Cultural ecology of heritage building adaptation in tropical cities

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**Abstract.** The colonization left some buildings which still used by the cities until now. Rapid urbanization puts pressure on the sustainability of heritage buildings. Heritage buildings have not only historical-cultural values but also reflect the relationship between the building and its location or occupants. This article aims to identify the cultural ecology concept in the form of heritage building adaptation in tropical cities, as a part of heritage building conservation efforts. This research conducted a literature review method to specify the concept of cultural ecology and to find tropical cities' characteristics related to environmental aspects that affect the form of building adaptation. The results show that climate elements, topography, and vegetation conditions are important characteristics that affect the heritage building adaptation in tropical cities. The adaptation efforts that have been carried out on heritage buildings are the existence of additional elements in buildings that function to overcome the adverse effects environment conditions. The existence of heritage buildings for long periods is evidence that adaptation is an essential point in protecting and preserving heritage buildings. Building adaptation in the cultural ecology concept provides opportunities for heritage buildings to survive in a dynamic environmental condition and increasingly varied human needs.

1. Introduction
The From the cultural ecology perspective, every city has its own identity, uniqueness, cultural value, and special character, which make it different to each other. Cities functioned as the container of many values; also many activities and communities that reflect the urban cultural value \([1,2]\). Cultural values, as well as historical values, come together as the identity of a city. As part of the city's history, heritage districts, which consist of heritage buildings, have not only historical-cultural values but also reflect the relationship between the building and its location or occupants. Heritage districts cover tangible heritage with historical buildings and sites, and intangible heritage such as arts, music, etc.

There is limited research about how cultural ecology can affect the physical environment of the city; which in this case, tangible heritage such as historical buildings and sites. Some research have discussed about how historical districts were conserved using the cultural ecology approach \([3-6]\). Cultural ecology seems to have indirect impacts to tangible heritage in traditional architecture or buildings. Nevertheless, this case might have been different in tropical cities where the cultural values have also been influenced by its climate and tropical character besides local character, and this can be seen from its built environment.
The outsiders have colonized many tropical cities before finally became independent. The colonization left some buildings which still persistently used by the cities until now. Nowadays, rapid urbanization puts pressure on the sustainability of heritage buildings. Despite heritage buildings' ability to survive in the city development process, not all cities decided to preserve and conserve their heritage buildings.

As part of the city, buildings have been a central part of the human’s life from time to time. We can assess cultural values through historical or heritage buildings. Cultural ecology can be used to evaluate the condition of heritage buildings which is located in tropical cities. How buildings can adapt from time to time due to the condition in tropical cities are initial to be identified in this research. The adaptation can conclude how the cultural ecology affecting the form of heritage buildings in tropical cities. Cultural ecology concept in heritage building adaptation in tropical cities can be used as a part of heritage building conservation efforts and to support heritage building sustainability.

2. Methodology
This research conducted a literature review method to find characteristics of tropical cities related to environmental aspects. Books and journal articles were assessed to specify the concept of cultural ecology in tropical cities. Journal articles were obtained through Google Scholar and Science Direct from 2000 to 2020. Personal observations on parameters and findings are comments on the gap of studies. The search range was from publications all over the world. Multi disciplinaries journals from urban planning, anthropology, and sociology were also reviewed. Keywords used were including cultural ecology, heritage building, building adaptation, and tropical cities. A total of 15 journal articles that relevant to the topic were selected and reviewed using content analysis to define how cultural ecology affecting the building adaptation in tropical cities.

3. Results and discussion

3.1. Cultural ecology and tropical city characteristics
All characteristics of the interaction between humans as a cultural component and the natural environment as an ecological component are called cultural ecology. The goal of cultural ecology is to understand the capacity of cultural adaptation to manage glitches today that are related to nature and humans [7].

The features of a tropical city include: get more exposure to sunlight, high and constant average temperature throughout the year, only has two seasons, namely the rainy (wet) and dry seasons, high rainfall, low air pressure, and high evaporation. The main elements of climate that affect humans are air temperature, solar radiation, air movement, and relative humidity [8]. Residents of tropical cities have special needs that are closely related to climate elements, such as the need for thermal comfort, lighting, and ventilation. The climate-responsive designs, such as passive design and bioclimatic building design, are efforts to reach comfortable conditions for humans as building users [9].

Design in the scope of tropical urban areas needs to pay attention to local conditions, topography, sun, and wind as determinants of orientation, variations in height and distance between buildings, as well as the distribution of green open spaces [10]. The built environment in hot regions has some characteristics, such as a house with courtyard, underground, and shading. The built environment in a tropical city considers indoor and outdoor conditions that can affect community activities in the city.

