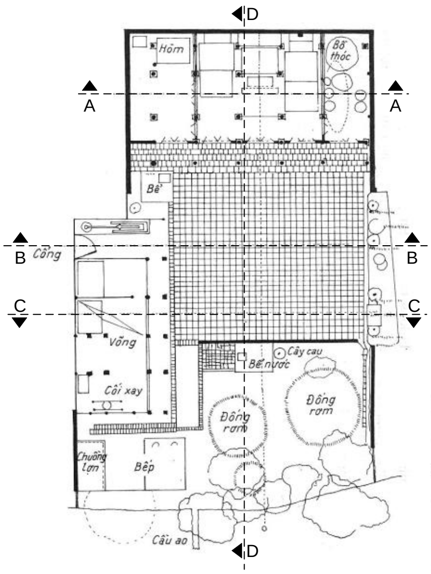
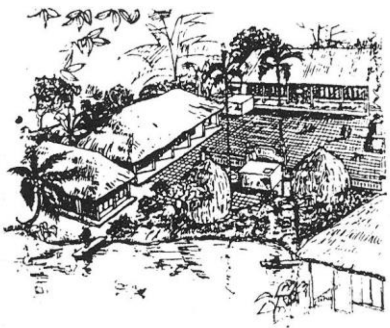
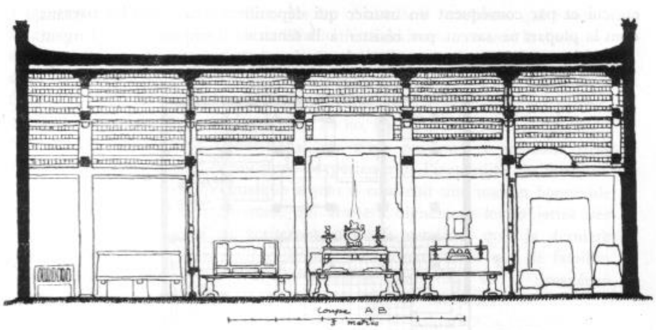
## A-1 Case V1: Mr. Hung's House

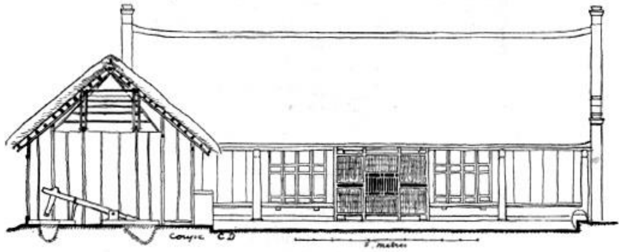
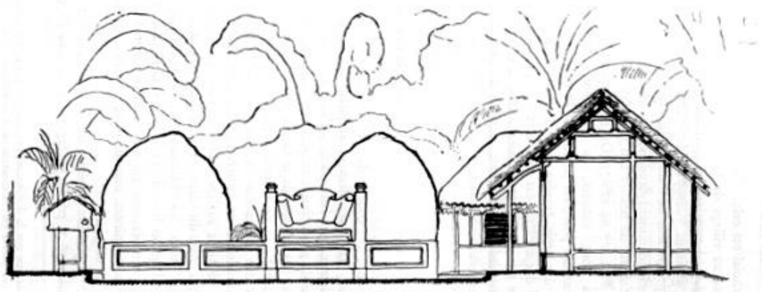
| General Information | | |
|---|---|---|
| Name: | Mr. Hung's House | |
| Owner: | Mr. Nguyen Van Hung (Nguyễn Văn Hùng) | |
| Location: | Sui Duoi hamlet, Mong Phu village, Duong Lam commune, Son Tay town, Son Tay province | |
| Year of Construction: | 1649, (12 generations of living) | |
| Functions: | Living | |
| Architectural Style: | Northern traditional style | |
| Main House Plan: | Five compartments and two lean-tos | |
| Construction Method: | Northern traditional methods, wooden structures are constructed by the locally skilled carpenter bands, drystone wall | |
| Drawings & Images | | |
| Site Plan |  | Legend:<br>1- Gate<br>2- Entry<br>3- Incense burner<br>4- Garden<br>5- Main house<br>6- Paved courtyard<br>7- Well<br>8- Area for washing<br>9- Kitchen<br>10- Animal shelter<br>11- Haystack<br>12- Toilet |
| Main House Plan & Section |  | |
| Main House Elevation |  | |

<table>
<tr><td colspan="3">Main house (1,2)</td></tr>
<tr><td colspan="3"> </td></tr>
<tr><td colspan="2">Courtyard & ancillary buildings (3,4)</td><td>Garden (5)</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Altar space (6)</td><td colspan="2">Roofing structures (7,8)</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="2">Structural details (9,10)</td><td>Gate (11)</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Source:</td><td colspan="2">(drawings, 7) Research Institute of Architecture, Conservation of the Traditional Vietnamese Village, Architecture and Landscape, Research Institute of Architecture, Hanoi, 2003. (p. 46-49)<br>(2~5,8,11) http://vietlandmarks.com/module/groups/action/viewimages/id/913/album/0#0<br>(6,9,10)_http://giadinh.vnexpress.net/tin-tuc/nha-dep/khong-gian-song/nhung-ngoi-nha-300-nam-van-dep-o-lang-co-duong-lam-2965158.html<br>(1) http://6hsang.com/xa-hoi/ve-tham-lang-co-duong-lam-331972.html</td></tr>
</table>

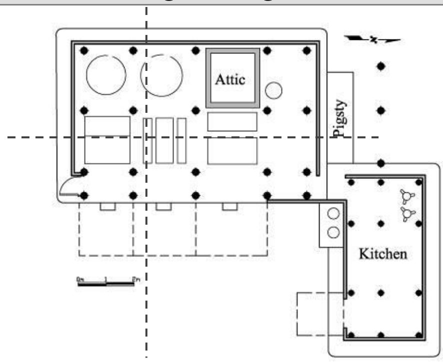
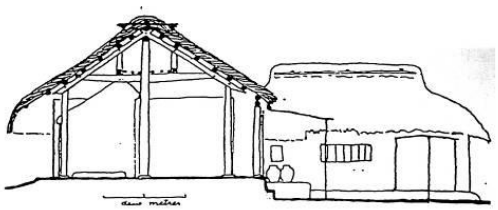
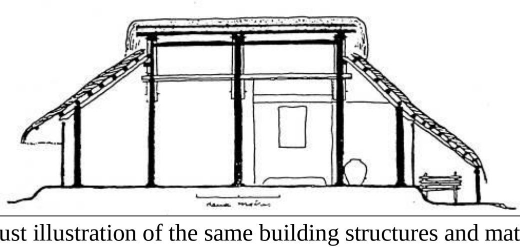
## A-2 Case V2: Quan Nhan House

| General Information | |
|---|---|
| Name: | Quan Nhan house |
| Owner: | Unknown |
| Location: | Khuong Dinh ward, Thanh Tri district, Hanoi |
| Year of Construction: | Unknown |
| Functions: | Living space & agricultural activities |
| Architectural Style: | Vernacular style |
| Main House Plan: | Five compartments |
| Construction Method: | Northern methods, wooden structures are constructed by the locally skilled carpenter bands, drystone wall |

| Drawings & Images | |
|---|---|
| Site Plan & Perspective |   |
| Section AA |  |

| | |
|---|---|
| Section BB |  |
| Section CC |  |
| Section DD |  |
| Source: | (Drawings) extracted from Gourou, Pierre, Les paysans du delta tonkinois. Etude de géographie humaine, Éd. d’Art et d’Histoire, Publication de l’École française d’Extrême-Orient, 1936. pp. 289-92. through Brélle, Dany Michelle, ‘The regional discourse of French geography in the context of Indochina: the theses of Charles Robequain and Pierre Gourou’, Univesrity, 2002.<br>(Site Plan & Perspective) Tran, Dinh Hieu, Design Principles of Housing Architecture [in Vietnamese], (Hue: Hue University of Sciences, 2007), 44. |

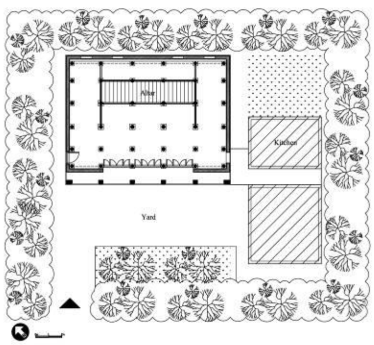
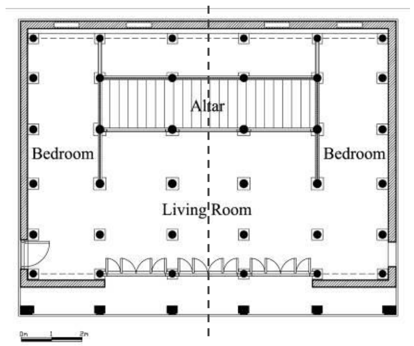
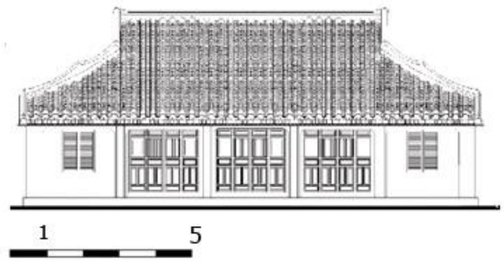
## A-3 Case V3: Di Luan House

| General Information | |
|---|---|
| Name: | Di Luan house |
| Owner: | Unknown |
| Location: | Hien Luong commune, Vinh Linh distirct, Quang Tri province |
| Year of Construction: | Unknown |
| Functions: | Living space & agricultural activities |
| Architectural Style | Vernacular style |
| Main House Plan: | Three compartments and one lean-tos |
| Construction Method | Timber framing, thatch roofs and walls, bamboo, rattan, cane and earthen walls |
| **Drawings & Images** | |
| Site Plan |  |
| Section 1 |  |
| Section 2 |  |
| Note: The below images are just illustration of the same building structures and materials, not the real Di Luan house | |
| Perspectives (1,2) | |

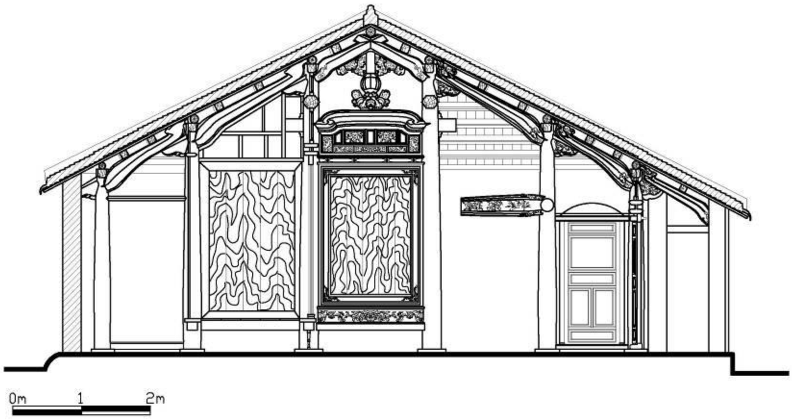
| | | |
|---|---|---|
|  | |  |
| Overhang and shading devices (3,4) | | Side façade (5) |
|  |  |  |
| Interior spaces (6,7) | | |
|  | |  |
| Source: | (Drawings) Gourou, Pierre, Esquisse D'une Etude De L'habitation Annamite Dans L'annam Seftentrional Et Central Du Thanh Hoa Au Binh Dinh, : Les Editions d'art et d'historie, Paris, 1936.<br>(1,5,6,7)_http://www.panoramio.com/user/4974548/tags/Ngh%E1%BB%87%20An-Nam%20%C4%90%C3%A0n retrieved on July 2nd, 2014.<br>(2,3) http://dantri.com.vn/van-hoa/phuc-dung-3-can-nha-hang-xom-cua-bac-ho-873209.htm<br>(4) http://landtoday.net/vn/print/38844/index.aspx | |

# A-4 Case V4: Huynh Anh House

| General Information | |
|---|---|
| Name: | Huynh Anh house |
| Owner: | Origin: Mr. Nguyen Dinh Hoang, 3rd gen.: Mr. Nguyen Huynh Anh, present: Mr. Nguyen Dinh Hoan |
| Location: | Loc Yen village, Tien Canh ward, Tien Phuoc district, Quang Nam province |
| Year of Construction: | 1850 (3 years of construction) |
| Functions: | Living & agricultural activities |
| Architectural Style: | Ruong house of Quang Nam traditional style |
| Main House Plan: | Three compartments and two lean-tos |
| Construction Method: | Wooden structure, constructed by local skilled carpenter bands at Van Ha village |

| Drawings & Images | |
|---|---|
| Site Plan & Main Building Plan |    |
| Elevation |   |

Section




Main Building (1,2)

Main Entrance & Garden (3)

Veranda Space (4)

Front Doors (5,6)

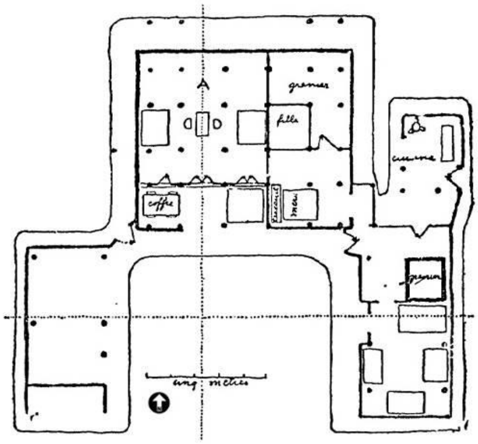
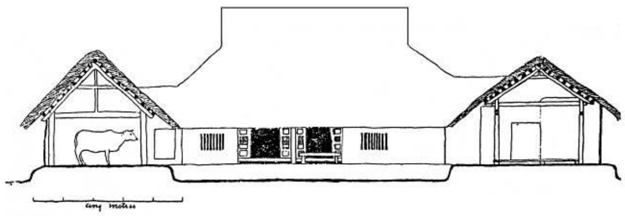
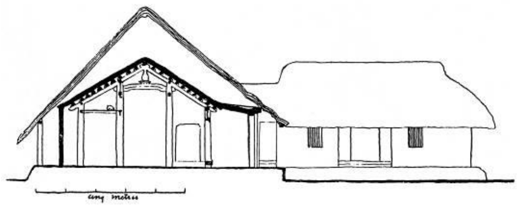
Interior Space (7,8)

Roof Tiles (9)

Interstices for ventilation (10,11,12)

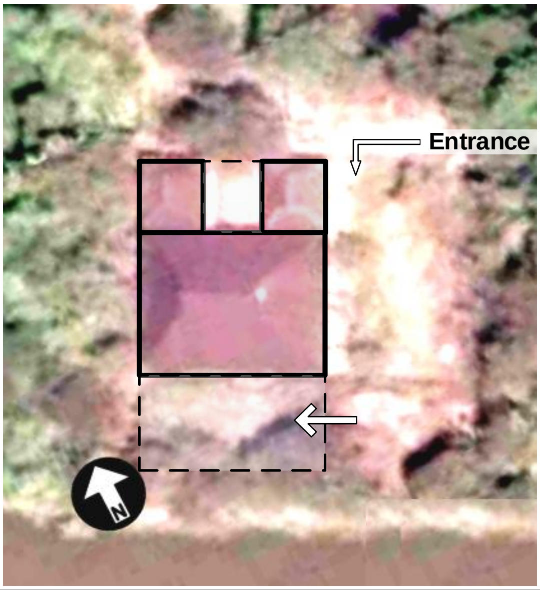
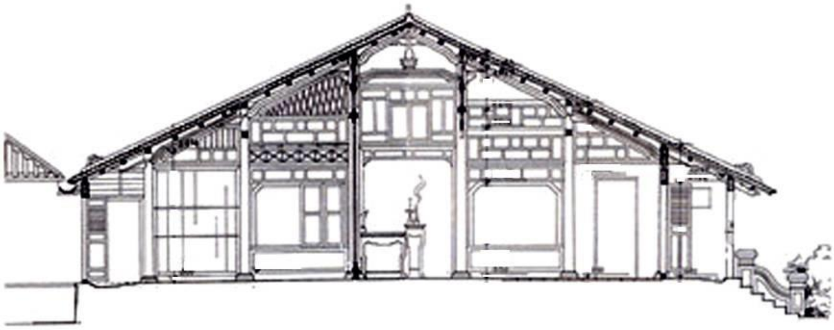
| | |
|---|---|
|    | |
| Source: | http://vietnamnet.vn/vn/kinh-doanh/206609/nha-co-trieu-do-khong-ban-cua-lao-nong-xu-quang.html<br>http://dominiart.net/bv/chiem-nguong-nha-co-1597.html<br>https://nguyenanhtuandn.wordpress.com/2013/08/21/nha-co-dat-quang-nam/<br>(Elevation): Nguyen, Anh-Tuan, Quoc-Bao Tran, Duc-Quang Tran, and Sigrid Reiter. "An Investigation on Climate Responsive Design Strategies of Vernacular Housing in Vietnam." Building and Environment 46, no. 10 (2011): 2088-106. |

## A-5 Case V5: My Hoa House

| General Information | |
|---|---|
| Name: | My Hoa house |
| Owner: | Unknown |
| Location: | My Hoa commune, Phu My town, Binh Dinh province |
| Year of Construction: | Unknown |
| Functions: | Living space & agricultural activities |
| Architectural Style | La Mai house of Binh Dinh vernacular style |
| Main House Plan: | Three compartments and two lean-tos |
| Construction Method | Timber framing, thatch and earthen roofs and walls, bamboo, rattan, cane and earth walls |
| **Drawings & Images** | |
| Site Plan |  |
| Section 1 |  |
| Section 2 |  |
| Source: | Gourou, Pierre, Esquisse d'une etude de l'habitation annamite dans l'Annam Seftentrional et central du Thanh Hoa au Binh Dinh (Paris: Les Editions d'art et d'historie, 1936). fig. 31 and 32 |

## A-6 Case V6: Nha Tram Cot House

| General Information | |
|---|---|
| Name: | Nha Tram Cot house |
| Owner: | Mr. Tran Van Hoa (Original) |
| Location: | Cau Ngang hamlet, Long Huu Dong ward, Can Duoc district, Long An province |
| Year of Construction: | 1901 (3 years of construction from 1901 to 1903) |
| Functions: | Living space & agricultural activities |
| Architectural Style | Traditional style of Ruong house in Hue |
| Main House Plan: | Three compartments and two double lean-tos |
| Construction Method | Wooden structures are constructed by the skilled carpenter bands that are originated from Central Vietnam |

| Drawings & Images | |
|---|---|
| Site Plan |  |
| Section |  |

Main façade (1,2,3); Side façade (4)

Back courtyard (5,6)

Roofing structure (7)

Veranda Space (8,9)

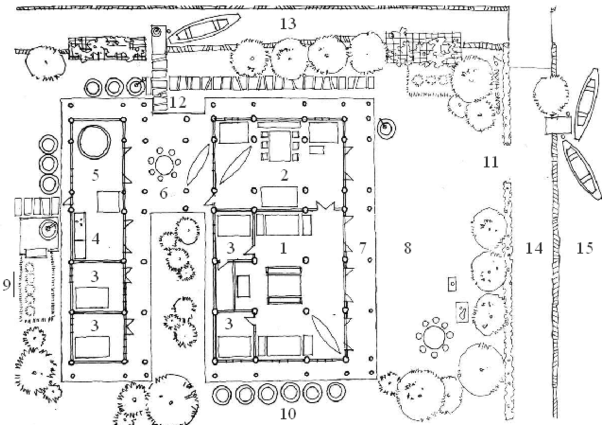
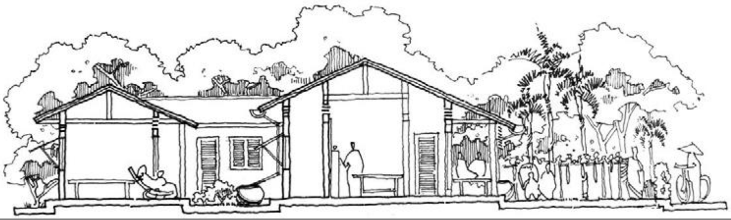
Entrance (10)


