



Sustainable Architectural Characteristics of Housing in Vietnamese Mekong River Delta

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Abstract. The study aims to investigate sustainable architectural characteristics of housing in Vietnamese Mekong River Delta. To achieve the objective, the following approaches were implemented. Firstly, the concepts of sustainable architecture, which the styles and construction principals adapting to surrounding environment, are briefly described. Secondly, Khmer and Cham ethnic group are known as the second and third largest ethnic groups living in Vietnamese Mekong River Delta. Their housing is located in the rural areas, where is affected by disadvantage of natural environment. Khmer and Cham ethnic group's housing contains the characteristics adapting to surrounding environment. Hence, a survey of Khmer and Cham ethnic group's housing in Vietnamese Mekong River Delta is conducted to examine characteristics of settlement, planning scheme, form, façade and housing materials. Twenty of Khmer housing and fifteen of Cham housing are comprehensively surveyed in this study. Lastly, these characteristics are analyzed and compared to the concepts of sustainable architecture to determine whether the sustainable architectural perception have existed in Khmer and Cham ethnic housing. The result reveals that the Khmer and Cham housing contains the characteristics which are designed in harmony with surrounding the environment. These characteristics should be the valuable lessons to apply to current housing design in Vietnamese Mekong River Delta.

Keywords: Sustainable architecture · Khmer ethnic housing · Cham ethnic housing · Vietnamese Mekong River Delta

1 Introduction

1.1 Concept of Sustainable Architecture

Sustainable architectural characteristics is a complex subject, especially in relation to housing design. Sustainable architecture must show ecological awareness, which both functional and formal buildings should be created in relation to the surrounding environment through its appearance. There have existed two words for sustainability in architecture: sustainable architecture or green architecture. Both of them mean that the building is constructed in accordance with environmentally friendly principles [2]. The

friendly principles mean being able to not only satisfying inhabitants' requests, but also taking the time and natural resources needed into consideration, entering the context in the most natural way possible, and planning ahead by making the space and materials employed completely reusable, or using the existing local materials. As stated by [1], sustainable or green architecture contains some general characteristics which have many common consents followed as the Table 1.

Table 1. Characteristics of green architecture

No	Characteristics of green architecture	Environmental impact
1	Landscapes planned to maximize passive solar energy	Conservation the ecosystem
2	Ventilation system designed for efficient heating and cooling	Less waste generation
3	Efficient use of space	Satisfaction of inhabitant
4	Non-synthetic, non-toxic material	Conservation the ecosystem

Source [1]

1.2 Khmer and Cham Ethnic Group in Vietnamese Mekong River Delta

The Vietnamese Mekong River Delta (VMRD) is located in Southwestern Vietnam, and is characterized by hot and humid tropical climates. There are usually two seasons in a year, the dry season and the rainy season [11]. The average yearly air temperature is 28 °C and less volatile. The annual rainfall is over 2000 mm (occurring between May and October). The rainfall and the flow of the Mekong River are main causes the annual flood at this area. Flood directly affects more than two million local residents [10]. On the whole, the VMRD has been affected by natural environments such as floods, heavy rain, drought, landslides, and saline intrusion. However, the annual flood is crucial to sustain agriculture at this region. Therefore, VMRD is considered the largest “Rice bowl” of Vietnam [8], and this is home to many ethnic groups. Among ethnic groups, there have existed four main ethnic groups- Kinh Vietnamese, Khmer, Chinese, and Cham. Each ethnicity keeps the unique culture of its ethnic, therefore the VMRD is recognized as one of the most culturally diverse regions in Vietnam [5]. Besides the Kinh Vietnamese culture, the culture of the Khmer and Cham ethnic groups contains particular characteristics.

a. Khmer ethnic group

Khmer people live in the rural areas of Tra Vinh, Soc Trang, Kien Giang, An Giang, Bac Lieu, Can Tho, and Vinh Long, where is shaped by many rivers and fruit trees are very common. Based on the natural environment, the Khmer people do various works. The Khmer people have traditionally intensive cultivation, most especially by plowing by two buffaloes. They are skilled laborers in fishing, weaving, knitting, making pottery products, and the special type of sugar from “thot not” tree. Breeding cattle, pigs, chickens, and ducks is quite common. They have a rich culture of folk songs, folk tales, festivals, temples, and pagodas.