In tropical buildings, the principles of bioclimatic architecture are often applied to obtain good thermal comfort, air conditioning and circulation, and lighting. Building adaptation efforts in the tropics, namely: the orientation of the building and openings facing north or south, availability of transition space that serves to create a microclimate in the building, and passive shading design on buildings to reduce solar radiation [11]. The existence of transition space in tropical buildings provides a blocking space to reduce the outdoor temperature received by the building, optimize the energy use, and support occupant thermal comfort [12]. Overhead and vegetation shading can provide shading and shelter from sun radiations and rain [13]. All the tropical cities' characteristics influence the built
environment and city community, and especially in this context are city buildings. Tropical city buildings and their elements are the forms of human adaptation to climatic conditions and become the identity and feature of those cities.

### 3.2. Heritage city and building from cultural ecology perspective

The heritage building is classified as a landmark, city identity, and product of the past preserved today to bequeathed to future generations. Heritage buildings become carriers of history, as the identity of a community, and illustrate architectural styles and technological innovations in the past [14]. Historical buildings as part of cultural heritage contain attachment to place, sense of place, and the results of climate adaptation and integration [15]. As an integral part of the urban context, heritage buildings are expected to be able to promote and enhance development in the socio-economic aspects and quality of life of urban residents. Heritage buildings have important values and significance for public and local governments because of their potential to contribute to maintaining a sustainable culture [16].

The diversity of natural conditions causes differences in the characteristics and features of each heritage building based on the location it was built. Most countries located in the tropics are countries that have experienced the colonial period in the past. Therefore, it specifically discussed the characteristics of heritage buildings in tropical urban areas. Table 1 shows some previous studies about cultural ecology applications in city and building scope. In Table 1, cultural ecology studies classified into two groups based on the location, namely China and tropical cities. Relevant studies about cultural ecology in China have become an important point because that subject is more developed in China within the scope of historical and heritage areas, as shown in Table 1, section 1.

| No | Authors, Year | Parameters | Findings |
|----|----------------|------------|----------|
| 1  | Li and Ling [2] | The intangible heritage of Xi'an Bei Yuan Men Historic District (Muslim District) | Cultural Ecology in the historic district conservation, it can be seen from public space for collective life, housing improvement, and the structure of the traditional courtyard. |
| 2  | Wang and Qu [5] | The cultural ecology of modern historical architecture in China. | Application of 3D modeling to build a model of historical building and assess it based on ancient architecture features. |
| 3  | Wang [3] | The intangible heritage of China's ethnic minority areas. | “Cultural-ecological protection village” is an effective way to protect the authenticity of the characteristics of the village culture. |
| 4  | Wu et al. [1] | The preservation of architecture, historical sites, and spatial texture in the Qingdao Road Historic District. | Conservation based on the concept of cultural ecology requires guard of architectural heritage, spatial environment, and texture of urban space at the tangible form level, protection, utilization, and development of intangible cultural heritage. |
| 5  | Dai, Fu, and Zhao [17] | Traditional village and cultural ecology of Wuhe village. | The natural environment and cultural ecology of the traditional village can be beneficial if they can integrate. |
Table 1. Cont.  
*Cultural Ecology of Heritage Building in Tropical Cities*

|   | Authors [Ref] | Building | Description |
|---|---------------|----------|-------------|
| 6 | Permata et al. [18] | The Centrum | The transformation of the Centrum adjusted its function and adapt to architectural needs and activity trends. Building elements: the wide-span roof. Outdoor elements: an outdoor park. |
| 7 | Kumurur and Tampi [19] | Dutch Colonial Architecture of Old Manado City | The characteristics of European Architecture buildings in tropical climate typically use large overhangs and cross ventilation. |
| 8 | Silvero, et al. [20] | A Dwelling in the Historic Centre of Asunción, Paraguay | The passive strategy was applied by making the high thermal mass building's envelope and improvement of natural ventilation. |
| 9 | Sharma [21] | Heritage buildings in general | Heritage buildings design depend on the climate and geographical location, use locally available building material, consider wall thickness, protect the outer surface, and use overhang. |
| 10 | Sekatia, et al. [22] | Semarang Cathedral Church that was built in 1940 | The indoor thermal condition influence by the existence of low ventilation. Low ventilation becomes the Church's unique feature. |
| 11 | Agaperi, Hidayat, and Rijal [23] | Art Museum | Building orientation to north/south, cross ventilation, sloping roof, stage, the use of natural colors, and the availability of vegetation. |
| 12 | Lukito and Rizky [24] | Cut Meutia Mosque in Jakarta, Indonesia, as a heritage building that was built in 1922 | The building has symmetrical shape, ventilation tower, gable roof, big openings, ventilation holes, brick and cement as material, the use of columns and dome, and the availability of front garden. |
| 13 | Septirina [25] | Heritage buildings in Malioboro Street, Yogyakarta City, Indonesia | The historic buildings elements: combined-styles of roof types, symmetrical façade and window positions, big opening, jalousie window, combine dark and light color in design, and ornament. |
| 14 | Sulaiman, et al. [26] | Historic Building in Kuala Lumpur, Malaysia that was built in 1907 | The original building features are building openings facing the Northeast or Southwest, operable windows, balcony, heavy and thick masonry wall, high ceiling, and open courtyard. |
| 15 | Prasidha, Martokusumo, and Lubis [27] | Heritage buildings in Depok City, Indonesia | The buildings have a huge roof, stone and wooden columns, use local materials, high ceiling, large air vents above the door, tall and wide window. |
Based on the relevant literature, the characteristics of heritage buildings in tropical cities are characterized by some elements, as shown in Table 1, section 2. The characteristics of heritage buildings in tropical cities are divided into characteristics of the building elements and the elements outside the buildings (external elements). The uniqueness that becomes characteristic of heritage buildings in tropical cities shows that buildings are not only influenced by users, culture, and history, but buildings in heritage cities also interact with their natural conditions in the form of adaptation.