Interior Space (11,12,13)

| | |
|---|---|
|    | |
| Source: | [Site Plan] Google maps<br>[Section],(7) http://hcmufa.edu.vn/tap-chi/thong-tin-my-thuat-so-1-2/net-dep-cham-khac-nha-tram-cot/<br>(1)_http://www.phuot.vn/threads/88872-Nh%C3%A0-tr%C4%83m-c%E1%BB%99t-Ph%C3%A1o-%C4%91%C3%A0i-R%E1%BA%A1ch-C%C3%A1t-v%C3%A0-H%E1%BB%93-D%E1%BA%A7u-Ti%E1%BA%BFng-2-ng%C3%A0y-cu%E1%BB%91i-tu%E1%BA%A7n<br>(2),(8),(10)_http://www.phuot.vn/threads/189927-Lang-thang-1-ng%C3%A0y-C%E1%BA%A7n-Giu%E1%BB%99c-C%E1%BA%A7n-%C4%90%C6%B0%E1%BB%9Bc-G%C3%B2-C%C3%B4ng<br>(3) https://ssl.panoramio.com/photo/13830090<br>(4) https://ssl.panoramio.com/photo/13830100<br>(5) Back side: http://ditichlichsuvanhoa.com/dttc/NHA-TRAM-COT-a980.html<br>(6) https://ssl.panoramio.com/photo/13830096<br>(9) https://ssl.panoramio.com/photo/13830092<br>(11),(12),(13) http://vietnam.vnanet.vn/vietnamese/doc-dao-nha-tram-cot/25139.html |

## A-7 Case V7: Chau House

| General Information | |
|---|---|
| Name: | Chau house |
| Owner: | n/a |
| Location: | Cai Lay district, Tien Giang province |
| Year of Construction: | n/a |
| Functions: | Living space & agricultural activities |
| Architectural Style | Traditional southern style, (influenced by Ruong house in central Vietnam) |
| Main House Plan: | Complex |
| Construction Method | Wooden structures are constructed by the locally skilled carpenter bands |

| Drawings & Images | | |
|---|---|---|
| Site Plan |  | Legend:<br>1. Main room<br>2. Secondary room<br>3. Bedroom<br>4. Kitchen<br>5. Store<br>6. Dining room<br>7. Veranda<br>8. Front courtyard<br>9. Garden<br>10. Water pots<br>11. Main gate<br>12. Secondary Entrance<br>13. Small canal<br>14. Riverside road<br>15. River |
| Section |  | |
| Main Building |  | |
| Front courtyard (1,2,3) | | |



Veranda Space (4,5,6)



Interior Space (7,8)

Garden (9,10)





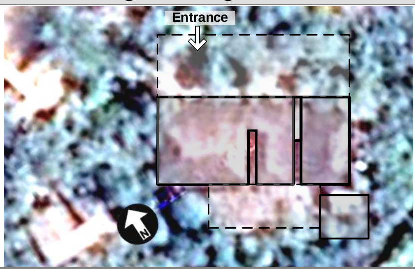
| | |
|---|---|
| Source: | (all) Giang, Ngoc Huan, 'A Design Method for High-Rise Housing in Ho Chi Minh City Following the Ensuring of Micro-Climatic Conditions and Energy Efficiency Using (in Vietnamese)', Master, Univesrity, 2007. |

## A-8 Case V8: Mr. Kiet's House

| General Information | |
|---|---|
| Name: | Mr. Kiet's house |
| Owner: | Mr. Tran Tuan Kiet |
| Location: | Phu Hoa hamlet, Dong Hoa Hiep ward, Cai Be district, Tien Giang province |
| Year of Construction: | 1838 |
| Functions: | Living space & agricultural activities |
| Architectural Style | Traditional southern style (influenced by south central style) |
| Main House Plan: | Complex, "丁" shaped plan with five compartments |
| Construction Method | Wooden structures are constructed by the skilled carpenter bands that are originated from Central Vietnam |

Drawings & Images

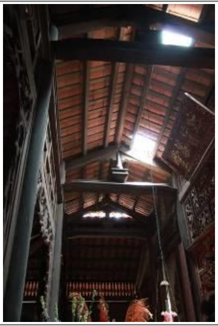
Site Plan




Front courtyard (1,2)

Back façade (3)

Side façade (4)

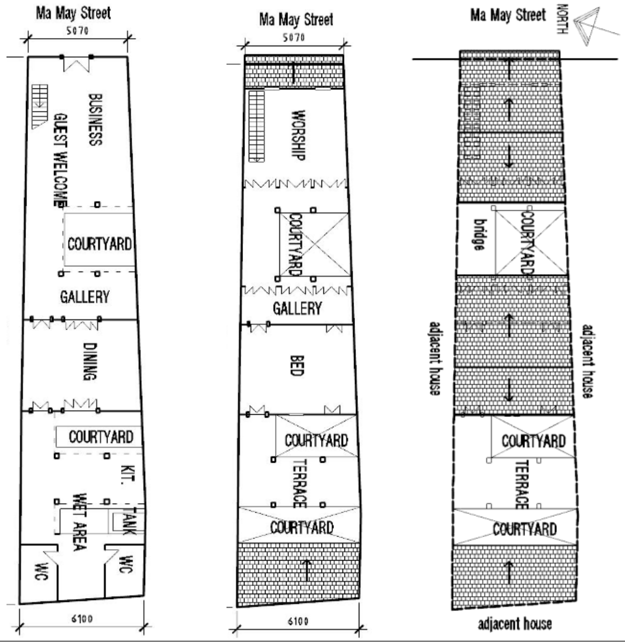
| Veranda Space (5,6,7) | | |
|---|---|---|
|  |  |  |
| Interior Spaces (8,9,10) | | |
|  |  |  |
| Ventilation & Daylighting (11,12) | | |
|  |  | |
| Gate & Front Garden (13,14,15) | | |
|  |  |  |
| Source: | http://khucquanhanh.vn/diendan/showthread.php?t=258&page=3<br>http://dili006.blogspot.kr/2014/06/tham-quan-nha-co-ba-kiet-o-cai-be.html<br>http://tinnong.thanhnien.com.vn/du-hi/den-cai-be-tham-nha-co-ut-kiet-47907.html<br>http://www.tongphuochiep71.com/index.php?mod=detail_chiase&id=2115<br>https://picasaweb.google.com/116087015881189831884/2014053003#6019126290214899602<br>http://www.lamsao.com/ve-tien-giang-tim-nha-xua-p214a55926.html<br>http://dulich.nld.com.vn/goc-anh-lu-hanh/nha-co-o-tien-giang-20110912040153861.htm<br>http://www.baovinhlong.com.vn/xa-hoi/du-lich/201511/le-hoi-du-lich-lang-co-dong-hoa-hiep-2640194/#.VlJkbUeUeFs<br>http://www.vnphoto.net/forums/showthread.php?t=28998&page=5 | |

# A-9 Case V9: Urban house in Hanoi

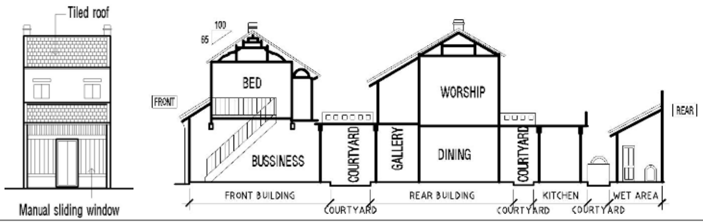
| General Information | |
|---|---|
| Name: | (Urban house in Hanoi) |
| Owner: | n/a |
| Location: | 87 Ma May St., Hang Buom Ward, Hoan Kiem Dist., Hanoi |
| Year of Construction: | 1890 |
| Functions: | Commercial & living space |
| Architectural Style | Traditional style |
| House Plan: | Tube-shaped |
| Construction Method: | Wooden structure, wooden floors, brick walls |

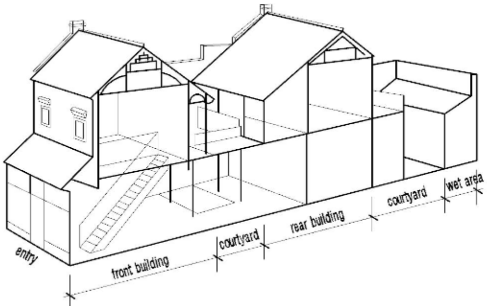
Drawings & Images

PLAN:
1F, 2F, Roof




Elevation &
Section



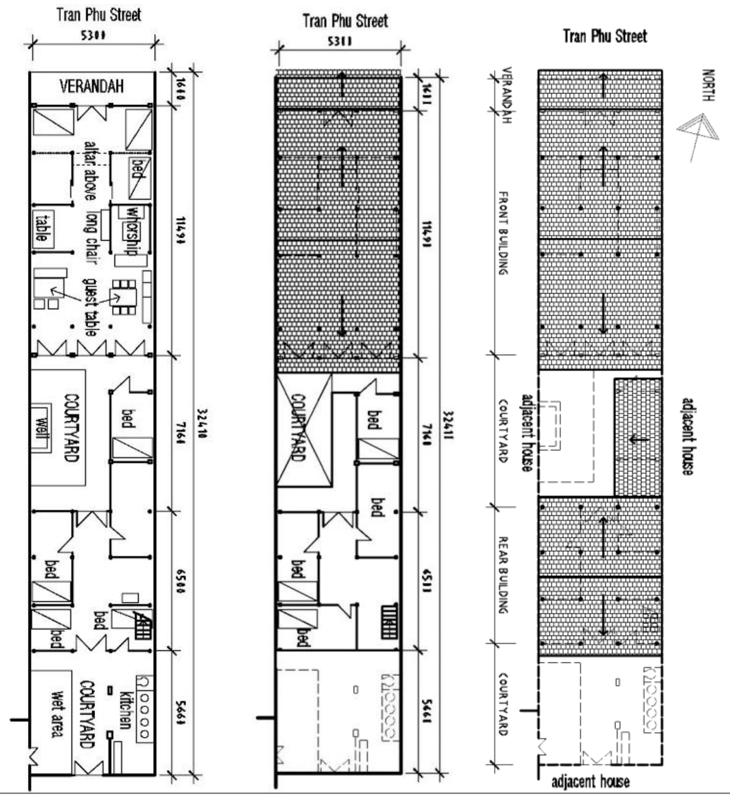
| | | |
|---|---|---|
| Space Composition |  | |
| Main façade (1) | Interior space (2) | Back courtyard (3) |
|  |  |  |
| Center courtyard (4,5,6) | | |
|  |  |  |
| Source: | Ly, Phuong The, 'A Critical Regionalist Approach to Housing Design in Vietnam: Socio-Environmental Organisation of Living Spaces in Pre-and Post-Reform Houses', Univesrity, 2012.<br>http://kienthuc.net.vn/nha-dat/kham-pha-nha-cuc-co-giua-ha-noi-337144.html?p=1<br>http://thanglong.gocom.vn/47220p1c30/pho-co-ha-noi-nha-bao-ton-87-ma-may.htm<br>(2,4) http://hanoitrip.net/dia-diem-du-lich/noi-thanh-ha-noi/nha-co-87-ma-may/<br>http://vivuhanoi.com/den-nha-co-87-ma-may-de-tim-hieu-lich-su-36-pho-phuong-ha-noi.html | |

## A-10 Case V10: Urban house in Hoi An

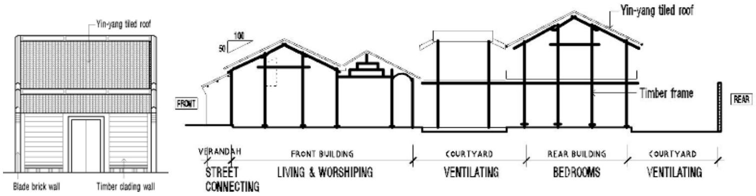
| General Information | |
|---|---|
| Name: | Quan Thang House (Urban house in Hoi An) |
| Owner: | n/a |
| Location: | 77 Tran Phu St., Hoi An City |
| Year of Construction: | 1850s |
| Functions: | Commercial & living space |
| Architectural Style | Traditional style (influenced Chinese and Japan styles) |
| House Plan: | Tube-shaped |
| Construction Method: | Wooden structure, wooden floors, brick walls, constructed by local skilled workers of traditional carpenter bands |

**Drawings & Images**

PLAN:
1F, 2F, Roof




Elevation &
Section



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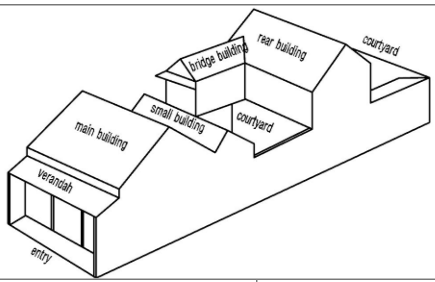
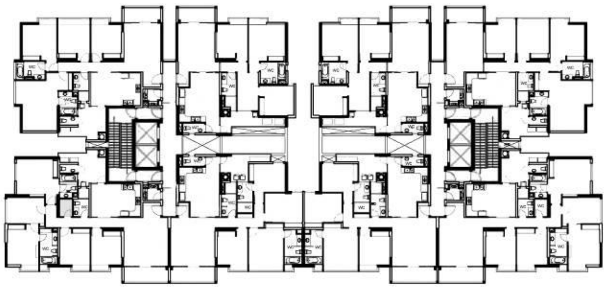
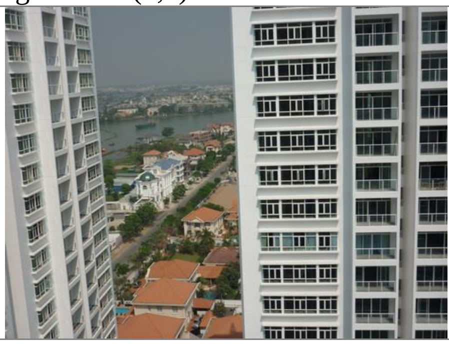
<tr><td>Space Composition</td><td colspan="3">
</td></tr>
<tr><td colspan="2">Main façade (1)</td><td>Interior space (2)</td><td>Center courtyard (3)</td></tr>
<tr><td colspan="2"></td><td>
</td><td></td></tr>
<tr><td>Source:</td><td colspan="3">Ly, Phuong The, ‘A Critical Regionalist Approach to Housing Design in Vietnam: Socio-Environmental Organisation of Living Spaces in Pre-and Post-Reform Houses’, Univesrity, 2012.<br>(2,3)http://www.tripadvisor.com/LocationPhotoDirectLink-g298082-d7590313-i135059786-Nha_Co_Quan_Thang-Hoi_An_Quang_Nam_Province.html accessed on 4th November 2015<br>http://www.hoianworldheritage.org.vn/vi/news/Diem-di-tich/Nha-co-Quan-Thang-651.hwh accessed on 4th November 2015</td></tr>
</table>

# Appendix B: High-Rise Apartment Buildings in HCMC Case Study Models

## B-1 Case A1: Hoang Anh River View

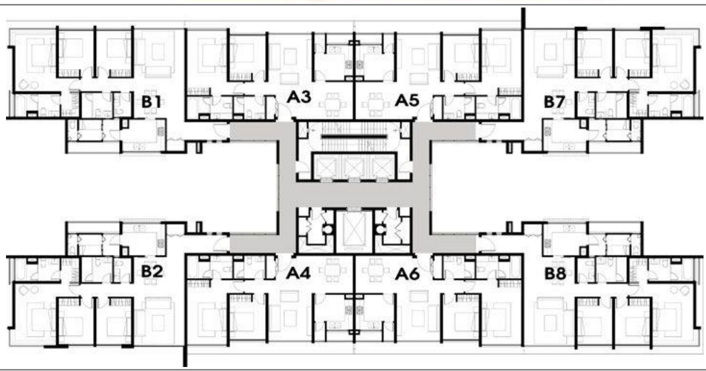
| General Information | |
|---|---|
| Name: | Hoang Anh River View |
| Owner: | HAGL Land |
| Location: | 37 Nguyen Van Huong St., Thao Dien Ward, Dist. 2. HCMC |
| Land lot / Density: | 16.230 m2; |
| Completion date: | 2011 |
| No. Blocks/ Floors/Apts: | 3 blocks; 25 floors; 576 apartment units |
| Functions: | Living and office space |
| Internal facilities: | Swimming pool, tennis court, communal hall, supermarket, kindergarten, outdoor playground for children, gym, health spa |
| Externally facilities near the site: | British International School, Cutural University, An Phu supermarket, Metro supermarket, |
| Public transport hubs: | Bus stop, subway station (future), |

| Drawings & Images | |
|---|---|
| Site Plan |  |
| Typical Floor Plan |  |

<table>
<tr><td>Typical Apartment Plan</td><td>
</td></tr>
<tr><td colspan="2">Perspective (1,2)</td></tr>
<tr><td colspan="2">
</td></tr>
<tr><td colspan="2">Building facades (3,4)</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="2">Landscape (5,6)</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="2">Living room (7,8)</td></tr>
</table>

| | |
|---|---|
|  |  |
| Bedroom (9) | Kitchen (10) |
|  |  |
| Source: (Accessed on 5 Oct 2015) | http://www.hagl.com.vn/land/detailland/9<br>http://www.hagl.com.vn/Land_Posts/DetailPost/20110316090840840<br>(Typical apartment plan) http://dainamhung.vn/hoang-anh-riverview/mat-bang-can-ho<br>(3,5,6)http://thuecanhosg.com/cho-thue-can-ho-chung-cu-hoang-anh-river-view/cho-thue-can-ho-cao-cap-hoang-anh-river-view-quan-2-gia-16-5-trieu-thang-pr67292.htm<br>http://banchungcusaigon.com/ban-can-ho-chung-cu-hoang-anh-river-view/can-ban-can-ho-harv-q2-157m2-4pn-tang-cao-view-song-shcc-noi-that-lh-090-545-7956-pr291903.htm<br>(7,9)http://www.vnrental.com/apartment/district-2/1200$us-4brs---apartment-for-rent-in-hoang-anh-gia-lai-building--district-2--hcm-city--vietnam/1531_en-US.aspx<br>(8) http://quan2nhadat.com/q2_nhadat_3.20150520083533-f32d.jpg |

## B-2 Case A2: The Vista

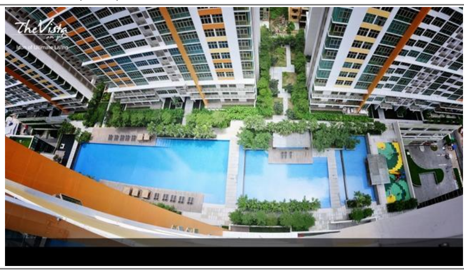
| General Information | |
|---|---|
| Name: | The Vista |
| Owner: | CapitalLand |
| Location: | Hanoi highway, An Phu Ward, Dist. 2 |
| Land lot / Density: | 2,3 ha; 26.5% |
| Completion date: | 2011 |
| No. Blocks/ Floors/Apts: | 6 blocks; 28 floors; 750 apartment units |
| Functions: | Living, office space, and commercial center |
| Internal facilities: | Swimming pool, tennis court, communal hall, supermarket, kindergarten, outdoor playground for children, gym, health spa |
| Externally facilities near the site: | School & university, supermarkets, kindergarten, coffee shops & restaurants, post offices, banks, clinics, fitness centers |
| Public transport hubs: | Bus stop, subway station (future) |
| **Drawings & Images** | |
| Site Plan |   |
| Typical Floor Plan |   |

Typical Apartment Plan



Perspective (1,2)


Building Facade (3,4)

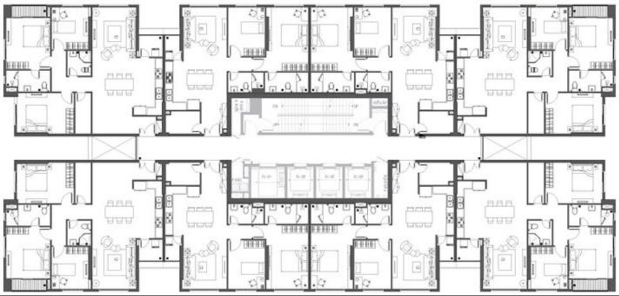



Swimming pool (5,6)