Khmer people were among the earliest population in the VMRD [7]. The Khmer people live in Khmer hamlets called “Phum” (consisting of 3–8 small families with kinship relationships) and villages called “soc” (traditional self-governing social institutions). Blood relation and marriage are two of the basic relationship in “Phum”, while neighborly, territorial relations mixed with close kinship is the basic relationship in “Soc”. The Khmer people lived in the house on stilts, but at present, this number just left very little. They mainly dwell in the house on the land and live with Kinh people in houses with thatch walls and straw roofs.

b. Cham ethnic group

The Cham people live in the Mekong Delta, especially in An Giang province [4]. According to [3], Cham housing in the Mekong Delta has lost its Cham authenticity because they change their culture to adapt to the surrounding environment. Cham people carry out combined economic activities such as agricultural production, fishing, traditional crafts, weaving, and small business. According to Vo et al. [9], the economic activity of the Cham people is various, which is combination of agricultural production with fishing, craft weaving, and trading.

Most of Cham’s accommodation is located along the river branch in An Giang province, where has been affected by the annual flood [6]. The Cham’s accommodation is a wooden house on high stilts, which has a ladder in the front of the house to go up and down. The ground floor is often empty and used for avoiding floods. Unlike the other ethnic housing in VMRD, the Cham stilt housing is designed very delicately in a large and airy space with the environment. Currently, a large number of Cham stilts housing have remained in An Giang province and has become a unique housing typology in the VMRD [6].

2 Method

The Khmer, and Cham housing is located in the VMRD, so this research proposes a new approach for analyzing the Khmer, and Cham housing in terms of building physics. This approach includes three subsequent steps as shown in Table 2.

2.1 Step 1-Research-Site Selection

This study selected the Khmer village in Tra Vinh province, and Cham villages in Tan Phu district- An Giang, where has existed Khmer, and Cham communities for long time. The Khmer, and Cham houses in the village have expressed a relationship between their dwellings and environment. The selection procedure had four following steps:

- (a) The satellite map was used to identify the Khmer, and Cham village location.
- (b) The collected documents, which relate to the settlement characteristics, were summarized in this study;
- (c) The numerous visits were conducted to survey various areas of Tra Vinh and An Giang province;
- (d) The interviews with the owner were performed to collect more of the necessary information.

Table 2. Steps applied to this study

Step	Method	Material	Results
1	Area selection	–An Giang province –Tra Vinh province	Climate and socio-cultural characteristics
2	Actual survey	Investigation on housing typology	Qualitative evaluation
	Self-observation, records	Settlement characteristics, architectural form, spatial configuration, building material	Photo, perspective, sketch
	Interview occupants	How they use the space for activities of daily living	Information
3	Systematic analysis	Discussion on image analysis	Concluding remarks

Source Authors

2.2 Step 2—Actual Survey and Field Measurement in Khmer Village and Cham Village

The particularity of the Khmer and Cham ethnic groups is living in rural areas. Hence, the Khmer and Cham housings samples in this study must be selected in accordance with three primary criteria such as:

- (a) Housings were owned by Khmer or Cham communities;
- (b) Housing were located in the rural area;
- (c) Housings were built before the 2000s year.

The survey was conducted between May 2020 and September 2020 in order to represent the actual status of these housing samples, and to examine their sustainable characteristics. Following previous criteria, 20 buildings of Khmer and 15 buildings of Cham were finally selected from Tra Vinh and An Giang (as seen in Fig. 1a, b). The local geography and climate condition is an important factor that decide the complexion of the Khmer and Cham housing. Selected samples were photographed from the field study and analyzed based on the natural aspect. The conclusion was drawn from their similarities to the surrounding environmental adaptation.