### 3.3. Cultural ecology forms in tropical heritage buildings

The main content in the field of cultural ecology is human interaction and adaptations with their physical and natural environment. Climatic and natural conditions strongly influence building components and styles, so the building is one indicator of the identity and characteristics of cities in different climatic regions. In tropical cities, several building components show the form of human adaptation to the natural environment. These components are referred to as the cultural ecology forms in tropical buildings. The elements of heritage buildings’ adaptation as cultural ecology forms are shown in Table 2.

| Main Elements | Special Features |
|---------------|------------------|
| Building Shape | Symmetrical |
| Orientation | Adjust the direction of the sun and wind (facing a different direction from the sun, but follow the direction of the wind). |
| Material | Use locally available materials. |
| Roof | Wide-span, gable roof, high ceiling, and the combination of local-outsiders architectural style. |
| Wall | Thick wall and high thermal mass of the building's envelope. |
| Door and Windows | Adjust to the sun and wind direction, equipped by a canopy and air vents, symmetrical shape and position, use jalousie window. |
| Ornament and Decoration | The combination style, use natural colors or dark-light colors, heritage building also often uses big columns on building façade. |
| Complementary Elements | Overhangs, ventilation, balcony/veranda, stage, ventilation towers and transition space. |
| External Vegetation | It has to function as external shading to minimize the sun's radiation received by building and air circulation. |
| Open Space | It has the function as an area for vegetation and air circulation. |

Based on Table 2, cultural ecology forms are seen from building unit components and external components that play a role in the adaptation effort of heritage buildings. The heritage buildings that became a relic of the colonial period show that the influence of cultural domination, tastes, and background of colonizers is greater than the impact of local (traditional) residents who occupy these locations. During the colonial period, the colonialists used traditional buildings as inspiration for their building designs, because of the awareness that traditional buildings that have already existed and are a tangible form of cultural ecology in a location can be a reference design, provide a connection between humans and the environment, and perform well in the local climate characters [28]. In the
past, material, construction techniques, and technologies principles applied were already existed and known from the countries of the colonizers' origin. The application of construction technology and techniques became the reason why heritage buildings have outstanding durability and quality, so that they can last for a very long time.

In its implementation, cultural ecology forms in heritage buildings in the tropics are more than interactions in the form of adaptation between humans and their natural environment. Cultural ecology forms have become a tangible form of acculturation of different cultures that live together in the same climate and natural region, then visualized in the form of heritage buildings and their supporting elements. For cities that have colonial dan heritage buildings, conservation efforts urgently needed to preserve the representations of cultures, history, and local identity. Identification of the components and characteristics of heritage building features based on cultural ecology principles in tropical cities expected to be able to be a part of building conservation efforts.

4. Conclusion

The characteristics of heritage buildings in tropical climate regions have been identified by studying various related literature. The results of the literature study show that the cultural ecology form in heritage buildings is a form of building adaptation that can be seen in the building component and its external components. The characteristics of the building are influenced by sunlight, humidity, wind, topography, and vegetation conditions. Heritage buildings in tropical cities are not only the interaction between humans and their natural environment that forms cultural ecology but also the cultural acculturation that occurred in the past also affects the form of human adaptation to the surrounding natural conditions. Identification of the characteristics of heritage buildings and understanding of cultural ecology principles is expected to be able to enrich the concepts and efforts to preserve heritage buildings, especially in tropical cities.

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