Landscape (7,8)

<table>
<tr><td colspan="2"> </td></tr>
<tr><td colspan="2">Living room (9,10)</td></tr>
<tr><td colspan="2"> </td></tr>
<tr><td>Source: (Accessed on 5 Oct 2015)</td><td>(Site plan) http://thevistaapartment.com/uploadsys/siteplan.jpg<br>(Typical floor plan) http://thevista.vn/wp-content/uploads/2013/06/mat-bang-The-Vista.jpg<br>(Typical apartment plan) http://www.thevistaanphus.com/can-ho-the-vista-an-phu-quan-2/<br>(1)http://www.thevistaanphus.com/wp-content/uploads/2015/08/can-ho-the-vista-thuc-te-1024x683.jpg<br>(2) http://thanhnien.vn/kinh-doanh/the-vista-khuyen-mai-hap-dan-thang-10-90853.html<br>(3) http://nhadatcanho.vn/hinhanh_fckeditor/images/chup%20tu%20duoi%20len-the-vista.jpg<br>(4)http://nhadatcanho.vn/hinhanh_fckeditor/images/chup%20tu%20tren%20cao_CAN%20HO%20THE%20VISTA.jpg<br>(5) http://banchungcusaigon.com/banchungcu_saigon_2.20140925114750752.jpg<br>(6) http://banchungcusaigon.com/banchungcu_saigon_2.20140925114802515.jpg<br>(7) http://banchungcusaigon.com/banchungcu_saigon_2.20140925114750393.jpg<br>(8) http://banchungcusaigon.com/banchungcu_saigon_2.20140925114726025.jpg<br>(9) http://nhadatcanho.vn/hinhanh_fckeditor/images/phong%20khach.jpg<br>(10)_http://nhadatcanho.vn/hinhanh_fckeditor/images/can%20ho%20The%20Vista%20view%20tu%20phong%20ngu.JPG</td></tr>
</table>

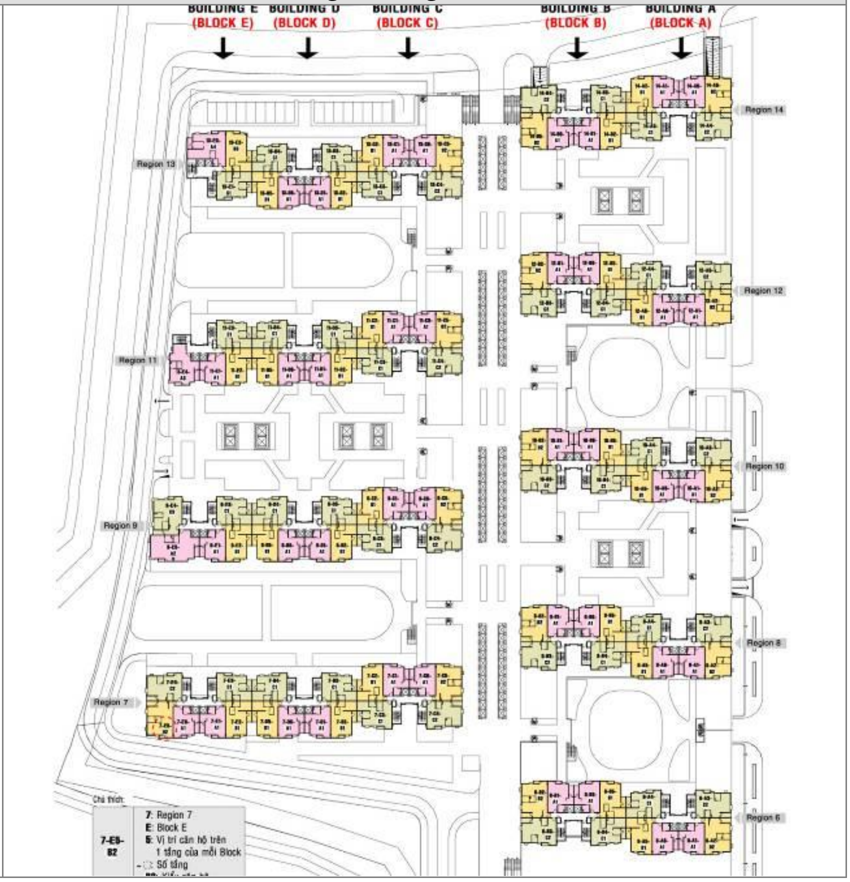
## B-3 Case A3: Tropic Garden

| General Information | |
|---|---|
| Name: | Tropic Garden |
| Owner: | Novaland Group |
| Location: | 49 St. 66, Thao Dien ward, District 2, HCMC |
| Land lot / Density: | 2,5 ha, 28% |
| Completion date: | 2014 (Block C1 & C2) |
| No. Blocks/ Floors/Apts: | 05 blocks, 27 floors, 1008 apartment units |
| Functions: | Living and commercial space |
| Internal facilities: | Coffee shops & restaurants, supermarket, gym, health spa, walkway, swimming pool |
| Externally facilities near the site: | Kindergarten, schools, coffee shops & restaurants, supermarkets, post offices, banks, clinics, fitness centers |
| Public transport hubs: | Bus stops |
| **Drawings & Images** | |
| Site Plan |  |
| Typical Floor Plan (C1&C2 Tower) |  |

<table>
<tr><td>Typical Apartment Plan</td><td></td></tr>
<tr><td colspan="2">Building Perspective (1, 2)</td></tr>
<tr><td colspan="2"> </td></tr>
<tr><td colspan="2">Landscape (3, 4, 5)</td></tr>
<tr><td colspan="2">  </td></tr>
<tr><td colspan="2">Interior Space (6, 7)</td></tr>
<tr><td colspan="2"> </td></tr>
<tr><td>Source: (Accessed on 5 Oct 2015)</td><td>(Information) http://www.canhotropicgarden.com/<br>(Site plan) http://www.canhotropicgarden.com/gioi-thieu-tropic-garden<br>(Typical floor plan)<br>http://canhotot.com/wp-content/uploads/mat-bang-tang-6-den-23-thap-c-can-ho-tropic-garden-quan-2.jpg<br>(Typical apartment plan) http://diaoc-vn.com/can-ho-tropic-garden-q2/<br>(1) http://canhosunrisecity.info/wp-content/uploads/2015/08/du-an-can-ho-tropic-garden-quan-2.jpg<br>(2) http://www.novaland.com.vn/Data/Sites/1/media/Tin-du-an/TropicGarden/TropicGarden-view.jpg<br>(3)http://canhosunrisecity.info/wp-content/uploads/2015/08/khu-vuc-bbq-du-an-can-ho-tropic-garden-quan-2.jpg<br>(4)http://www.novaland.com.vn/Data/Sites/1/media/Tin-du-an/TropicGarden/Cudan-TropicGarden1.jpg</td></tr>
</table>

| | |
|---|---|
| | (5)http://canhosunrisecity.info/wp-content/uploads/2015/08/ho-boi-can-ho-tropic-garden-quan-2-2.jpg<br>http://www.canhocaocap.info.vn/can-ho-tropic-garden-quan-2/<br>(6) http://quan2nhadat.com/q2_nhadat_3.20150705225901-5e64.jpg<br>(7) http://quan2nhadat.com/q2_nhadat_3.20150705225901-5b82.jpg<br>http://quan2nhadat.com/cho-thue-can-ho-chung-cu-tropic-garden/cho-thue-can-ho-tropic-garden-3pn-view-song-noi-that-hien-dai-co-ban-cong-pr106647.htm |

# B-4 Case A4: Sky Garden III

| General Information | |
|---|---|
| Name: | Sky Garden III |
| Owner: | Phu My Hung |
| Location: | Phu My Hung, district 7 |
| Land lot / Density: | 4.27ha, 62% (Built 26,494m2), 1774 apartment units |
| Completion date: | |
| No. Blocks/ Floors/Apts: | 9 (22 small blocks), 12-20 floors |
| Functions: | Living space and commercial space |
| Internal facilities: | Coffee shops & restaurants, supermarket, gym, health spa, walkway, swimming pool, tennis court |
| Externally facilities near the site: | Kindergarten, schools, universities, coffee shops & restaurants, supermarkets, post offices, banks, clinics, fitness centers |
| Public transport hubs: | Bus stops, subway station (future) |
| Drawings & Images | |
| Site Plan |  |

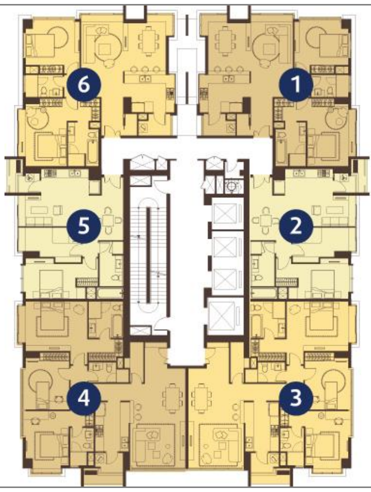
<table>
<tr><td>Typical Apartment Units</td><td colspan="2"> </td></tr>
<tr><td colspan="3">Perspective (1,2)</td></tr>
<tr><td colspan="3"> </td></tr>
<tr><td colspan="3">Facades (3,4)</td></tr>
<tr><td colspan="3"> </td></tr>
<tr><td colspan="3">Landscape (5,6)</td></tr>
<tr><td colspan="2"></td><td></td></tr>
<tr><td colspan="2">Interior space (7)</td><td>Landscape (8)</td></tr>
</table>

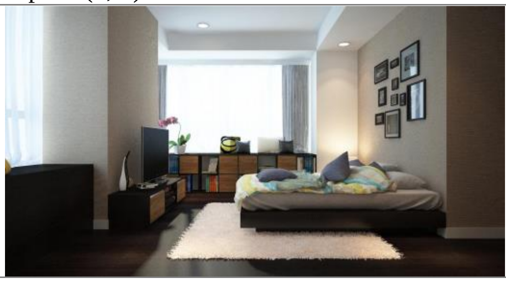
| | |
|---|---|
|  |  |
| Source: (Accessed on 5 Oct 2015) | http://thuecanhosg.com/cho-thue-can-ho-chung-cu-sky-garden-3/cho-thue-can-ho-cao-cap-sky-garden-3-khu-dc-phu-my-hung-dt-57m2-2pn-day-du-noi-that-cao-cap-gi-pr36446.htm<br>http://vforum.vn/diendan/showthread.php?33479-Nhung-dia-diem-chup-hinh-cuoi-dep-tai-TP-Ho-Chi-Minh<br>http://www.skyscrapercity.com/showthread.php?t=1071409 |

## B-5 Case A5: Sunrise City – South Towers

| General Information | |
|---|---|
| Name: | Sunrise City – South Towers |
| Owner: | Novaland |
| Location: | 23-25-27 Nguyen Huu Tho Street, Tan Hung Ward, District 7, HCMC |
| Land lot / Density: | 20,168m² (Total project: 51,000m²) |
| Completion date: | 2012 |
| No. Blocks/ Floors/Apts: | 6 blocks, 30-34 floors & 2 basements, |
| Functions: | Complex, office and commercial spaces on lower floor levels, living space in upper floors |
| Internal facilities: | Swimming pool, tennis court, communal hall, supermarket, banks, kindergarten, outdoor walkway & playground for children, gym, health spa, restaurant & coffee shop |
| Externally facilities near the site: | Kindergarten, schools, universities, coffee shops & restaurants, supermarkets, post offices, banks |
| Public transport hubs: | Bus stops, subway station (future) |

| Drawings & Images | |
|---|---|
| Site Plan |  |
| Typical Floor Plan (V2 Tower) |  |

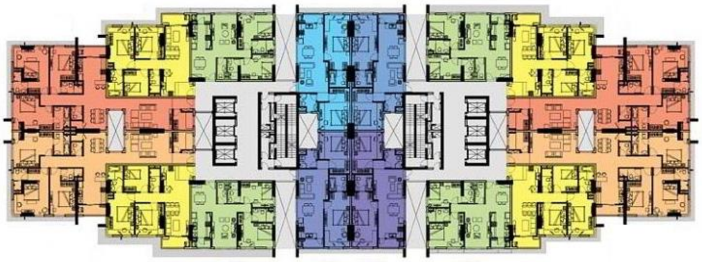
<table>
<tr><td>Typical Floor Plan (V6 Tower)</td><td>


</td></tr>
<tr><td colspan="2">Building Perspective (1, 2)</td></tr>
<tr><td colspan="2"> 
</td></tr>
<tr><td colspan="2">Landscape (3,4)</td></tr>
<tr><td colspan="2"> </td></tr>
<tr><td colspan="2">Interior Space (5, 6)</td></tr>
<tr><td colspan="2"> </td></tr>
<tr><td>Source:</td><td>(Information) http://www.novaland.com.vn/sunrisecity/</td></tr>
</table>

| | |
|---|---|
| (Accessed on 5 Oct 2015) | (Site plan) http://www.diaocquan2.com/kcfinder/upload/images/South-Towers-Sunrise-City.jpg<br>(V2 Tower Plan)<br>http://canhosunrisecity.nova-land.vn/photos/201409/Mat-bang-novaland-sunrise-city-quan-7-south-v2-tongthe.jpg<br>(V6 Tower Plan)<br>http://alocanho.vn/data/upload/MB-Sunrise-City-Thap-SOUTH-TOWERS-V6.jpg<br>(1) http://file1.batdongsan.com.vn/guestthumb745x510.20140305104316201.jpg<br>(2)https://lh4.googleusercontent.com/-IbtMRkuIK3E/Uh05oTsNOfI/AAAAAAAACsk/wCi8oVXiMhU/s800/can-ho-sunrise-city-1.jpeg<br>(3)https://lh5.googleusercontent.com/-IcU-PXUrmr4/Uh05nxjACEI/AAAAAAAACoM/wfdy2RvNwHk/s800/can-ho-sunrise-city-ho-boi.jpg<br>(4)http://www.infocanho.com/wp-content/uploads/2014/09/ho-boi-can-ho-sunrise-city-quan-7-khu-south-1.jpg<br>(5)https://lh6.googleusercontent.com/-LlQUg-E5mWU/Uh05pcYT-OI/AAAAAAAACoo/YIVZCJcWg6M/s800/can-ho-sunrise-city-living-room.jpg<br>(6) http://quan7nhadat.com/nha_dat_quan_7_3.20150504153841-6245.jpg |

## B-6 Case A6: Ky Nguyen Era Town – Area 1

| General Information | |
|---|---|
| Name: | Ky Nguyen Era Town – Area 1 |
| Owner: | Duc Khai company |
| Location: | Nguyen Luong Bang street. Phu My ward, District 7, HCMC |
| Land lot / Density: | 5.003ha, 35% |
| Completion date: | 2014 |
| No. Blocks/ Floors/Apts: | 5 blocks, 30 floors, 1,768 apartment units |
| Functions: | Residential and commercial spaces |
| Internal facilities: | - |
| Externally facilities near the site: | - |
| Public transport hubs: | Bus stops |

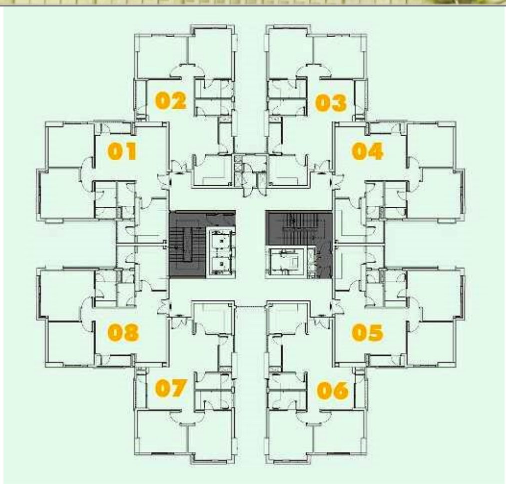
| Drawings & Images | |
|---|---|
| Site Plan |  |
| Typical Floor Plan (A2 Tower) |  |

<table>
<tr><td>Typical Apartment</td><td></td></tr>
<tr><td colspan="2">Building Perspective (1, 2)</td></tr>
<tr><td colspan="2"> </td></tr>
<tr><td colspan="2">Building Envelope (3,4)</td></tr>
<tr><td colspan="2"> </td></tr>
<tr><td colspan="2">Landscape (5,6)</td></tr>
</table>

<table>
<tr><td colspan="2"></td></tr>
<tr><td colspan="2">Interior Space (7,8)</td></tr>
<tr><td colspan="2"> </td></tr>
<tr><td>Source: (Accessed on 5 Oct 2015)</td><td>(Information) http://kland.vn/can-ho-era-town-p22.html<br>http://www.hdreal.com.vn/ChiTietDuAn.aspx?ID=118<br>(A2 Tower Plan)<br>http://media.bizwebmedia.net/Sites/78302/data/upload/2014/9/so_do_mat_bang_era_town_a_ii.jpg?0<br>(2)_http://www.duckhai.com.vn/fckFiles/Tin%20tuc%20su%20kien/Tin%20noi%20bo/Duong15B_1.png<br>(3) http://chothuesaigon.net/chothuesg_2.20141016193232504.jpg<br>(4)_http://1.bp.blogspot.com/-adJalyU9NxQ/U5Qe9B2vPjI/AAAAAAAAAV0/1tV3G7O_I38/s1600/Era+Town+208.JPG<br>(5)_http://1.bp.blogspot.com/-XkcShjTp288/U5QfELtaNkI/AAAAAAAAAXQ/GBfoSkNN6d0/s1600/EraTown305.JPG<br><br>(7) http://chothuesaigon.net/chothuesg_2.20141016193214548.jpg<br>(8) http://chothuesaigon.net/chothuesg_2.20141016193151256.jpg<br>http://typhubatdongsan.vn/can-ho-era-town.html<br>http://chungcueratownquan7.blogspot.kr/2014/06/cho-thue-can-ho-chung-cu-era-town-2pn.html</td></tr>
</table>

# B-7 Case A7: Him Lam Cho Lon

| General Information | |
|---|---|
| Name: | Him Lam Cho Lon |
| Owner: | Him Lam Company |
| Location: | Hau Giang street, district 6 |
| Land lot / Density: | 4.08ha, 25% |
| Completion date: | 2016 |
| No. Blocks/ Floors/Apts: | 8 blocks; 1448 apartment units |
| Functions: | Living and commercial space |
| Internal facilities: | Swimming pool, park, schools, |
| Externally facilities near the site: | Schools, supermarker, market, cinema, hospital |
| Public transport hubs: | Bus stops |

<table>
<tr><th colspan="3">Drawings & Images</th></tr>
<tr><td>Site Plan</td><td></td><td>
</td></tr>
<tr><td>Typical Floor Plan</td><td></td><td>
</td></tr>
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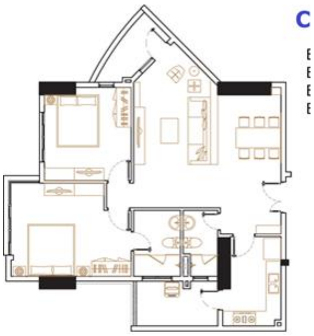
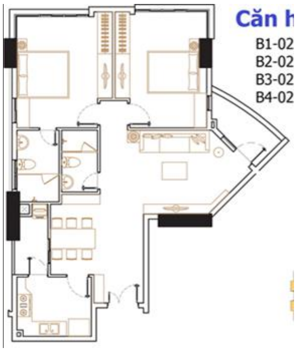
| | |
|---|---|
| Typical Apartment |    |
| Perspective (1,2) | |
|  |  |
| Landscape (3) | |
|  | |
| Living room (4,5) | |
|   |  |
| Source: (Accessed on 5 Oct 2015) | http://duanhimlam.vn/du-an/can-ho-him-lam-cho-lon-quan-6-814.html<br>http://typhunhadat.com/can-ho-him-lam-cho-lon-quan-6.html<br>(4,5) http://canhohimlam.blogspot.kr/p/him-lam.html |