2.3 Step 3—Systematic Analysis

A process of systematic analysis was carried out to assess the sustainable characteristics of housing. The information recorded in the survey is examined in four terms of the concept of sustainable architecture: landscape design, natural ventilation, efficiency in using space, and natural material. These characteristics of Khmer and Cham dwellings were qualitatively investigated and evaluated by using the description and image approach. In this approach, there are two main general points with regard to the characteristics of

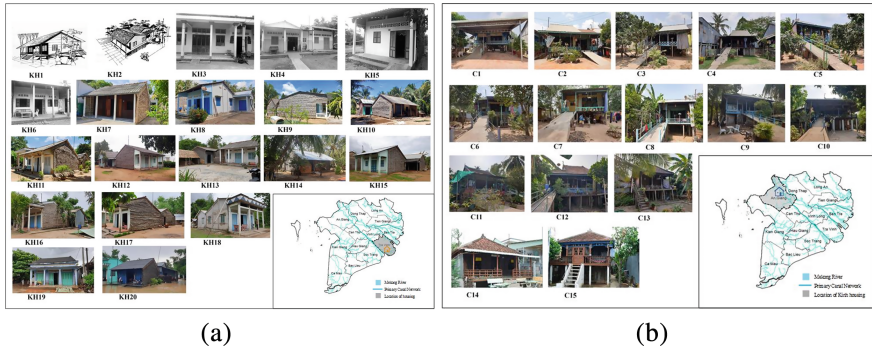


Fig. 1. **a** Properties of 20 Khmer housing in Mekong Delta, **b** Properties of 15 Cham housing using stilt structure in Mekong Delta. *Source* Authors

housing described below. Firstly, all Khmer and Cham dwellings collected in this study have their own typology. Secondly, these houses are regarded as completely adapted to the local environmental conditions. The drawings and photos of these samples were analyzed to derive a conclusion of climate-responsive solution.

3 Results of Analysis of Sustainable Architecture Characteristics

3.1 Landscapes Planned to Maximize Passive Solar Energy

Both Khmer and Cham housing was considered an adaptation to the surrounding environment. They preserve existing plants and respect water resources, and soil to avoid the disadvantage of climate. The settlement characteristics of Khmer and Cham housing are listed as follows, as seen in Fig. 2a, b:

- Housing is often settled in the South direction to receives the most sunlight throughout the day;
- Organization of trees well designed into the landscape can save energy as the biggest trees are often planted in the west to avoid the hot afternoon sun, in contrast, small trees are put in the South to get the warm morning sun and cool wind from the South;
- Taking advantage of the existing water (river, lake) to provide a harmonious space for the owners.

3.2 Ventilation System Designed for Efficient Cooling

To keep housing cool during hot days, Khmer and Cham ethnic people use the natural ventilation system, as seen in Fig. 3a, b:

- Opening the large window and door to deliver fresh air into the housing by cross-ventilation. It helps encourage to maintain indoor temperatures close to outdoor temperatures;
- Using a light-colored material to help roof reflect heat;

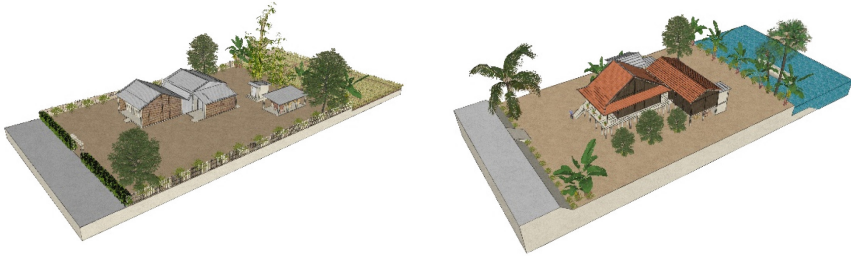


Fig. 2. Landscape design to reduce the heat of the afternoon sun. **a** Landscape design of Khmer's settlement. **b** Landscape design of Cham's settlement. *Source* Authors

- Creating a high-pitched roof to reduce heat transfer to space below;
- Stilt housing of Cham people with an empty ground floor to help enhances natural cross ventilation.

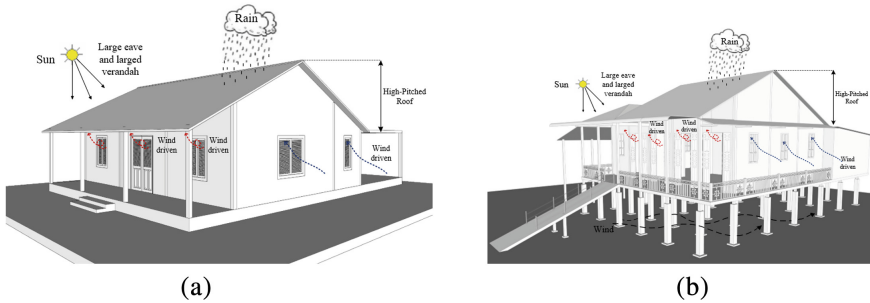


Fig. 3. Built form of **a** Khmer housing and **b** Cham housing. *Source* Authors