# B-8 Case A8: The Eastern

<table>
<tr><th colspan="2">General Information</th></tr>
<tr><td>Name:</td><td>The Eastern</td></tr>
<tr><td>Owner:</td><td>HVK Co., Ltd & KRDF</td></tr>
<tr><td>Location:</td><td>Lien Phuong St. Phu Huu Ward, Dist. 9</td></tr>
<tr><td>Land lot / Density:</td><td>15,869 m2, 28,79%</td></tr>
<tr><td>Completion date:</td><td>2013</td></tr>
<tr><td>No. Blocks/ Floors/Apts:</td><td>2 blocks, 22 floors, 648 units</td></tr>
<tr><td>Functions:</td><td>Living & commercial space</td></tr>
<tr><td>Internal facilities:</td><td>Kindergarten, swimming pool, shopping centers, gym, health spa, playground & park, communal hall, tennis court, restaurant & bar</td></tr>
<tr><td>Externally facilities near the site:</td><td>Coffee shop & restaurant, hotel, park, shops</td></tr>
<tr><td>Public transport hubs:</td><td>Internal bus route to city center,</td></tr>
<tr><th colspan="2">Drawings & Images</th></tr>
<tr><td>Site Plan</td><td>
</td></tr>
<tr><td>Typical Floor Plan</td><td></td></tr>
</table>

<table>
<tr><td>Typical Apartment</td><td></td></tr>
<tr><td colspan="2">Building Perspective (1, 2)</td></tr>
<tr><td colspan="2"> </td></tr>
<tr><td colspan="2">Building facades (3, 4)</td></tr>
<tr><td colspan="2"> </td></tr>
<tr><td colspan="2">Landscapes (5, 6)</td></tr>
</table>

<table>
<tr><td colspan="2"> </td></tr>
<tr><td colspan="2">Interior Spaces (7, 8)</td></tr>
<tr><td colspan="2"> </td></tr>
<tr><td>Source: (Accessed on 5 Oct 2015)</td><td>http://theeastern.biz/<br>http://wikimapia.org/24986098/vi/C%C4%83n-h%E1%BB%99-The-Eastern<br>http://chothuesaigon.net/ban-can-ho-chung-cu-the-eastern/cho-thue-can-ho-chung-cu-tai-du-an-the-eastern-quan-9-tp-hcm-dien-tich-76m2-gia-7-trieuthang-du-noi-that-pr108773.htm<br>http://thuecanhosg.com/cho-thue-can-ho-chung-cu-the-eastern/cho-thue-can-ho-the-eastern-gia-re-tai-quan-9-pr85760.htm<br>http://dothidiaoc.com/cho-thue-can-ho-chung-cu-the-eastern/cho-thue-chcc-han-quoc-q2-day-du-noi-that-gia-chi-tu-7-6tr-thang-lh-0903607775-pr2738575.htm<br>http://thuecanhohcm.net/cho-thue-can-ho-chung-cu-tai-the-eastern-18pj3573/chung-cu-moi-100-day-du-tien-ich-noi-that-cuc-dep-xach-vali-vao-o-ngay-lien-he-0934006901-sg51939<br>http://www.vatgia.com/raovat/2589/7237475/can-ho-the-eastern-phuong-phu-huu-quan-9-gia-cuc-shock.html</td></tr>
</table>

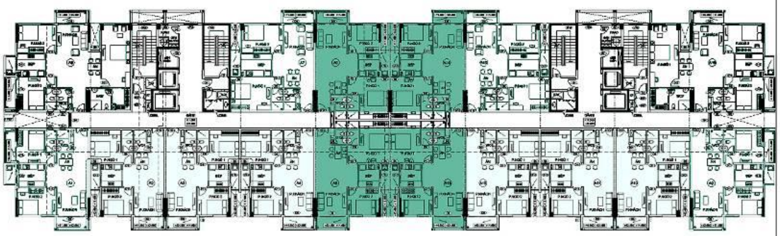
## B-9 Case A9: Le Thanh Twin Towers

| General Information | |
|---|---|
| Name: | Le Thanh Twin Towers |
| Owner: | Le Thanh Company |
| Location: | 198A Ma Lo street, Binh Tri Dong A ward, Binh Tan district, HCMC |
| Land lot / Density: | 7,686 m2, 42% |
| Floor area ratio: | 5.4 |
| Completion date: | 2014 |
| No. Blocks/ Floors/Apts: | one building with 2 blocks, 19 floors, 352 apartment units |
| Functions: | Living and commercial space, 2 lower floors used for commercial space, 3rd floor used for services, 4-19th floor used for apartment, rooftop used for multipurpose services |
| Internal facilities: | Supermarket, bookstore, coffeeshop, wedding restaurant, children playground, swimming pool, spa |
| Externally facilities near the site: | Hospital, kindergarten, schools, banks, district office |
| Public transport hubs: | Bus stops |
| **Drawings & Images** | |
| Site Plan |  |
| Typical Floor Plan |  |

<table>
<tr><td>Typical Apartment</td><td>
</td></tr>
<tr><td colspan="2">Perspective (1,2)</td></tr>
<tr><td colspan="2"> </td></tr>
<tr><td colspan="2">Building facades (3,4)</td></tr>
<tr><td colspan="2"> </td></tr>
<tr><td colspan="2">Landscape (5,6)</td></tr>
<tr><td colspan="2"> </td></tr>
<tr><td colspan="2">Interior Spaces (7,8)</td></tr>
</table>

| | |
|---|---|
|  |  |
| Source: (Accessed on 5 Oct 2015) | (Plans; 4) https://lethanhtwintower.wordpress.com/<br>(1,2,3) http://www.chungcu24h.com.vn/Chung-Cu/Can-Ho-Chung-Cu-Le-Thanh-Twin-Towers<br>(5)_http://www.chungcu24h.com.vn/upload/tin/datdongsan/thang072012/can-ho-chung-cu-le-thanh-khu-b.jpg<br>(6)_http://www.chungcu24h.com.vn/Can-Ho/Cho-Thue-Can-Ho-Le-Thanh-Twin-Towers-Chi-Tu-3,5-Trieu-/-Thang/19/<br>(7) https://lethanhtwintower.files.wordpress.com/2012/04/111.jpg<br>(8) https://lethanhtwintower.files.wordpress.com/2012/04/3.jpg |

## B-10 Case A10: Phuc Loc Tho (Emerald)

| General Information | |
|---|---|
| Name: | Phuc Loc Tho (Emerald) |
| Owner: | Phuc Loc Tho Land |
| Location: | 35 Le Van Chi street, Linh Trung ward, Thu Duc district, HCMC |
| Land lot / Density: | 8,637 m2; 40% (built area: 3,455m2); Floor area ratio: 6 |
| Completion date: | 2013 |
| No. Blocks/ Floors/Apts: | 3 blocks, 16 floors and , 452 apartment units |
| Functions: | Living and commercial space |
| Internal facilities: | Complex, commercial spaces on two lower floor levels, apartments in upper floors |
| Externally facilities near the site: | Swimming pool, park, restaurant, kindergarten, supermarket, gym, health spa, coffee shop |
| Public transport hubs: | Bus stops, subway station (future) |
| **Drawings & Images** | |
| Site Plan |  |
| Typical Floor Plan (Block A) |  |

<table>
<tr><td>Typical Floor Plan (Block B)</td><td></td></tr>
<tr><td colspan="2">Perspective (1,2)</td></tr>
<tr><td colspan="2"> </td></tr>
<tr><td colspan="2">Living room (3,4)</td></tr>
<tr><td colspan="2"> </td></tr>
<tr><td>Source: (Accessed on 5 Oct 2015)</td><td>(Site Plan & 1)<br>http://chungcuphucloctho.blogspot.kr/2012/08/can-ho-phuc-loc-tho-moi-truong-song-tri.html<br>(Typical Floor Plan – Block A)<br>https://sites.google.com/site/canmuanhadatgiare/can-ho-emerald-apartment-thu-duc/mat-bang-thiet-ke-can-ho-emerald<br>(Typical Floor Plan – Block B)<br>http://www.phucloctholand.com/mo-ban-dhot-cuoi-block-b-chung-cu-phuc-loc-tho<br>(2)_http://chothuesaigon.net/cho-thue-can-ho-chung-cu-emerald/cho-thue-can-ho-phuc-loc-tho-emerald-dt-86m2-gia-6tr-thang-pr210389.htm<br>(3)_http://thuecanhosg.com/cho-thue-can-ho-chung-cu-emerald/cho-thue-gap-can-ho-phuc-loc-tho-gan-nga-tu-thu-duc-2pn-2wc-gia-6-trieu-thang-pr103998.htm<br>(4)_http://banchungcusaigon.com/ban-can-ho-chung-cu-emerald/chung-cu-phuc-loc-tho-da-ban-giao-nha-cho-khach-chi-con-20-can-nhieu-chinh-sach-uu-dai-pr48877.htm</td></tr>
</table>

# Appendix C: Townhouses in HCMC Case Study Models

C-1 Case T1: Mr. Quang's House

C-2 Case T2: Mr. Hai's House

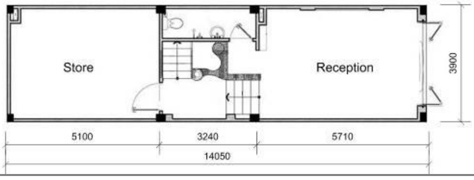
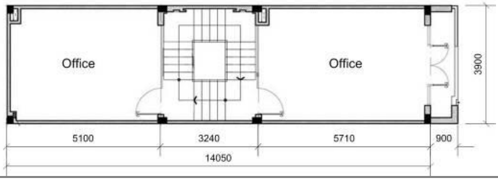
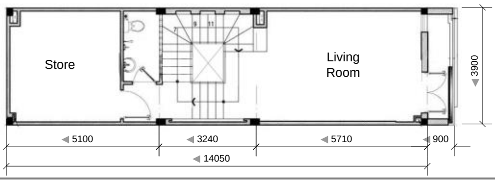
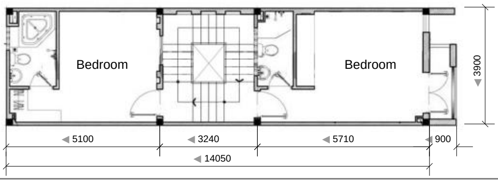
C-3 Case T3: Mr. Cuong's House

C-4 Case T4: Park Riverside Residential Area

C-5 Case T5: Mega Village Townhouse Type No. 5

## C-1 Case T1: Mr. Quang’s House

| | | |
|---|---|---|
| In project: | Private house | <br> |
| Location: | 28/47 Cu Xa Lu Gia St., Ward 15, Dist. 11, HCMC | |
| Year of Built: | 2013 | |
| Owner: | Mr. Quang | |
| Category: | Individual townhouse | |
| Function: | Office & living space | |
| Land lot: | 14.050m x 3.9m (54.8 sq.m) | |
| Storey: | 5 | |

| | |
|---|---|
| First Floor Plan | <br> |
| Second Floor Plan | <br> |
| Third Floor Plan | <br> |
| Fourth Floor Plan | <br> |

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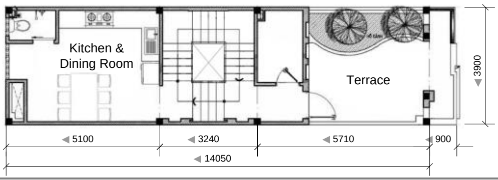
<tr><td>Fifth Floor Plan</td><td colspan="2">
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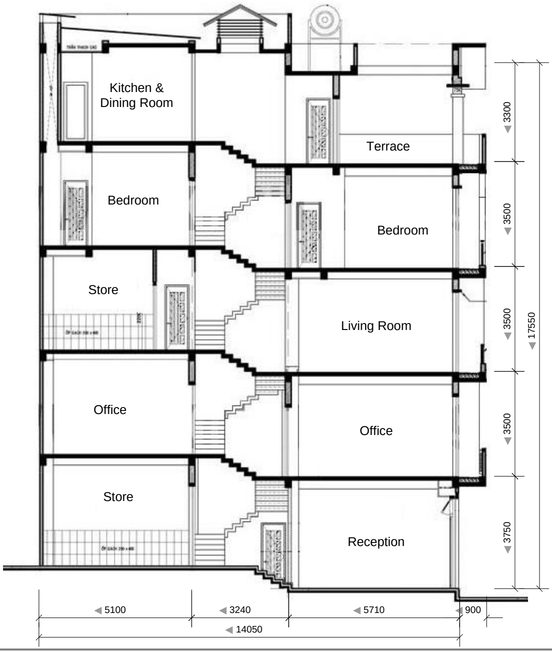
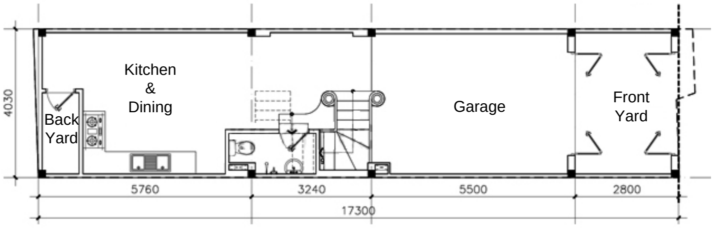
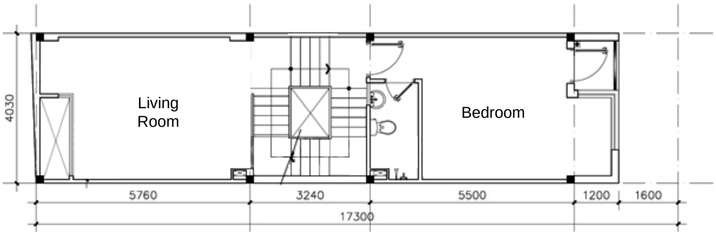
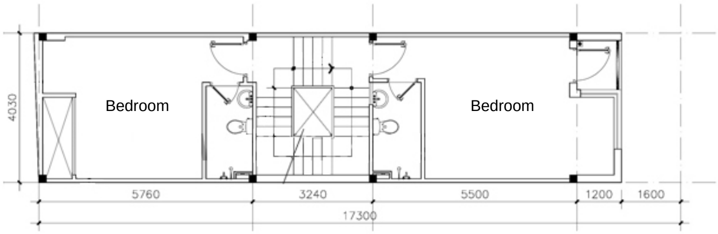
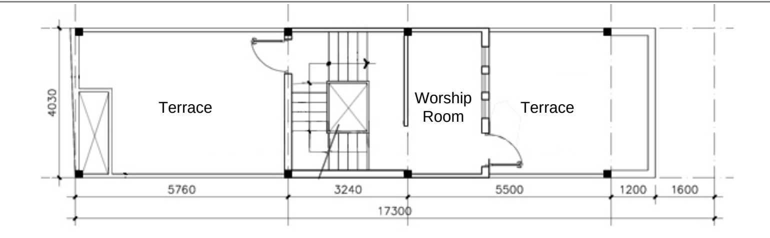
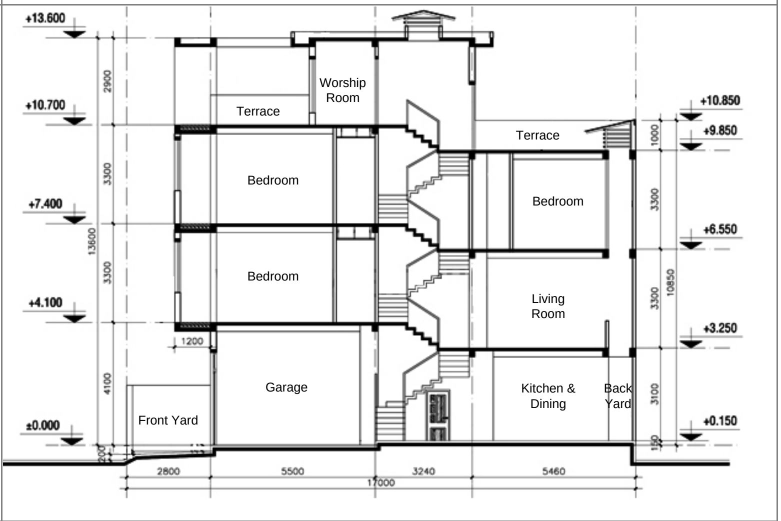
<tr><td>Section</td><td colspan="2">
</td></tr>
<tr><td colspan="2">Source:</td><td>(Original images and drawings)<br>http://kientruc999.vn/baiviet/vi/thi-cong/hinh-anh-hoan-thien-nha-anh-quang---lu-gia--quan-11--tp.hcm-138.html (accessed on November 20, 2015)</td></tr>
</table>

## C-2 Case T2: Mr. Hai’s House

| | |
|---|---|
| In project: | Private house |
| Location: | Do Xuan Hop St., Dist. 9, HCMC |
| Year of Built: | 2012 |
| Owner: | Mai Van Hai (Mr.) |
| Category: | Individual townhouse |
| Function: | Living space |
| Land lot: | 4.0 m x 17.3 m (69.2 sq.m) |
| Storey: | 3 |

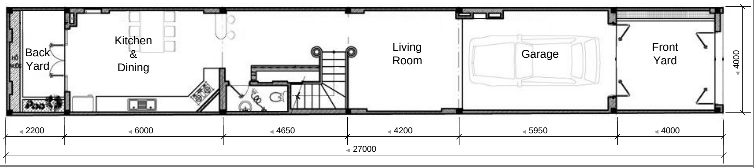
| | |
|---|---|
| First Floor Plan |  |
| Second Floor Plan |  |
| Third Floor Plan |  |

| | | |
|---|---|---|
| Fourth Floor Plan |  | |
| Section |  | |
| Source: | (Original images & drawings)<br>http://kientruc999.vn/baiviet/vi/thi-cong/thiet-ke-nha-pho-dep-q9-147.html (accessed on November 20, 2015) | |

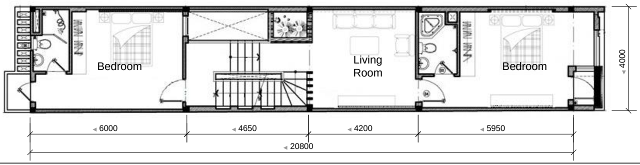
## C-3 Case T3: Mr. Cuong's House

| | |
|---|---|
| In project: | Private house |
| Location: | 84/7 Tan Son Nhi St., Tan Son Nhi Ward, Tan Phu Dist., HCMC |
| Year of Built: | 2009 (design), 2012 (construction) |
| Owner: | Mr. Cuong |
| Category: | Individual townhouse |
| Function: | Living space |
| Land lot: | 4.0 m x 27.0 m (108 sq.m) |
| Storey: | 3 |

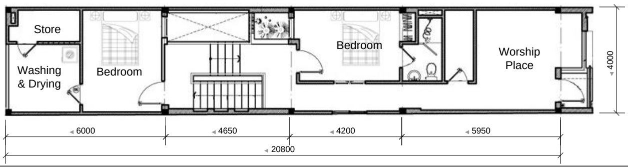

First Floor Plan



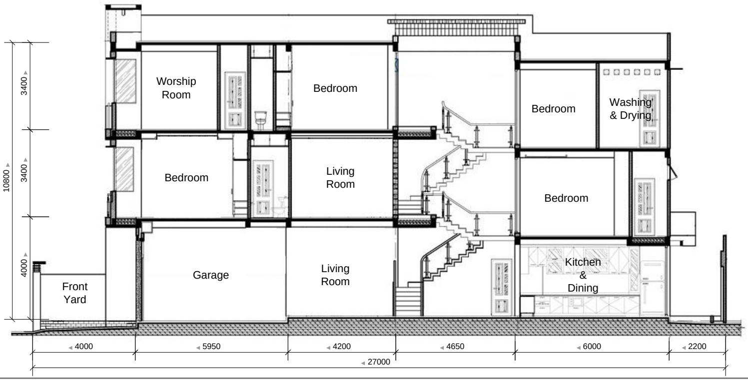

Second Floor Plan




Third Floor Plan



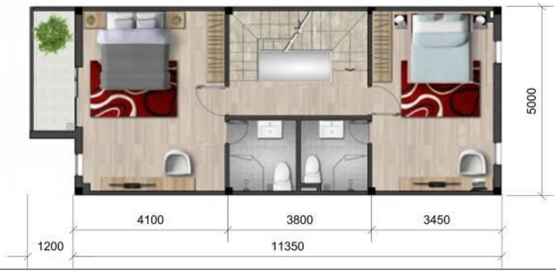
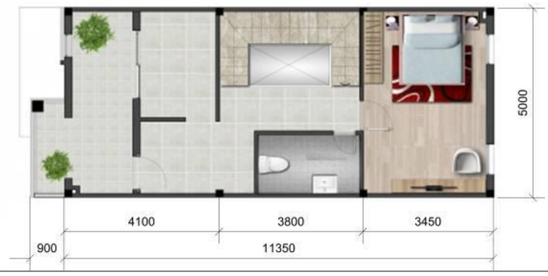

Section




| | |
|---|---|
| Source: | (Original images and drawings) http://kientruc999.vn/Album/Nha-pho-hien-dai/27.html (accessed on November 20, 2015) |

## C-4 Case T4: Park Riverside Residential Area

| | |
|---|---|
| In project: | Compound Park Riverside |
| Location: | Bung Ong Thoan St., Phu Huu Ward, Dist. 9, HCMC |
| Year of Built: | 2015 (under construction) |
| Developer: | M.I.K CORPORATION |
| Category: | Townhouse in new residential area |
| Function: | Living space |
| Land lot: | 5m x 16.35m (81.75 sq.m) |
| Floor(s): | 3 |

| | |
|---|---|
| First Floor Plan |   |
| Second Floor Plan |   |
| Third Floor Plan |   |
| Source: | (Building images) http://www.mik-corporation.com/2015/10/tien-o-park-riverside-quan-9.html (accessed on November 20, 2015);<br>(Building plans) http://parkriversideq9.net/ (accessed on November 20, 2015) |

## C-5 Case T5: Mega Village Townhouse Type No. 5

| | |
|---|---|
| Projects: Mega Village residential area<br>Location: Vanh Dai Trong St., Phu Huu Ward, Dist. 9, HCMC<br>Year of Built: 2015<br>Developer: Khang Dien JSC<br>Category: Townhouse in new residential area<br>Function: Living space<br>Land lot: 5m x 17m (85 sq.m)<br>Floor(s): 3 |  |
| First Floor Plan |  |
| Second Floor Plan |  |
| Third Floor Plan |  |
| Source: | (Building images) http://nhadatmuaban.net/ban-nha-dat-mat-pho/nha-pho-mega-village-khu-vuc-q-9-duong-vanh-dai-2-qua-cau-phu-my-175186.html (accessed on November 20, 2015);<br>(Building plans) http://megavillagequan9.com/du-an-mega-village-mat-bang/ (accessed on November 20, 2015) |

# Appendix D: Green Building Assessment Methods Selected for Analysis

D-1 LEED-NC 2009 (Version 3.0)

D-2 CASBEE for Building (New Construction) – 2014 Edition

D-3 Green Mark for New Buildings (Version 4.1, 2012, Criteria for Residential Building)

D-4 Green Building Index (GBI) – Residential New Construction (RNC) Version 3.1 (2014)

D-5 BERDE Green Building Rating Scheme Version 1.1.0 (2013) (for New Construction: Vertical Residential Development)

D-6 LOTUS-R Extended Pilot Version (2013)

## D-1 LEED-NC 2009 (Version 3.0)

| Index | Category / Credit | Indicator Description | Points | Weight (%) | Indicator Type | Equivalent Criteria for Review |
|---|---|---|---|---|---|---|
| **SS** | **Sustainable Sites** | | **26** | **26.00** | | |
| SS-P1 | Construction activity pollution prevention | To prevent loss of soil during construction by stormwater runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse; To prevent sedimentation of storm sewers or receiving streams; To prevent pollution of the air with dust and particulate matter. | R | **R** | | Construction Activity Pollution Control |
| SS-1 | Site Selection | Avoid the development on sites that is prime farmland, undeveloped land, habitat for special species, wetlands, public land | 1 | **1.00** | | Site Selection |
| SS-2 | Development Density and Community Connectivity | Construct a building on a site that meets the following criteria: Is located on a previously developed site / Is within 1/2 mile (800m) of a residential area or neighborhood with an average density of 10 units per acre net / Is within 1/2 mile (800m) of at least 10 basic services / Has pedestrian access between the building and the services | 5 | **5.00** | | Community Connectivity |
| SS-3 | Brownfield Redevelopment | Rehabilitate damaged sites: contaminated / brownfield sites | 1 | **1.00** | | Brownfield Redevelopment |
| SS-4.1 | Alternative Transportation – Public Transportation Access | Locate the project within 1/2-mile (800m) walking distance of an existing or planned and funded commuter rail, light rail or subway station OR Locate the project within 1/4-mile (400m) walking distance of 1 or more stops for 2 or more public, campus, or private bus lines usable by building occupants. | 6 | **6.00** | | Public Transportation Access |
| SS-4.2 | Alternative Transportation – Bicycle Storage and Changing Rooms | For residential projects: Provide covered storage facilities for securing bicycles for 15% or more of building occupants | 1 | **1.00** | | Bicycle Rider Amenities |
| SS-4.3 | Alternative Transportation – Low-Emitting and fuel-Efficient Vehicles | Provide preferred parking and a discounted parking rate for low-emitting and fuel-efficient vehicles for 5% of the total vehicle parking capacity OR Install alternative-fuel fueling stations for 3% of the total vehicle parking capacity OR Provide low-emitting and fuel-efficient vehicles for 3% of full-time equivalent (FTE) occupants OR Provide building occupants access to a low-emitting or fuel-efficient vehicle-sharing program | 3 | **3.00** | | Amenities for Low-Emitting and Fuel-Efficient Vehicles – Parking &Fueling Station |
| SS-4.4 | Alternative Transportation – Parking Capacity | For residential projects: Size parking capacity to meet but not exceed minimum local zoning requirements & Provide infrastructure and support programs to facilitate shared vehicle use OR Provide no new parking | 2 | **2.00** | | Parking Capacity not exceeding the Minimum Code Requirements |
| SS-5.1 | Site Development – Protect or Restore Habitat | With greenfield sites: limit all site disturbance 40 feet beyond the building perimeter / 10 feet beyond surface/ 15 feet beyond primary roadway curbs/ 25 feet beyond constructed areas with permeable surfaces OR With previously developed areas or graded sites Restore or protect a minimum of 50% of the site (excluding the building footprint) or 20% of the total site area (including building footprint) | 1 | **1.00** | | Ecological Features Preservation & Improvement |
| SS-5.2 | Site Development – Maximize Open Space | Sites with Local Zoning open space requirements: the amount of vegetated open space exceeds local zoning requirements by 25%. OR Sites with Zoning ordinances but No open space requirements: provide vegetated open space equal to 20% of the project site area. | 1 | **1.00** | | Vegetated Open Space and Biodiversity Promotion |
| SS-6.1 | Stormwater Design – Quantity Control | Implement a stormwater management plan that :<br>In sites with existing imperviousness 50% or Less: prevents peak discharge rate and the 1- and 2-year 24-hour design | 1 | **1.00** | | Stormwater Design – Quantity Control |

| Index | Category / Credit | Indicator Description | Points | Weight (%) | Indicator Type | Equivalent Criteria for Review |
|---|---|---|---|---|---|---|
| | | storms OR protects receiving stream channels from excessive erosion. In sites with Existing imperviousness Greater than 50%: decrease 25% volume of stormwater runoff from the 2-year 24-hour design storm. | | | | |
| SS-6.2 | Stormwater Design - Quality control | Reduce impervious cover, promotes infiltration and captures and treats the stormwater runoff from 90% of the average annual rainfall using best management practices (BMPs). | 1 | **1.00** | | Stormwater Design - Quality control |
| SS-7.1 | Heat island Effect - Nonroof | Shade 50% of the site hardscape OR parking spaces by high Solar Reflectance Index (SRI) structures, landscape, solar panels | 1 | **1.00** | | Heat Island Effect – Hardscape |
| SS-7.2 | Heat island Effect - Roof | Use high SRI for at least 75% of the roof surfaces OR install a vegetated roof that covers at least 50% of the roof area OR combination of both | 1 | **1.00** | | Heat Island Effect – Building Roof; Green Roof |
| SS-8 | Light Pollution Reduction | Interior: reduce the input power at least 50% OR light transmittance of less than 10% between 11 p.m. and 5 a.m; Exterior: meet exterior lighting control requirements from standards. | 1 | **1.00** | | Light Pollution Reduction |
| **WE** | **Water Efficiency** | | **10** | **10.00** | | |
| WE-P1 | Water use Reduction | Employ strategies that in aggregate use 20% less water than the water use baseline (not including irrigation). | R | **R** | | Water Efficient Fixtures |
| WE-1 | Water-Efficient Landscaping | Reduction of domestic water consumption by 50 %(2pts) OR no use of domestic water (4pts) for irrigation | 4 | **4.00** | | Water-Efficient Landscaping |
| WE-2 | Innovative Wastewater Technologies | Reduce wastewater generation and potable water demand: Reduce potable water use by 50% through the use of water-conserving fixtures or nonpotable water (e.g., captured rainwater, recycled graywater, on-site or municipally treated wastewater) OR Treat 50% of wastewater on-site | 2 | **2.00** | | Sewer Discharge Reduction / Water Efficient Fixtures / Rainwater Harvesting / Waste Water Recycling |
| WE-3 | Water use Reduction | By 30 % (2pts) / 35 % (3pts) / 40 %(4pts) through using water efficient fixtures and fixture fittings | 4 | **4.00** | | Water Efficient Fixtures |
| **EA** | **Energy & Atmosphere** | | **35** | **35.00** | | |
| EA-P1 | Fundamental commissioning of Building Energy Systems | Fundamental commissioning process activities must be completed by the project team. Commissioning process activities must be completed for the energy-related systems. | R | **R** | | Commissioning |
| EA-P2 | Minimum Energy Performance | Whole building energy simulation with 10% improvement rating for new buildings | R | **R** | | Minimum Energy Performance |
| EA-P3 | Fundamental Refrigerant Management | Zero use of chlorofluorocarbon (CFC)-based refrigerants in new base building heating, ventilating, air conditioning and refrigeration (HVAC&R) systems. | R | **R** | | Refrigerant Management |
| EA-1 | Optimize Energy Performance | 12%(1pt) / 14%(2pts) / … / up to 48%(19pts) OR implement prescriptive compliance path (1~3pts) | 19 | **19.00** | | Optimize Energy Performance |
| EA-2 | On-site Renewable Energy | 1%(1pts) / 3%(2pts) /… / up to 13%(7pts) | 7 | **7.00** | | On-Site Renewable Energy |
| EA-3 | Enhanced commissioning | To begin the commissioning process early in the design process and execute additional activities after systems performance verification is completed. | 2 | **2.00** | | Commissioning |
| EA-4 | Enhanced Refrigerant Management | Do not use refrigerants OR select refrigerants and HVAC and refrigeration (HVAC&R) equipment that minimize the emission of compounds | 2 | **2.00** | | Enhanced Refrigerant Management |
| EA-5 | Measurement and Verification | Implement a measurement and verification (M&V) plan in at least 1 year of post-construction occupancy. Provide a process for corrective action if the results of the M&V plan indicate that energy savings are not being achieved. | 3 | **3.00** | | Measurement and Verification |
| EA-6 | Green Power | At least a 2-year renewable energy contract to provide at least 35% of the building's electricity from renewable sources | 2 | **2.00** | | Off-Site Renewable Energy |

| Index | Category / Credit | Indicator Description | Points | Weight (%) | Indicator Type | Equivalent Criteria for Review |
|---|---|---|---|---|---|---|
| **MR** | **Materials and Resources** | | **14** | **14.00** | | |
| MR-P1 | Storage and collection of Recyclables | Provide an easily-accessible dedicated areas for the collection and storage of materials for recycling for the entire building. | R | **R** | | Recycling Facilities |
| MR-1.1 | Building Reuse - Maintain Existing Walls, Floors, and Roof | Maintain the existing building structure (including structural floor and roof decking) and envelope (the exterior skin and framing) 55%(1pt) / 75%(2pts) / 95%(3pts) | 3 | **3.00** | | On-site Materials Reuse |
| MR-1.2 | Building Reuse - Maintain interior nonstructural Elements | Use existing interior nonstructural elements (e.g., interior walls, doors, floor coverings and ceiling systems) in at least 50% (by area) | 1 | **1.00** | | On-site Materials Reuse |
| MR-2 | Construction Waste Management | Recycle and/or salvage nonhazardous construction and demolition debris: 50% (1pt) / 75%(2pts) | 2 | **2.00** | | Construction Waste Management |
| MR-3 | Materials Reuse | Use salvaged, refurbished or reused materials: 5% (1pt) / 10% (2pts) (based on cost) | 2 | **2.00** | | Off-site Materials Reuse |
| MR-4 | Recycled content | 10%(1pt) / 20%(2pts) (based on cost) | 2 | **2.00** | | Materials with Recycled Content |
| MR-5 | Regional Materials | Materials are derived within 500miles (800km) of the project site , 10% (1pt) / 20% (2pts) (based on cost) | 2 | **2.00** | | Regional Materials |
| MR-6 | Rapidly Renewable Materials | Use 2.5% (based on cost) of rapidly renewable building materials and products. | 1 | **1.00** | | Rapidly Renewable Materials |
| MR-7 | Certified Wood | Use a minimum of 50% (based on cost) of wood-based materials and products that are certified | 1 | **1.00** | | Certified Wood |
| **IEQ** | **Indoor Environmental Quality** | | **15** | **15.00** | | |
| IEQ-P1 | Minimum indoor air Quality Performance | | R | **R** | | Ventilation for Indoor Air Quality Improvement |
| IEQ-P2 | Environmental tobacco smoke (ETS) control | | R | **R** | | Environmental Tobacco Smoke Control |
| IEQ-1 | outdoor air Delivery Monitoring | | 1 | **1.00** | | Outdoor Air Delivery Monitoring |
| IEQ-2 | increased Ventilation | | 1 | **1.00** | | Ventilation for Indoor Air Quality Improvement |
| IEQ-3.1 | construction indoor air Quality Management Plan—During construction | | 1 | **1.00** | | Construction Indoor Air Quality Management Plan – During Construction |
| IEQ-3.2 | construction indoor air Quality Management Plan—Before occupancy | | 1 | **1.00** | | Construction Indoor Air Quality Management Plan – Before Occupancy |
| IEQ-4.1 | Low-Emitting Materials—adhesives and sealants | | 1 | **1.00** | | VOC Minimization - Adhesives & sealants; Paints & coatings; flooring Systems |
| IEQ-4.2 | Low-Emitting Materials—Paints and coatings | | 1 | **1.00** | | VOC Minimization - Adhesives & sealants; Paints & coatings; flooring Systems |
| IEQ-4.3 | Low-Emitting Materials—flooring systems | | 1 | **1.00** | | VOC Minimization - Adhesives & sealants; Paints & coatings; flooring Systems |
| IEQ-4.4 | Low-Emitting Materials—composite Wood and agrifiber Products | | 1 | **1.00** | | Formaldehyde Minimization – Composite Wood and Agrifiber Products |
| IEQ-5 | Indoor Chemical and | | 1 | **1.00** | | Indoor Chemical and |

| Index | Category / Credit | Indicator Description | Points | Weight (%) | Indicator Type | Equivalent Criteria for Review |
|---|---|---|---|---|---|---|
| | Pollutant Source Control | | | | | Pollutant Source Control |
| IEQ-6.1 | Controllability of Systems - Lighting | Provide individual lighting controls for 90% (minimum) of the building occupants / Provide lighting system controls for all shared multi-occupant spaces | 1 | **1.00** | | Controllability of Systems – Lighting & Thermal Comfort |
| IEQ-6.2 | Controllability of Systems - Thermal Comfort | Provide individual comfort controls for 50% (minimum) of the building occupants / Provide comfort system controls for all shared multi-occupant spaces | 1 | **1.00** | | Controllability of Systems – Lighting & Thermal Comfort |
| IEQ-7.1 | Thermal Comfort - Design | Design HVAC systems and the building envelope to meet the requirements of ASHRAE Standard 55-2004 | 1 | **1.00** | | Design HVAC Systems & Building Envelope for Thermal Comfort |
| ~~IEQ-7.2~~ | ~~Thermal Comfort – Verification~~ | Not applicable for residential projects | ~~1~~ | ~~**1.00**~~ | | - |
| IEQ-8.1 | Daylight and Views - Daylight | Achieve daylighting in 75% of regularly occupied spaces through computer simulations / prescriptive / measurement | 1 | **1.00** | | Daylighting |
| IEQ-8.2 | Daylight and Views - Views | Direct line of sight to the outdoor environment via vision glazing for occupants in 90% of all regularly occupied areas | 1 | **1.00** | | External Views |
| **TOTAL** | | | **100** | **100** | | |
| **ID** | **Innovation in Design** | | **6** | **6.00** | | |
| ID-1 | innovation in Design | 1pt for each innovation achieved | 5 | **5.00** | | |
| ID-2 | LEED Accredited Professional | | 1 | **1.00** | | |
| **RP** | **Regional Priority** | | **4** | **4.00** | | |
| | Regional Priority | | 4 | **4.00** | | |
| NOTE: R=requirement | | | | | | |

## D-2 CASBEE for Building (New Construction) – 2014 Edition

The CASBEE for Building (NC) is applicable for non-residential and residential classification of building types. The apartments building type is involved in the residential group.