3.3 Efficient Use of Space

Khmer and Cham housing are divided into two housing: main house and sub-house. The spatial configuration of main housing has two main areas: social activities area: including veranda, living room, worship space. These spaces are located in the front of the main housing to welcome guests. The large vernacular seems to be an open space used for connecting to the outside; family area: including bedrooms, and sleeping area which is designed in the back of the main housing to limit the approach of guests. The sub-housing is located at the rear of the house, in the North, West-North direction, including a kitchen, storage, toilet, some houses contain sleeping areas, as seen in Fig. 4a, b.

3.4 Non-Synthetic, Non-Toxic Material

Using natural materials is one of the critical criteria among sustainable architectural characteristics. With the local existing material, Khmer and Cham people choose construction materials wisely to reduce the construction costs and the energy consumption.

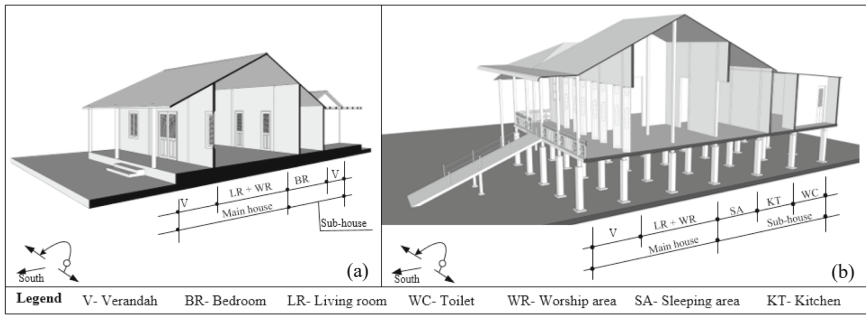


Fig. 4. Plan of a Khmer housing and b Cham housing. Source Authors

Generally, Khmer people use the dried leaves of the nipa palm and bamboo for building their houses. The housing is built with a simple structure using timber or bamboo. The roof and wall mostly used dried leaves of the nipa palm or corrugated sheet metal, as seen in Fig. 5a. The Cham stilt housing is built with a simple wooden post, or stone post and timber beam structure. The flooring is made of timber planks or plywood sheets. The roof structure is a timber structure with clay tile or corrugated sheet metal, as seen in Fig. 5b.

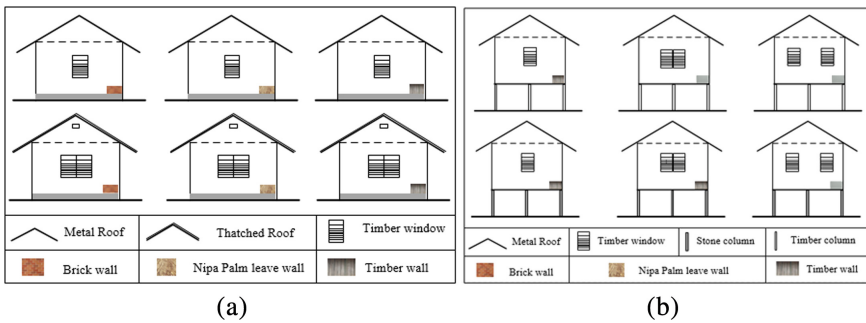


Fig. 5. a Form of Khmer housing and material use, b Form of Cham housing and material use. Source Authors

4 Conclusion

The paper presents the sustainable architectural characteristics of housing in the VMRD with a focus on Khmer and Cham housing. The paper compared the critical criterion of architectural sustainable concepts and the characteristics of Khmer and Cham housing by illustrating images. Although the confidence of the study indirectly relied on the analysis of housing characteristics, the study provided a comprehensive body of knowledge about Khmer and Cham housing from spatial structure to physical characteristics of housing.

Passive solar design in landscaping, natural ventilation, efficient design in using space, and natural materials have been an optimal thermal comfort performance of Khmer and Cham housing. These sustainable architectural characteristics are helpful perceptions for future housing design in the VMRD. However, not only Khmer and Cham housing but also all housing in the VMRD might face challenges by global warming and climate change in the future. Future studies need to include how housing in VMRD can adapt to new climate.

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