| Index | Category / Credit | Indicator Description | Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| **Q** | **ENVIRONMENTAL QUALITY OF BUILDING** | | | **100** | | |
| **Q1** | **Indoor Environment** | | | **40.00** | | |
| **Q1-1** | **Sound Environment** | | | **6.00** | | **Sound and Noise Level** |
| Q1-1.1 | Noise | Indoor background noise level | | 2.40 | | |
| Q1-1.2 | Sound Insulation | Sound insulation performance | | 2.40 | | |
| Q1-1.2.1 | Sound Insulation of Openings | | | | | |
| Q1-1.2.2 | Sound Insulation of Partition Walls | | | | | |
| Q1-1.2.3 | Sound Insulation Performance of Floor Slabs (light-weight impact source) | | | | | |
| Q1-1.2.4 | Sound Insulation Performance of Floor Slabs (heavy-weight impact source) | | | | | |
| ~~Q1-1.3~~ | ~~Sound Absorption~~(B) | | | - | | |
| **Q1-2** | **Thermal Comfort** | | | **14.00** | | |
| Q1-2.1 | Room Temperature Control | | | 7.00 | | Design HVAC Systems & Building Envelope for Thermal Comfort |
| Q1-2.1.1 | Room Temperature | | | | | |
| Q1-2.1.2 | Perimeter Performance | | | | | |
| ~~Q1-2.1.3~~ | ~~Zoned Control~~(B) | | | - | | - |
| Q1-2.2 | ***Humidity Control*** | | | 2.80 | | Humidity Control |
| Q1-2.3 | ***Type of Air Conditioning System*** | | | 4.20 | | Design HVAC Systems & Building Envelope for Thermal Comfort |
| ***Q1-3*** | ***Lighting & Illumination*** | | | **10.00** | | |
| ***Q1-3.1*** | ***Daylighting*** | | | 3.00 | | Daylighting |
| Q1-3.1.1 | Daylight Factor | | | | | |
| Q1-3.1.2 | Openings by Orientation | | | | | |
| Q1-3.1.3 | Daylight Devices | | | | | |
| ***Q1-3.2*** | ***Anti-glare Measures*** | | | 3.00 | | Glare Control |
| Q1-3.2.1 | Daylight Control | | | | | |
| ~~Q1-3.2.2~~ | ~~Reflection Control~~ (A) | | | | | - |
| ***Q1-3.3*** | ***Illuminance Level*** | | | 1.5 | | Proper Illuminance Level |
| ***Q1-3.4*** | ***Lighting Controllability*** | | | 2.5 | | Controllability of Systems |
| **Q1-4** | **Air Quality** | | | **10.00** | | |
| ***Q1-4.1*** | ***Source Control*** | | | 5.00 | | |
| Q1-4.1.1 | Chemical Pollutants | | | | | Indoor Chemical and Pollutant Source Control; VOC Minimization; Formaldehyde Minimization |
| ~~Q1-4.1.2~~ | ~~Asbestos~~ (A) | | | | | - |
| ***Q1-4.2*** | ***Ventilation*** | | | 3.00 | | |
| Q1-4.2.1 | Ventilation Rate | | | | | Ventilation for Indoor Air |

| Index | Category / Credit | Indicator Description | Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| | | | | | | Quality Improvement |
| Q1-4.2.2 | Natural Ventilation Performance | | | | | Naturally Ventilated Design |
| Q1-4.2.3 | Consideration for Outside Air Intake | | | | | Outdoor Air Delivery Monitoring |
| ~~Q1-4.3~~ | ~~Operation Plan~~ (B) | | | 2.00 | | - |
| ~~Q1-4.3.1~~ | ~~CO2 Monitoring~~ (B) | | | | | - |
| ~~Q1-4.3.2~~ | ~~Control of Smoking~~ (B) | | | | | Environmental Tobacco Monitoring |
| **Q2** | **Quality of Service** | | | **30.0** | | |
| ***Q2-1*** | ***Service Ability*** | | | **12.00** | | |
| ***Q2-1.1*** | ***Functionality & Usability*** | | | 4.80 | | |
| ~~Q2-1.1.1~~ | ~~Provision of Space & Storage~~ (B) | | | | | - |
| Q2-1.1.2 | Use of Advanced Information System | | | | | Internet connectivity |
| Q2-1.1.3 | Barrier-free Planning | New Barrier-free Building Law | | | | Provision Publicly Functional Space and Facilities; Access for People with Disabilities |
| ***Q2-1.2*** | ***Amenity*** | | | **3.60** | | |
| Q2-1.2.1 | Perceived Spaciousness & Access to View | Ceiling height | | | | Provision of Amenities (Ceiling height and Décor Planning) |
| ~~Q2-1.2.2~~ | ~~Space for Refreshment~~ (B) | | | | | |
| Q2-1.2.3 | Décor Planning | Efforts for the creation of attractive and pleasant spaces | | | | |
| ***Q2-1.3*** | ***Maintenance*** | | | 3.60 | | |
| Q2-1.3.1 | Design That Considers Maintenance | | | | | Design with Maintenance Consideration |
| Q2-1.3.2 | Securing Maintenance Functions | | | | | Maintenance Plan |
| **Q2-2** | **Durability & Reliability** | | | **9.00** | | |
| ***Q2-2.1*** | ***Earthquake Resistance*** | | | **4.50** | | Earthquake Resistance |
| Q2-2.1.1 | Earthquake-resistance | | | | | |
| Q2-2.1.2 | Seismic Isolation & Vibration Damping Systems | | | | | |
| **Q2-2.2** | **Service life of components** | | | **2.70** | | Use Durable Materials, Equipment and Services |
| Q2-2.2.1 | Service Life of Structural Materials | level of measures to prolong the period before replacement of materials used in structural skeletons etc. | | | | |
| Q2-2.2.2 | Necessary Refurbishment Interval for Exterior Finishes | Interior material lifespan | | | | |
| Q2-2.2.3 | Necessary Renewal Interval for Main Interior Finishes | Interior material lifespan | | | | |
| Q2-2.2.4 | Necessary Replacement Interval for Air Conditioning and Ventilation Ducts | | | | | |
| Q2-2.2.5 | Necessary Renewal Interval for HVAC and Water Supply and Drainage Pipes | | | | | |
| Q2-2.2.6 | Necessary Renewal Interval for Major Equipment and Services | | | | | |
| ~~Q2-2.3~~ | ~~Appropriate Renewal~~ (A) | | | | | - |
| **Q2-2.4** | **Reliability** | | | 1.80 | | Reliable Service |
| Q2-2.4.1 | HVAC System | | | | | |
| Q2-2.4.2 | Water Supply & Drainage | | | | | |
| Q2-2.4.3 | Electrical Equipment | | | | | |
| Q2-2.4.4 | Support Method of Machines & Ducts | | | | | |

| Index | Category / Credit | Indicator Description | Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| Q2-2.4.5 | Communications & IT Equipment | | | | | |
| **Q2-3** | **Flexibility & Adaptability** | | | **9.00** | | |
| ***Q2-3.1*** | ***Spatial margin*** | | | 2.70 | | Design for Flexibility and Adaptability to Future Change in Building Use |
| Q2-3.1.1 | Allowance for Floor-to-floor Height | | | | | |
| Q2-3.1.2 | Flexibility in Floor Layout | | | | | |
| ***Q2-3.2*** | ***Floor load margin*** | | | 2.70 | | |
| ***Q2-3.3*** | ***System Renewability*** | | | 3.60 | | |
| Q2-3.3.1 | Ease of Air Conditioning Duct Renewal | | | | | |
| Q2-3.3.2 | Ease of Water Supply and Drain Pipe Renewal | | | | | |
| Q2-3.3.3 | Ease of Electrical Wiring Renewal | | | | | |
| Q2-3.3.4 | Ease of Communications Cable Renewal | | | | | |
| Q2-3.3.5 | Ease of Equipment Renewal | | | | | |
| Q2-3.3.6 | Provision of Backup Space | | | | | |
| **Q3** | **Outdoor Environment (On-site)** | | | **30.00** | | |
| Q3-1 | Preservation & Creation of Biotope | | | 9.00 | | Vegetated Open Space and Biodiversity Promotion; Ecological Features Preservation & Improvement |
| Q3-2 | Townscape & Landscape | | | 12.00 | | |
| **Q3-3** | **Local Characteristics & Outdoor Amenity** | | | **9.00** | | |
| Q3-3.1 | Attention to local character & improvement of comfort | | | 4.50 | | Provision of Publicly Functional Spaced & Facilities; Heritage Features Protection & Promotion; Public Consultation; Local/Regional Materials; Consideration for Crime Prevention |
| Q3-3.2 | Improvement of the thermal environment on site | | | 4.50 | | Heat Island Effect – Hardscape; Heat Island Effect – Building Roof; Green roof; |
| **LR** | **ENVIRONMENTAL LOAD REDUCTION OF BUILDING** | | | **100** | | |
| **LR1** | **Energy** | | | **40.00** | | |
| LR1-1 | Control of Heat Load on the Outer Surface of Buildings | | | 8.00 | | Provision of Passive Design Strategies; Building Envelope Insulation; |
| LR1-2 | Natural Energy Utilization | | | 4.00 | | Daylighting; Naturally Ventilated Design; Use of Geothermal Heat Usage Systems for Air Conditioning; Water Heating System – Solar Thermal System |
| LR1-3 | Efficiency in Building Service System | | | 20.00 | | On-site Renewable Energy; Energy Efficient Performance; Water Heating – Energy Efficient System; Energy Efficient Artificial Lighting; Energy |

| Index | Category / Credit | Indicator Description | Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| | | | | | | Efficient HVAC System; Energy Efficient Equipment or Products |
| **LR1-4** | **Efficient Operation** | | | **8.00** | | |
| LR1-4.1 | Monitoring | | | | | Energy Sub-Metering; Measurement and Verification Plan in Post-Construction Occupation |
| LR1-4.2 | Operation & Management System | | | | | Building User Manual, |
| **LR2** | **Resources & Materials** | | | **30.00** | | |
| **LR2-1** | **Water Resources** | | | **6.00** | | |
| LR2-1.1 | Water saving | | | 2.40 | | Water Efficient Fittings & Fixtures |
| LR2-1.2 | Rain Water & Grey Water | | | 3.60 | | |
| LR2-1.2.1 | Rain Water Use System | | | | | Rainwater Harvesting and Reuse |
| ~~LR2-1.2.2~~ | ~~Grey Water Use System~~ (B) | | | | | |
| **LR2-2** | **Reducing Use of Non-renewable Resources** | | | **18.00** | | |
| LR2-2.1 | Reducing Usage of Materials | | | 1.80 | | Reducing Usage of Materials |
| LR2-2.2 | Continuing Use of Existing Structural Frame, etc. | - | | 3.60 | | On-site Materials Reuse |
| LR2-2.3 | Use of recycled Materials as Structural Materials | | | 3.60 | | Materials with Recycled Content |
| LR2-2.4 | Use of Recycled Materials as Non-structural Materials | | | 3.60 | | |
| LR2-2.5 | Timber from Sustainable Forestry | | | 1.80 | | Certified Wood |
| LR2-2.6 | Efforts to Enhance the Reusability of Components and Materials | | | 3.60 | | Design for Favorably Reusable Components and Materials |
| **LR2-3** | **Avoiding the Use of Materials with Pollutant Content** | | | **6.00** | | |
| LR2-3.1 | Use of Materials without Harmful Substances | | | 1.80 | | VOC Minimization – Adhesives & Sealants; Paints & Coatings; Flooring Systems; |
| ***LR2-3.2*** | ***Elimination of CFCs and Halons*** | | | 4.20 | | |
| LR2-3.2.1 | Fire Retardant | | | | | Low or Zero ODP/GWP Fire Retardant and Insulation Foaming Materials |
| LR2-3.2.2 | Foaming Agents (Insulation Materials, etc.) | Ozone-depleting potentials (ODP) & Global Warming Potential (GWP) | | | | |
| LR2-3.2.3 | Refrigerants | | | | | Refrigerant Management |
| **LR3** | **Off-site Environment** | | | **30.00** | | |
| LR3-1 | Consideration of Global Warming | Lifecycle CO2 emission rate | | 10.00 | | - |
| **LR3-2** | **Consideration of Local Environment** | | | **10.00** | | |
| LR3-2.1 | Air pollution | Gas and dust concentrations at sources of NOx, SOx and dust | | 2.50 | | Gas Pollutants and Greenhouse Gas Inventory (NOx, SOx, Cox, … and Dust) |
| LR3-2.2 | Heat island effect | Ground covering materials / rooftop greenery system or high reflective roof material / appropriate exterior wall | | 5.00 | | Heat Island Effect – Hardscape / Heat Island Effect – Building Roof / Green Roof |

| Index | Category / Credit | Indicator Description | Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| | | materials | | | | |
| ***LR3-2.3*** | ***Load on local infrastructure*** | | | 2.50 | | |
| LR3-2.3.1 | Reduction of Rain water Discharge Loads | | | | | Storm-water Design – Quantity Control/ Storm-water Design – Quality Control |
| LR3-2.3.2 | Sewage Load Suppression | The Water Pollution Control Law, the Sewerage Law | | | | - |
| LR3-2.3.3 | Traffic Load Control | Appropriate Cycle parking spaces; appropriate car parking spaces | | | | Bicycle Rider Amenities – Storage & Lane / Appropriate Parking Capacity |
| LR3-2.3.4 | Waste Treatment Loads | Stock space for collection waste; waste sorting and collection containers; equipment for waste composting | | | | Dedicated Recycling Storage Area / Composting |
| **LR3-3** | **Consideration of Surrounding Environment** | | | **10.00** | | |
| LR3-3.1 | Noise, Vibration & Odor | | | 4.00 | | - |
| LR3-3.1.1 | Noise | | | | | - |
| LR3-3.1.2 | Vibration | | | | | - |
| LR3-3.1.3 | Odor | | | | | - |
| ***LR3-3.2*** | ***Wind/Sand Damage & Daylight Obstruction*** | | | 4.00 | | |
| LR3-3.2.1 | Restriction of Wind Damage | | | | | Planning for Restriction of Wind Damage |
| ~~LR3-3.2.2~~ | ~~Sand and Dust~~ (B) | | | | | |
| LR3-3.2.3 | Restriction of Daylight Obstruction | | | | | Daylighting |
| ***LR3-3.3*** | ***Light Pollution*** | | | 2.00 | | Light Pollution Reduction; Glare Control |
| LR3-3.3.1 | Outdoor Illumination and Light that Spills from Interiors | - | | | | |
| LR3-3.3.2 | Measures for Reflected Solar Glare from Building Walls | - | | | | |
| NOTE: (A) Inapplicable under CASBEE for Building (New Construction); (B) Inapplicable for Apartments Building Type | | | | | | |

# D-3 Green Mark for New Buildings (Version 4.1, 2012, Criteria for Residential Building)

| Index | Category / Credit | Indicator Description | Max. Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| **RB 1** | **Energy Efficiency** | | **87** | **58.78** | | |
| RB 1-1 | Thermal Performance of Building Envelope – RETV | RETV: Maximum Permissible RETV = 25 W/m 2<br>Each reduction 1 W/m2 (3pts) up to 5 W/m2<br>**PR: Gold 22** W/m2**; Platium: 20** W/m2 | 15 | **10.14** | | Building Envelope Insulation |
| RB 1-2 | Naturally Ventilated Design and Air-Conditioning System | Use of <u>ventilation simulation modeling/ wind tunnel</u> testing OR <u>ventilation design and using energy efficient air-conditioning system</u> | 22 | **14.86** | ○ | Naturally Ventilation Design / Energy Efficient HVAC System |
| RB 1-3 | Daylighting | Use of daylight and glare simulation software to identify dwelling units' living and dining areas in at least 80% of the units. 1~3pts based on the extent of the daylight zones from building façade perimeter. Daylighting for lift lobbies and corridors (1pt)/ staircases (1pt) / carparks (1pt) | 6 | **4.05** | | Daylighting |
| RB 1-4 | Artificial Lighting | 0.25 point for every percentage improvement in the lighting provisions (up to 10 points) | 10 | **6.76** | ○ | Energy Efficient Artificial Lighting |
| RB 1-5 | Ventilation in Carparks | Carpark spaces that are fully naturally ventilated (6pts) OR 4 points for carparks using fume extract system and 3 points for those with MV with or without supply | 6 | **4.05** | | Ventilation in Carparks |
| RB 1-6 | Lifts | Use of lifts with energy efficient features (1pt) | 1 | **0.68** | | Energy Efficient Lifts |
| RB 1-7 | Energy Efficient Features | Use of energy efficient equipment or products (up to 2pts)<br>Use of heat recovery devices / thermal insulation or cool paints on the east and west facing external walls / occupancy sensors for private lift lobbies, staircases, common toilets / Provision of vertical greenery system on building facades / gas water heater / clothes drying facilities and open spaces / lifts with better energy efficient features / sun pipes for natural lighting / ductless fans for basement ventilation / the computation of Energy Efficiency Index (EEI) for common facilities (up to 5pts) | 7 | **4.73** | | Use energy efficient equipment or products; Drying space; Water Heating – Energy Efficient System; Energy Efficient Lifts |
| RB 1-8 | Renewable Energy | Every 1% replacement of electricity (3pts) (exclude household's usage) (up to 20 pts) | 20 | **13.51** | | On-site Renewable Energy |
| **RB 2** | **Water Efficiency** | | **14** | **9.46** | | |
| RB 2-1 | Water Efficient Fittings | Use of water efficient fittings that are certified under the Water Efficiency Labeling Scheme (WELS). | 10 | **6.76** | ○ | Water Efficient Fittings & Fixtures |
| RB 2-2 | Water Usage Monitoring | Provision of private meters to monitor the major water usage such as irrigation, swimming pools and other water features. | 1 | **0.68** | ○ | Water Usage Monitoring |
| RB 2-3 | Irrigation System and Landscaping | Use of non-potable water for irrigation (1pt); Use of automatic water efficient irrigation system with rain sensor (at least 50%) (1pt); Use of drought tolerant plants (1pt). | 3 | **2.03** | | Water-Efficient Irrigation & Landscaping |
| **RB 3** | **Environmental Protection** | | **41** | **27.70** | | |
| RB 3-1 | Sustainable Construction | - use of Green Cements with approved industrial by-product to replace Ordinary Portland Cement (OPC) by at least 10% by mass for superstructural works. (1pt). | 10 | **6.76** | ○ | Green Cements & Efficient Concrete Usage |

| Index | Category / Credit | Indicator Description | Max. Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| | | - Use of Recycled Concrete Aggregates (RCA) or Washed Copper Slag (WCS) from approved sources to replace coarse or fine aggregates for concrete production of main building elements. 1 point for every incremental of 0.5 times (0.5x) of the usage requirement (Up to 2x) (4pts)<br>- Efficient concrete usage for building components based on the percentage reduction in the prescribed Concrete Usage Index (CUI) (m3/m2) limit with ≤0.70 (1pt) up to ≤0.35 (5pts) | | | | |
| RB 3-2 | Sustainable Products | - (A) The use of environmental friendly products or recycled materials used for all dwelling units will be considered as high impact (1 point). Items that are used for all common areas, external works and communal facilities are considered as low impact (0.5 point).<br>- (B) The weightage given will be based on based on the extent of environmental friendliness as determined by the approved local certification body and are subject to BCA's evaluation. (Good (0.5), Very Good (1.5), (Excellent(2)) Point= Σ(A)x(B) (max. 8pts) | 8 | **5.41** | ○ | Materials with Recycled Content / Regional Materials / Rapidly Renewable Materials / Certified Wood |
| RB 3-3 | Greenery Provision | - (up to 6pts) provision of greenery within the developments including roof top/ sky garden and green roof, points allocation based on Green Plot Ratio (GnPR).<br>- (1pt) restoration, conservation or relocation of existing trees on site.<br>- (1pt) the use of compost recycled from horticulture waste. | 8 | **5.41** | ○ | Vegetation & Ecological Features Preservation / Green Roof / Composting |
| RB 3-4 | Environmental Management Practice | - (1pt) if effective implementation of environmental friendly programmes including monitoring and setting targets to minimise energy use, water use and construction waste are in place.<br>- (1pt) if main builder has good track records in the adoption of sustainable, environmentally friendly and considerate practices during construction.<br>- (1pt+1pt) if the building quality is assessed under the<br>Construction Quality Assessment System (CONQUAS)/ Quality Mark<br>- (1pt) if the developer, main builder, M & E consultant and architect are ISO 14000 certified.<br>- (1pt) if the project team comprises one Certified Green Mark Manager (GMM)(0.5 pt), one Certified Green Mark Facility Manager (GMFM)(0.5 pt) or one Certified Green Mark Professional (GMP)(1 pt)<br>- (1pt) provision of building users' guide<br>- (1pt) provision of facilities or recycling bins at each block of development. | 8 | **5.41** | ○ | Adoption of Environmental Friendly Practices |
| RB 3-5 | Green Transport | - (1pt) provides good access (< 500m walking distance) to public transport networks.<br>- (1pt) provision of covered walkway to facilitate connectivity and the use of public transport.<br>- (1pt) provision of electric vehicle charging stations within the development (1 charging station for every | 4 | **2.70** | ○ | Public Transportation Access / Bicycle Rider Amenities – Storage & Lane |

| Index | Category / Credit | Indicator Description | Max. Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| | | 100 carpark lots, max. 5 stations)<br>- (1pt) provision of covered/sheltered bicycles parking lots (10% (1pt); 5% (0.5pt)) | | | | |
| RB 3-6 | Stormwater Management | Treatment of stormwater runoff from up to 10% (1pt), more than 10% to up to 35% (2pts), more than 35% (3pts) of total site area or paved area. | 3 | **2.03** | ● | Stormwater Runoff Management; Stormwater Runoff Treatment |
| **RB 4** | **Indoor Environmental Quality** | | **6** | **4.05** | | |
| RB 4-1 | Noise Level | The building is designed to achieve ambient internal noise level: 55 dB (6am-10 pm) LeqA; 45 dB (10pm-6 am) LeqA (1pt) | 1 | **0.68** | | Sound Insulation & Noise Level |
| RB 4-2 | Indoor Air Pollutants | Use of low volatile organic compounds (VOC) certified paints for at least 90% of the internal wall areas (1pt) / Use of environmentally friendly certified adhesives for at least 90% of the applicable building works or areas (1pt) | 2 | **1.35** | | Volatile Organic Compounds Minimization |
| RB 4-3 | Waste Disposal | The refuse chutes are located at open ventilation areas such as service balconies or common corridors (1pt) to minimize airborne contaminants from waste. | 1 | **0.68** | | Waste Disposal Location |
| RB 4-4 | Indoor Air Quality in Wet Areas | Provision for adequate natural ventilation and daylighting in wet areas i.e. kitchens, bathrooms and toilets. Applicable areas: 50% to 90% (1pt), more than 90% (2pts). | 2 | **1.35** | | Indoor Air Quality in Wet Areas |
| **TOTAL** | | | **148** | **100** | | |
| **RB 5** | **Other Green Features** | | **7** | **4.73** | | |
| RB 5-1 | Green Features & Innovations | | 7 | **4.73** | | - |

# D-4 Green Building Index (GBI) – Residential New Construction (RNC) Version 3.1 (2014)

| Index | Category / Credit | Indicator Description | Max. Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| **EE** | **ENERGY EFFICIENCY** | | **23** | **25.00** | | |
| EE1 | Minimum EE Performance | Comply MS1525:<br>OTTV ≤ 50W/m 2; Lightweight Roof U-value ≤ 0.4 W/m 2 K Heavyweight Roof U-value ≤ 0.6 W/m 2 K. | 1 | **1.09** | ● | Energy Efficiency Performance |
| EE2 | Advanced EE Performance | For High-Rise:<br>OTTV ≤ 46 W/m 2(1pt) up to ≤ 30 W/m 2 (9pts);<br>Lightweight Roof U-value ≤ 0.35 W/m 2 K (up to ≤ 0.25 W/m 2 K (3pts))/ Heavyweight Roof U-value ≤ 0.50 W/m 2 K (1pt) (up to ≤ 0.30 W/m 2 K (3pts)) | 12 | **13.04** | ● | Energy Efficiency Performance |
| EE3 | Renewable Energy | For High-Rise:<br>3 kWp is generated by renewable energy (1pt); 6 kWp (2pts) up to 30 kWp (5pts) or 10% of building energy consumption (2pt) up to 25% (5pts) | 5 | **5.43** | ● | On-Site Renewable Energy |
| EE4 | External Lighting and Control | For High-Rise: Provide High Efficiency External Lighting to at least 90% of the common areas (1pt); Provide photo-sensors with motion detectors (1pt) | 2 | **2.17** | ○ | External Lighting and Control |
| EE5 | Internet Connectivity | Provide infrastructure for internet connectivity to meet the speed capacity provided by the service providers. | 1 | **1.09** | ○ | Internet Connectivity |
| EE6 | Sustainable Maintenance and Building User Manual (BUM) | | 2 | **2.17** | ○ | Building User Manual / Maintenance Plan |
| **EQ** | **INDOOR ENVIRONMENTAL QUALITY** | | **12** | **13.04** | | |
| EQ1 | Minimum Indoor Air Quality Performance | For High-Rise: All habitable rooms to meet the minimum requirements of ventilation rate in the local building code. (1pt); ≥75% of the total habitable rooms to be provided with cross and/or stack ventilation. (1pt); All public and circulation spaces to be naturally ventilated to meet the minimum requirements of ventilation rate in the local building code.(1pt) | 3 | **3.26** | ● | Minimum Indoor Air Quality Performance |
| EQ2 | Volatile Organic Compounds Minimisation | Use low VOC /paint and coating to walls/ ceiling/ carpet or flooring/ adhesive and sealant (at least 90%) OR no use. (1pt for each 2 items up to max 2pts. | 2 | **2.17** | ○ | Volatile Organic Compounds Minimization |
| EQ3 | Formaldehyde Minimisation | Use products with no formaldehyde OR low as recognized by GBI | 1 | **1.09** | ● | Formaldehyde Minimization |
| EQ4 | Daylighting | For High-Rise: ≥50% (1pt) ≥75%(2pts) of habitable rooms; All public and circulation spaces being naturally lit. (1pts) | **3** | **3.26** | ● | Daylighting |
| EQ5 | External Views | Demonstrate that all the habitable rooms have a direct line of sight to the outdoor environment through vision glazing.<br>If the view is towards an internal light well or | 1 | **1.09** | ○ | External Views |

| Index | Category / Credit | Indicator Description | Max. Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| | | courtyard, the window size must be substantially larger than the minimum size stipulated in the UBBL. | | | | |
| EQ6 | Sound Insulation | Ensure that the sound penetrations between dwellings are controlled within the following criteria; Sound Transmission Class (STC) value between dwelling units ≥45. | 1 | **1.09** | ● | Sound Insulation |
| EQ7 | Post Occupancy Evaluation | Conduct a post-occupancy comfort survey of building occupants within 12 months after issuance of Certificate of Completion and Compliance (CCC). | 1 | **1.09** | ○ | Post Occupancy Evaluation |
| **SM** | **SUSTAINABLE SITE PLANNING & MANAGEMENT** | | **33** | **35.87** | | |
| SM1 | Site Selection and Planning | 1. Approved Layout plan, 2. Support letters from all Infrastructure Providers, 3. The proposed buildings, hardscape, roads or parking on sites to meet any one of the following creteria: Prime agricultural land/ Land that is specifically identified as habitat for any species threatened or endangered lists;/ Within 30m of any wetlands | 1 | **1.09** | ○ | Site Selection |
| SM2 | Re-habilitation of Brownfield Sites OR Re-development of Existing Buildings | Reward rehabilitation of Brownfield site and development in existing building. 1. Rehabilitation of brownfield sites, OR 2. Re-use OR refurbishment of site with existing development to improve the quality of the development | 1 | **1.09** | ○ | Brownfield Redevelopment |
| SM3 | Community Connectivity | Basic Amenities (2pts); Other Amenities (2pts) are to be provided or are available within 750m. | 4 | **4.35** | ○ | Community Connectivity |
| SM4 | Earthworks – Construction Activity Pollution Control | Creating and implementing an Erosion and Sedimentation Control (ESC) Plan for all project's construction activities. | 1 | **1.09** | ○ | Earthworks – Construction Activity Pollution Control |
| SM5 | QLASSIC – Quality Assessment System For Building Construction Work | Subscribe to independent method to assess and evaluate quality of workmanship of building based on CIDB's CIS7: Quality Assessment System for Building Construction Work (QLASSIC) or equivalent systems recognized by GBI. Project should achieve a minimum score of 70%. | 1 | **1.09** | ○ | Construction Work Quality Assessment System |
| SM6 | Workers' Site Amenities | Create and implement a Site Amenities Plan for all construction workers of project, which focus on: Proper accommodation, Prevent pollution of storm sewer or receiving stream, Prevent polluting the surrounding, Provide, at reasonable distance, adequate health and hygiene facilities for workers on site. | 1 | **1.09** | ○ | Workers' Site Amenities |
| SM7 | IBS – Industrialised Building System | CIDB IBS score ≥ 50% (1pt); ≥ 70% (2pts). | 2 | **2.17** | ○ | IBS – Industrialised Building System |
| SM8 | Public Transportation Access | Provision of Covered Waiting Area for ≥ 2% of total residents; Quality of Pedestrian Dedicated Access : Dedicated walkway(1pt), Dedicated covered walkway (2pts) | 8 | **8.70** | ○ | Public Transportation Access |
| SM9 | Dedicated Cycling Network | Provision of bicycle lanes and bicycle parking for ≥ 2% of total residents, up to maximum of 20 parking spaces (1pt), dedicated cycling network with man-made shades or natural shade-providing trees at regular spacings covering at least 70% of the cycling network. | 2 | **2.17** | ○ | Bicycle Rider Amenities – Storage & Lane |
| SM10 | Stormwater Design – | Control post-development peak flow (1pt), OR | 3 | **3.26** | ● | Stormwater Design – Quantity |

| Index | Category / Credit | Indicator Description | Max. Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| | Quantity and Quality Control | Reduce post-development peak flow by another 30% (2pts); Provide permanent pollutant control facilities (1pt) | | | | Control; Stormwater Design – Quality Control |
| SM11 | Heat Island Effect – Greenscape and Water Bodies | For Highrise: provide greenscape with native & adaptive plants and/or water body to ≥ 15%(1pt); ≥ 25% (2pts);≥35% (3pts);≥45% (4pts);≥55%(5pts) of land area, | 5 | 5.43 | ○ | Vegetation & Ecological Features Preservation |
| SM12 | Heat Island Effect – Hardscape | Provide any combination of the following strategies for 50% of the site hardscape (including sidewalks,courtyards, plazas and parking lots):<br>• Shade (within 5 years of occupancy);<br>• Paving materials with a Solar Reflectance Index (SRI) of at least 29;<br>• Open grid pavement system; | 2 | 2.17 | ○ | Heat Island Effect – Hardscape |
| SM13 | Heat Island Effect – Roof | 1. Use roof material with appropriate SRI; OR 2. Install a vegetated roof to at least 50% of the roof area; OR 3. Install high albedo and vegetated roof surface. | 1 | 1.09 | ○ | Heat Island Effect – Building Roof |
| SM14 | Composting | 1. Recycle landscape and/or organic waste to meet at least 50% of landscape fertilizer needs AND 2. To provide a programme for the recycling of the landscape and/or organic waste. | 1 | 1.09 | ○ | Composting |
| **MR** | **MATERIALS & RESOURCES** | | **12** | **13.04** | | |
| MR1 | Materials Reuse and Selection | Where reused products or materials constitutes ≥ 2% (1pt); ≥5%(2pts) of the project's total material cost value. (counting for both materials found on-site and off-site including temporary structures) | 2 | 2.17 | ● | Materials Reuse |
| MR2 | Recycled Content Materials | Where use of products or materials with recycled content is such that the sum of post-consumer recycled plus one-half of the pre-consumer content constitutes ≥ 10% (1pt); ≥ 30%(2pts) (based on cost) of the total value of the materials in the project | 2 | 2.17 | ● | Materials with Recycled Content |
| MR3 | Regional Materials | Use building products or materials that have been extracted, harvested or recovered, as well as manufactured, within Malaysia for ≥ 50% (1pt); ≥ 75% (2pts) (based on cost) of the total material value. | 2 | 2.17 | ● | Regional Materials |
| MR4 | Sustainable Timber | Where ≥ 50%(1pt); ≥ 75%(2pts) of wood-based materials and products used are certified | 2 | 2.17 | ● | Certified Wood |
| MR5 | Storage and Collection of Recyclables | During Construction, provide dedicated area(s) and storage for collection of non-hazardous materials for recycling (1pt). During Building Occupancy, provide permanent recycling bins AND provide Recyclable Segregation Plan. (2pts) | 2 | 2.17 | ○ | Dedicated Recycling Storage Area |
| MR6 | Construction Waste Management | Recycle and/or salvage ≥50%(1pt), ≥75%(2pts) volume/tonnage of non-hazardous construction debris | 2 | 2.17 | ● | Construction Waste Management |
| **WE** | **WATER EFFICIENCY** | | **12** | **13.04** | | |
| WE1 | Rainwater Harvesting | Rainwater harvesting that leads to ≥ 10%(1pt), > 30%(2pts), > 40%(3pts), > 50%(4pts) reduction in potable water consumption (Common Areas only). | 4 | 4.35 | ● | Rainwater Harvesting |

| Index | Category / Credit | Indicator Description | Max. Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| WE2 | Waste Water Recycling | Treat and recycle ≥ 10% (1pt) or 30% (2pts) wastewater (grey and/or black) leading to reduction in potable water consumption (Common Areas only). | 2 | **2.17** | ● | Waste Water Recycling |
| WE3 | Water Efficient Irrigation and Landscaping | Reduce potable water consumption for landscape irrigation by ≥ 50% (1pt) OR Do not use potable water at all for landscape irrigation (2pts) | 2 | **2.17** | ○ | Water-Efficient Irrigation & Landscaping |
| WE4 | Water Efficient Fittings | Reduce annual potable water consumption by ≥ 10% (1pt); ≥ 30%(2pts); ≥ 40%(3pts); ≥ 50% (4pts) | 4 | **4.35** | ● | Water Efficient Fittings & Fixtures |
| **TOTAL** | | | **92** | **100** | | |
| **IN** | **INNOVATION** | | **8** | **8.70** | | |
| | Innovation in Design and Environmental Design Initiatives | Encourage the design team by providing the opportunity to score points for exceptional performance above the requirements set by GBI rating system | 7 | **7.61** | ○ | |
| | Green Building Index Facilitator (GBIF) | At least one principal participant of the project team shall be a Green Building Index Facilitator who is engaged at the onset of the design process until completion of construction and Green Building Index certification is obtained. | 1 | **1.09** | ○ | |

## D-5 BERDE Green Building Rating Scheme Version 1.1.0 (2013) (for New Construction: Vertical Residential Development)

| Index | Category / Credit | Indicator Description | Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| **MN** | **Management** | | **14** | **14.00** | | |
| MN-RQ-1 | Commitment | | R | - | | - |
| MN-RQ-2 | Project Team | | R | - | | - |
| MN-RQ-3 | Technical Site Assessment | | R | - | | Technical Site Assessment |
| MN-RQ-4 | Basis of Design | | R | - | | - |
| MN-RQ-5 | Design Management System | | R | - | | - |
| MN-RQ-6 | Construction Management System | | R | - | | Construction Work Quality Assessment System |
| MN-RQ-7 | Coordinated Building Commissioning System | | R | - | | Commissioning |
| MN-PT-1 | BERDE Consultant | | 2 | 2.00 | | - |
| MN-PT-2 | Stakeholder Consultation | | 6 | 6.00 | | Stakeholder Consultation |
| MN-PT-3 | Design Charrette | | 1 | 1.00 | | Design Charrette |
| MN-PT-4 | Security | | 1 | 1.00 | | Security in Buildings Design |
| MN-PT-5 | Sustainability Commitment | | 4 | 4.00 | | Considerate Constructors Commitment |
| **LE** | **Land Use and Ecology** | | **20** | **20.00** | | |
| LE-RQ-1 | Construction Activities Pollution Control | | R | - | | Construction Activity Pollution Control |
| LE-PT-1 | Land Reuse | | 6 | 6.00 | | Site Selection / Brownfield Redevelopment |
| LE-PT-2 | Protection and Improvement Of Ecological Features | | 6 | 6.00 | | Vegetation & Ecological Features Preservation |
| LE-PT-3 | Pro-Local Biodiversity Open Space | | 3 | 3.00 | | Biodiversity Protection |
| LE-PT-4 | Heat Island Effect: Non-Roof | | 2 | 2.00 | | Heat Island Effect: Hardscape |
| LE-PT-5 | Heat Island Effect: Building Roof | | 1 | 1.00 | | Green Roof |
| LE-PT-6 | Flood Risk Minimization | | 2 | 2.00 | | Flood Risk Minimization |
| **WT** | **Water** | | **7** | **7.00** | | |
| WT-RQ-1 | Effluent Quantity and Quality Monitoring | | R | - | | Water Usage Monitoring |
| WT-PT-1 | Water Sub-Metering | | 1 | 1.00 | | Water Usage Monitoring |
| WT-PT-2 | Potable Water Consumption Reduction | | 4 | 4.00 | | Water Efficient Fittings & Fixtures / Waste Water Recycling / Rainwater Harvesting |
| WT-PT-3 | Efficient Landscape Irrigation | | 2 | 2.00 | | Water Efficient Irrigation & Landscaping |

| Index | Category / Credit | Indicator Description | Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| **EN** | **Energy** | | **9** | **9.00** | | |
| EN-PT-1 | Energy Sub-Metering | Provide methods of sub-metering for the following systems: Space Cooling, Hot Water, Fans (major), lighting, and other appropriate major energy-consuming items. | 1 | 1.00 | ○ | Energy Sub-Metering |
| EN-PT-2 | Energy Efficient Lighting | Install light fittings, fixtures, and luminaires with a minimum luminous efficacy of 80 lumens per watt. Light fixtures and fittings must be compliant to the pertinent Philippine National Standards (PNS) | 1 | 1.00 | ● | Energy Efficient Artificial Lighting |
| EN-PT-3 | Natural Ventilation | Use natural ventilation techniques in 50% of regularly occupied ventilated spaces. | 1 | 1.00 | ● | Naturally Ventilated Design |
| EN-PT-4 | On-Site Renewable Energy Generation | Offset five percent (5%) of the building's total energy demand through the installation of renewable energy technologies in the building. | 1 | 1.00 | ● | On-Site Renewable Energy |
| EN-PT-5 | Energy Efficiency Improvement | Energy consumption reduction of 12.5% from baseline through: energy efficient equipment/ Energy efficient lighting/ Co-generation/ Passive methods (including envelope)/ Use of carbon dioxide sensors for controlling air volume of fresh air supply | 1 | 1.00 | ● | Optimize Energy Performance |
| EN-PT-6 | Energy Efficient Building Envelope | | 1 | 1.00 | | Building Envelope Insulation |
| EN-PT-7 | Energy Efficient Equipment | | 1 | 1.00 | | Energy Efficient Equipment or Products |
| EN-PT-8 | Building Automation Systems | | 2 | 2.00 | | Building Automation Systems |
| **TR** | **Transportation** | | **18** | **18.00** | | |
| TR-PT-1 | Bicycle Rider Amenities | The project's vicinity must have existing bicycle lanes. Provide secure bicycle parking for at least 5% of building occupants and connecting with offsite bicycle lanes. | 1 | 1.00 | ● | Bicycle Rider Amenities |
| TR-PT-2 | Low Emission, Fuel Efficient and Low Emitting Vehicles | Provide preferred parking for fuel efficient and low-emitting vehicles for at least 3% of the total vehicle parking capacity. | 1 | 1.00 | ● | Parking for Green Vehicles |
| TR-PT-3 | Parking | Ensuring allocated parking areas/slots do not exceed National Building Code of the Philippines or local government unit (LGU) requirements. | 3 | 3.00 | ● | Parking Area not exceeding Code Requirement |
| TR-PT-4 | Proximity to Key Establishments | Situate the building no farther than 250m from 10 basic services. | 3 | 3.00 | ○ | Community Connectivity |
| TR-PT-5 | Public Access | Implement design strategies that allow people to pass within the building premises and grounds to provide more options for pedestrian movement. | 1 | 1.00 | ○ | Community Connectivity |
| TR-PT-6 | Contribution To Public Transport Amenities | Provide the following public transport amenities: Covered walkways connecting the building to transport waiting areas/ Public Utility Vehicle (PUV) Waiting Areas/ PUV Terminals | 3 | 3.00 | ○ | Contribution To Public Transport Amenities |
| TR-PT-7 | Public Transportation Access | Locate project within 500 meters walking distance of the rail stations/ bus stops/ 250 meters walking distance of Public Utility Jeepney and Asian Utility Vehicle and/or Providing separate shuttle links. | 4 | 4.00 | ○ | Public Transportation Access |
| TR-PT-8 | Transportation Impact Assessment | Undergo a Transportation Impact Assessment (TIA) conducted by a transportation engineer or planner certified by the Environmental Management Bureau. | 2 | 2.00 | ○ | Transportation Impact Assessment |
| **EQ** | **Indoor Environment Quality** | | **7** | **7.00** | | |
| EQ-RQ-1 | Lighting Levels | Minimum illuminance (lux) levels in all internal areas in accordance with standards (PR) | R | - | ● | Minimum Lighting and Thermal Levels |
| EQ-RQ-2 | Thermal Levels | Calculate cooling load based on projected load submittals to identify thermal comfort levels. | R | - | ○ | Minimum Lighting and Thermal Levels |

| Index | Category / Credit | Indicator Description | Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| EQ-PT-1 | External View and Daylighting | | 1 | 1.00 | | External View / Daylighting |
| EQ-PT-2 | Illumination Control | Allow separate occupant control of lighting in applicable areas | 1 | 1.00 | ○ | Controllability of Systems – Lighting & Thermal Comfort |
| EQ-PT-3 | Glare Control | Install an occupant-controlled shading system on all windows, glazed doors and roof lights in regularly occupied spaces; OR Comply with the corresponding reflectance values (in percentage) for interior surfaces. | 1 | 1.00 | ○ | Glare Control |
| EQ-PT-4 | Thermal Control | Allow occupant control building cooling system of zoned areas. | 1 | 1.00 | ○ | Controllability of Systems – Lighting & Thermal Comfort |
| EQ-PT-5 | Indoor Air Quality | Comply with the provisions of ASHRAE No. 62.1-2004: Ventilation for Acceptable Indoor Air Quality. | 1 | 1.00 | ○ | Ventilation for Indoor Air Quality |
| EQ-PT-6 | Microbial Contamination Prevention | Require appropriate design of water system, duct systems, mats, carpets or grills. | 1 | 1.00 | ○ | Indoor Chemical and Pollutant Source Control and Microbial Contamination Prevention |
| EQ-PT-7 | Low VOC Environment | 60% of all indoor materials (paints, anti-corrosive and anti-rust coatings, wood finishes, floor coatings, stains, sealers, shellacs, adhesives) are officially certified products. | 1 | 1.00 | ○ | Volatile Organic Compounds Minimization |
| **MT** | **Materials** | | **6** | **6.00** | | |
| MT-PT-1 | Civil Works | Certified products compliance to ISO/IEC Guide 65: 50% of all wood used for structural components/ recycled content of 20% of cement used (percentage based on volume)/ recycled content of 20% of steel materials used (based on volume) | 2 | 2.00 | ○ | Materials with Recycled Content / Certified Wood |
| MT-PT-2 | Electrical Works | Use officially certified materials (lamps and ballasts) | 2 | 2.00 | ○ | Certified Electrical Equipment with no hazardous substances |
| MT-PT-3 | Architectural Works and Finishes | Use salvaged materials for non-structural purposes; officially certified materials; 20% (by cost) of certified wood, rapidly renewable materials, materials with recycled content | 2 | 2.00 | ○ | On-site Materials Reuse / Off-site Materials Reuse / Materials with Recycled Content / Rapidly Renewable Materials / Certified Wood |
| **EM** | **Emissions** | | **4** | **4.00** | | |
| EM-PT-1 | Pollutant and Greenhouse Gas Inventory | Conduct an Life Cycle Inventory (LCI) and account for values for: Criteria air pollutants as defined by the Clean Air Act; Greenhouse gases; Hazardous air pollutants as defined by the Clean Air Act. | 2 | 2.00 | ○ | Pollutant and Greenhouse Gas Inventory |
| EM-PT-2 | Ozone Protection | Avoid the use of ozone-depleting substances for refrigerants and fire suppression systems. | 1 | 1.00 | ○ | Refrigerant Management |
| EM-PT-3 | Emission Control | Verify that strategies have been implemented to alter the emissions of the building into an air quality level within DENR standards at a minimum. | 1 | 1.00 | ○ | Emission Control |
| **WS** | **Waste** | | **11** | **11.00** | | |
| WS-RQ-1 | Waste Management Plan | Establish a waste management compliant with national and local waste policies. | R | - | ○ | Construction Waste Management |
| WS-RQ-2 | Waste Management – During Construction | Establish a waste management system during construction process. | R | - | ○ | Construction Waste Management |
| WS-PT-1 | Construction Waste Diversion | Recycling or salvaging of construction waste 40% to 59% (2pts); 60% to 79% (4pts); >80% (6pts) | 6 | 6.00 | ● | Construction Waste Management |
| WS-PT-2 | Materials Recovery Facility | Comply with the requirements: Provide contained areas/ Locate the facility in an accessible area/ Allocate adequate | 5 | 5.00 | ○ | Dedicated Recycling Storage Area |

| Index | Category / Credit | Indicator Description | Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| | | space to store the projected volume of waste; Provide a policy for the tenants to segregate wastes generated. | | | | |
| **HC** | **Heritage Conservation** | | **4** | **4.00** | | |
| HC-RQ-1 | Conservation Assessment | Use green building practices, construction methods/systems. | R | - | ○ | Heritage Features Protection & Promotion |
| HC-PT-1 | Heritage Feature Protection | Use designs that preserve the significant heritage features, and materials/alternative materials/systems that promote green building practices. | 3 | 3.00 | ○ | |
| HC-PT-2 | Heritage Features Promotion | Use green building practices, construction methods/systems. | 1 | 1.00 | ○ | |
| **TOTAL** | | | **100** | **100** | | |
| | **Innovation** | | **20** | **20.00** | | |
| IN-PT-1 | Innovation In Design or Process | Incorporate groundbreaking technologies and inventive techniques in design or process | 10 | 10.00 | | Innovation In Design or Process |
| IN-PT-2 | Innovation In Performance | Incorporate groundbreaking technologies and inventive techniques in building operations | 10 | 10.00 | | Innovation In Performance |
| NOTE: R: Requirement; ● : Performance indicator; ○ : Prescriptive indicator | | | | | | |

# D-6 LOTUS-R Extended Pilot Version (2013)

| Index | Category / Credit | Indicator Description | Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| **E** | **Energy** | | **31** | **23.85** | | |
| E-PR-1 | Passive design | **Conduct passive design analysis (PR)** | R | **R** | ○ | Passive design |
| E-1 | Total Building Energy Use | Reduction of energy use: **10% (PR)**; additional 3% (1 pt) up to 52% | 14 | **10.77** | ● | Total Building Energy Use |
| E-2 | Building Envelope | OTTV of wall and roof: **meet BC (PR)**; additional 10% reduction (1 pt) up to 40% | 4 | **3.08** | ● | Building Envelope |
| E-3 | Natural Ventilation | Cross ventilation: in **80% of common areas (PR)**; in each 20% of total habitable spaces (1pt) up to 80% | 4 | **3.08** | ● | Natural Ventilation |
| E-4 | HVAC | COP of HVAC equipment: **meets BC (PR)**; additional 10% improvement (1pt) up to 30% | 3 | **2.31** | ● | HVAC |
| E-5 | Artificial Lighting | Lighting Power Density: **meets BC (PR)**; surpasses 50% (1pt), 60% (2pts) | 2 | **1.54** | ● | Artificial Lighting |
| E-6 | Hot Water | For High-rise: Thermal efficiency of fuel water heating systems surpasses BC by 5% (1pt), 10% (2pts) OR Solar thermal system produces 40% (1pt); 60% (2pts) of total hot water consumption | 2 | **1.54** | ● | Hot Water |
| E-7 | Renewable Energy | For High-rise: renewable energy used: >0.5% (1pt), >1.5% (2pts) of total energy used | 2 | **1.54** | ● | On-site Renewable Energy |
| **W** | **Water** | | **18** | **13.85** | | |
| W-1 | Water Efficient Fixtures | Total fixture water consumption: reduced by **10% (PR)**; each additional 5% (1pt) up to 45% | 7 | **5.38** | ● | Water Efficient Fittings & Fixtures |
| W-2 | Water Recycling/ Reuse | Recycled/ Reused water: 10% (1pt) of site' total water consumption; each additional 5% (1pt) up to 30% | 5 | **3.85** | ● | Waste Water Treatment and Recycling |
| W-3 | Rainwater Harvesting | Harvested rainwater: 5% (1pt) of site' total domestic water consumption, each additional 5% (1pt) up to 15% | 3 | **2.31** | ● | Rainwater Harvesting |
| W-4 | Water Efficient Landscaping | Non-domestic water used for landscape: 50% (1pt); 75% (2pts)l; 100% (3pts) | 3 | **2.31** | ● | Water Efficient Irrigation & Landscaping |
| **M** | **Materials** | | **17** | **13.08** | | |
| M-1 | Materials Reuse | On-site or off-site reused materials or products: 25% (1pt); each additional 15% (1pt) up to 70% of total materials value | 4 | **3.08** | ● | On-site Materials Reuse / Off-site Material Reuse |
| M-2 | Materials with Recycled Content | Materials with recycled content: 10% (1pt); each additional 5% (1pt) up to 25% of total materials value | 4 | **3.08** | ● | Materials with Recycled Content |
| M-3 | Rapidly Renewable Materials | Rapidly renewable materials: 1% (1pt), 2% (2pts) of total materials value | 2 | **1.54** | ● | Rapidly Renewable Materials |
| M-4 | Timber | Sustainable timber: 25% (based on cost) (1pt); 50% (2pts) of all timber used | 2 | **1.54** | ● | Certified wood |
| M-5 | Non-baked Materials | Non-baked materials used for non-structural walls:30% (by volume) (1pt); each additional 15% (1pt) up to 90% | 5 | **3.85** | ● | Non-baked Materials |
| **Eco** | **Ecology** | | **13** | **10.00** | | |
| Eco-1 | Environment | **Avoid high eco-value land site (PR) & conduct an environmental impact assessment (PR)**; strategies controlling site disturbance during the construction process (1pt) | 1 | **0.77** | ○ | Construction Activity Pollution Control |
| Eco-2 | Top Soil Preservation | Preserved topsoil area: 20% (1pt); each additional 20% (1pt) up to 60% of site's existing topsoil | 3 | **2.31** | ● | Top Soil Preservation |
| Eco-3 | Biodiversity | Demonstrate a measurable sustaining strategy for | 2 | **1.54** | ○ | Biodiversity Protection |

| Index | Category / Credit | Indicator Description | Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| | | native biodiversity within on-site eco-systems | | | | |
| Eco-4 | Site Selection | Use previously developed site (1pt); treat and use previously polluted site (3pts) | 3 | **2.31** | ○ | Site Selection; Brownfield Redevelopment |
| Eco -5 | Vegetation | Restored OR preserved vegetation area: 15% (1pt); 30% (2pts) of total site area (including roof) | 2 | **1.54** | ● | Vegetation & Ecological Features Preservation |
| Eco-6 | Green Roof | Green roof area: 30% (1pt); 50% (2pt) of the roof area | 2 | **1.54** | ● | Green Roof |
| **WP** | **Waste & Pollution** | | **10** | **7.69** | | |
| WP-1 | Sewer Discharge Reduction | Comply with NC (1pt) (PR); building sewer discharge: reduced by 30%(1pt); 40% (2pts) | 2 | **1.54** | ● | Water Efficient Fittings & Fixtures / Rainwater Harvesting and Reuse / Waste Water Treatment and Recycling |
| WP-2 | A/C System Refrigerants | All refrigerants: **Global Warming Potential (100 years) $GWP_{100}$=<2000 & Ozone Depleting Potential ODP<0.05 (PR)**; all use HFCs (2pts) | 2 | **1.54** | ○ | Refrigerant Management |
| WP-3 | Demolition and Construction Waste | Demolition and construction waste: management plan (PR); reused and/or recycled 20% (1pt); each additional 10% (1pt) up to 50%(4pts) | 4 | **3.08** | ○ | Construction Waste Management |
| WP-4 | Dedicated Recycling Storage Area | Provide collection and storage space for recyclable waste | 1 | **0.77** | ○ | Dedicated Recycling Storage Area |
| WP-5 | Light Pollution Minimisation | No exterior lighting fixtures shall be non-cutoff | 1 | **0.77** | ○ | Light Pollution Reduction |
| **H** | **Health and Comfort (H)** | | **13** | **10** | | |
| H-PR-1 | Indoor Smoking | Prohibit smoking in all common areas **(PR)** | R | **R** | | Environmental Tobacco Smoke (ETS) Control |
| H-1 | Indoor Air Quality | Ventilation rates meet national or international standards | 2 | **1.54** | ○ | Ventilation for Indoor Air Quality |
| H-2 | Hazardous Materials | Hazardous Materials Report **(PR)**; Low VOC and formaldehydes of: all flooring systems (1pt) OR/AND all interior paint and coatings (1pt) OR/AND all adhesives and sealants (1pt) OR/AND all composite wood products (1pt); | 4 | **3.08** | ○ | Volatile Organic Compounds Minimization / Formaldehyde Minimization |
| H-3 | Daylighting | Average daylight factor of 50% of all habitable spaces is between 1,5% and 3.5%; each additional 15% of net occupied area (1pt) up to 95%. | 4 | **3.08** | ● | Daylighting |
| H-4 | Noise Insulation | Design all walls and floors to com ply with NC (TCXDVN 277:2002) (1pt); improve by +2dB ($CK^{tc}$) – AND – 2dB ($CV^{tc}$) (2pts); +4dB ($CK^{tc}$) – AND – 4dB ($CV^{tc}$) (3pts) | 3 | **2.31** | ● | Sound Insulation |
| **A** | **Adaptation & Mitigation** | | **12** | **9.23** | | |
| A-1 | Flooding Resistance | Prepare a local flood risk report for the site **(PR)**; Building design resists current highest flood level (1pt); Building design resists predicted highest flood level in next 50 years (2pt). | 2 | **1.54** | | Flooding Resistance |
| A-2 | Stormwater Runoff | Total site is at least 30% pervious (1pt); 1 point for every additional 15% up to 60%. | 3 | **2.31** | ● | Stormwater Runoff Management; Stormwater Runoff Treatment |
| A-3 | Disaster Resilience | Incorporate within the building design the following: Structural disaster resilience (1pt) OR/AND Non-Structural disaster resilience (1pt) | 2 | **1.54** | ○ | Disaster Resilience |
| A-4 | Heat Island Effect | 30% (1pt); 50% (2pts) of the paved and roof area limits the heat island effect. | 2 | **1.54** | ● | Heat Island Effect – Hardscape / Heat Island Effect – Building Roof |
| A-5 | Collective Transport | Provide and display building occupants with information on the different collective transportation means to travel to and from the building **(PR)**; Situate building on site with links to the local public transport system (at least 2 different routes within a 0.5kms | 1 | **0.77** | ○ | Public Transportation Access |

| Index | Category / Credit | Indicator Description | Points | Weight (%) | Indicator Type | Equivalent Criteria for Comparison |
|---|---|---|---|---|---|---|
| | | radius)(1pt) | | | | |
| A-6 | Local Materials | 20% (1pt); 30% (2pts) of all materials are produced within a 500km radius. | 2 | **1.54** | ○ | Regional Materials |
| **CY** | **Community** | | **6** | **4.62** | | |
| CY-PR-1 | Public Consultation | Perform Public Consultation **(PR)** to ensure the engagement of individuals and communities (e.g. public meetings) during planning processes. | R | **R** | ○ | Public Consultation |
| CY-PR-2 | Heritage Preservation Assessment | Perform Heritage Preservation Assessment (EIA) **(PR)**. | R | **R** | ○ | Heritage Features Protection & Promotion |
| CY-PR-3 | Access for People with Disabilities | Building meets the requirements of QCXDVN 01:2002 Building Code of Construction Accessibility for People With Disabilities **(PR)**. | R | **R** | ○ | Access for People with Disabilities |
| CY-1 | Community Connectivity | Locate site within a 0.5km radius to at least 5 (1pt); 10 (2pts) basic services | 2 | **1.54** | ○ | Community Connectivity |
| CY-2 | Public space | 10% of the site area is public space (1pt); 1 point for every additional 10% up to 40% | 4 | **3.08** | ○ | Public Space Contribution |
| **Man** | **Management** | | **10** | **7.69** | | |
| Man-PR-1 | Building User Manual | Provide a building user manual for each individual residential unit as well as the building owner/management **(PR)** | R | **R** | ○ | Building User Manual |
| Man-1 | Design Stage | Perform an Eco-Charrette **(PR)**; Involve a LOTUS AP as a member of the design team (2pts) | 2 | **1.54** | ○ | Design Charrette / Involvement of Accredited Professionals (AP) in Design Team |
| Man-2 | Construction Stage | Produce a safety policy and safety plan **(PR)**; Project management is performed in accordance with internationally recognised systems (1pt) OR/AND Conduct trades training on the green aspects of the building design (1pt) | 2 | **1.54** | ○ | Safety Policy and Safety Plan / Standardized Project Management / Trades Training on the Green Aspects |
| Man-3 | Commissioning (Cx) | Appoint a commissioning team to conduct commissioning until building occupancy or verify individual contractor commissioning by a third party (3pt) AND Conduct post-occupancy analysis (add'l 1pt) | 4 | **3.08** | ○ | Commissioning |
| Man-4 | Maintenance | Produce a preventative maintenance plan (1pt); and involve the technical team before commissioning (additional 1pt) | 2 | **1.54** | ○ | Maintenance Plan |
| **TOTAL** | | | **130** | **100** | | |
| **Inn** | **Innovation** | | **8** | **6.15** | | |
| | Inn-1 Exceptional Performance enhancement | Surpass LOTUS requirements on a performance based credit by the next increment OR Surpass LOTUS requirements on a performance based credit by double | 8 | **6.15** | ○ | |
| | Inn-2 Innovative techniques/initiative | Create a credit template for a technique or strategy outside the scope of LOTUS and adhere to the requirements | | | ○ | |
| NOTE: R = Requirement | | | | | | |

# <국문초록>

## 호치민 시의 지속가능한 고층 아파트 설계지침의 기준체계에 관한 연구

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지구온난화와 기후변화는 명백하게 인류의 생존을 위협하는 세계적 문제이다. 1987년, 환경과 개발에 대한 세계위원회(WCED : World Commission on Environment and Development)에서 환경 위험을 예견하는 "지속가능한 개발"이라는 새로운 용어가 등장했다. 상정된 모든 분야 중에서 건축 분야는 지구온난화의 주요한 요인인 온실가스 배출에서 가장 큰 부분을 차지한다. 하지만 건축분야는 지구온난화에 큰 영향을 주기에, 온실가스 배출을 현저히 감소할 수 있는 큰 잠재력을 갖고 있다.

현재 베트남은 산업화와 현대화가 진행되는 과정에서 환경, 사회, 그리고 경제 측면의 이슈에서 어려움을 겪고 있다. 베트남에서 인구가 가장 많고 경제의 중심지인 호치민 시는 저층의 타운하우스에서 고층의 아파트로 주거 환경을 개선하고 있다. 하지만 고층 아파트 개발이 증가하는 추세임에도 불구하고, 현재 호치민 시에는 지속가능한 고층 아파트에 대한 설계지침이 부족하다.

본 연구는 호치민 시에서 지속가능한 고층 아파트에 대한 설계지침을 만들기 위해 그 기반이 될 설계지침의 기준체계를 만드는 것을 목적으로 한다. 구조물의 본 논문에서 작성한 설계지침의

기준체계는 '구성방식format'과 '내용content', 두 가지를 포함한다. 이 기준체계의 구성방식은 34개의 고급 지침에 대한 조성 구조들의 조사를 통해 이루어졌다. 또한 다섯 개의  대표적인 설계지침들의 구성방식에 대한 깊이 있는 분석을 포함한다. 그리고 이 기준체계의 구성방식에 대한 연구는 세 단계를 거친다. 이 세 단계들은 베트남의 토착 주거(Vietnam vernacular houses)와 현대 주택, 그리고 전세계의 저명한 지침으로부터 얻은 전략을 통해 진행된다. 이 연구에서 사용한 주요방법은 사례연구와 비교분석이다.

첫 번째 단계에서는 베트남의 토착 주거에 내재하는 전략을 정의하기 위해서 열 개의 사례를 연구하고, 이를 통해 베트남의 토착 주거에 대해 포괄적으로 분석한다. 첫 번째 단계의 분석 결과는 여덟 범주의 전략 40개를 포함한다.

두 번째 단계에서는 첫 번째 단계에서 얻은 베트남 토착 주거에 내재하는 전략에 기초를 두고, 이를 더 확대시킨다. 이 단계는 호치민 시의 현대 주택이 갖고 있는 긍정적인 전략과 부정적인 문제들을 조직적으로 분석한다. 사례연구를 수행하기 위해 고층 아파트의 열가지 주요한 사례와 타운하우스의 다섯 가지 사례를 선별하였다. 최종적으로 이 단계에서는 아홉개의 범주 속에 72개의 전략을 도출해냈다.

세 번째 단계에서는 두 번째 단계에서 도출한 전략을 더욱 확장한다. 본 단계는 호치민 시에서 고층 아파트를 설계하기 위해 가장 최신의 전략을 보완하고 갱신하기 위해 일반적으로 사용되는 지속가능한 건물 설계지침과 평가방법을 분석한다. 이를 위해 일곱 가지의 대표적인

평가방법들을 참조하여 아홉 가지의 설계 지침들을 선정 및 분석하였다. 마지막으로 이 단계에서는 아홉 개의 범주에 104개의 전략을 만들어냈다.

결과적으로, 호치민 시에서 고층 아파트에 대한 설계지침에 응용할 수 있는 기준체계를 두 가지 요소, 구성방식 요소와 내용 요소로서 104개의 최종전략 제안을 통해 정립했다. 본 연구에서 정립한 기준체계는 호치민 시에서 지속가능한 고층 아파트에 관여하는 모든 설계지침에 대한 기반으로 기능하리라 기대한다.

키워드: 지속가능한 주택, 지속가능한 설계, 설계지침, 고층아파트,
호치민 시, 베트남.

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