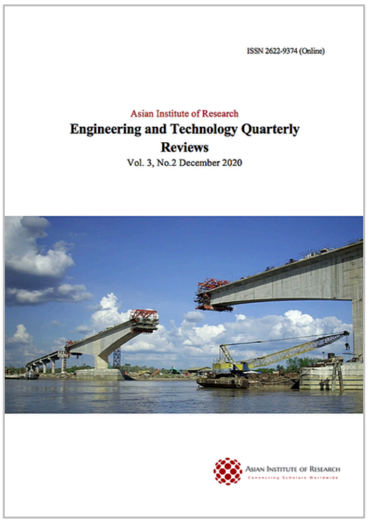

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Becoming Incomplete House: the Environmental Implication of the Traditional Balinese House Transformation in Tourism Area

I Dewa Gede Agung Diasana Putra[1]

[1] Department of Architecture, Faculty of Engineering, Udayana University, Bali, Indonesia

Correspondence: I Dewa Gede Agung Diasana Putra, Department of Architecture, Faculty of Engineering, Udayana University Bali, Indonesia. E-mail: diasanaputra@unud.ac.id

Abstract
The traditional Balinese house in rural areas is designed to optimize the use of available resources, to minimize energy consumption, and to provide spaces for garbage processing and biodiversity. However, the change of rural to become urban areas in tourism areas is an interesting phenomenon. In this phenomenon, the use of house as tourist facilities and the increase of occupants in the house have caused the changes in its physical configurations in which the house becomes an incomplete house since some spaces are transformed into tourist facilities. The increase of its building density also affects many components of the environmental aspects in the house including energy consumption. The aim of this paper is to demonstrate this environmental implication especially energy consumption in the rural-urban interface areas. This aspect in a number of houses transformed for tourist facilities has been investigated through utility meter data collection. Architectural investigation and interviews were then used to consolidate memory and to reconstruct the spatial stories of the house. The transformed houses were selected randomly. This study states that the transformation has affected the use of natural resources in the house. The transformed houses are the owner's attempts to demonstrate the improvement of their social status.

Keywords: Rural-Urban Interface, Traditional Balinese House, Environmental Implication, Transformation

1. Introduction

The traditional Balinese house in rural areas is designed to optimize the use of available resources, to minimize energy consumption, and to provide spaces for garbage processing and biodiversity. However, the change of rural to become urban areas in tourism areas is an interesting phenomenon. In this phenomenon, the use of house as tourist facilities in the house has caused the changes in its physical configurations in which the increase of its building density affects energy consumptions.

The natural environmental conditions, which are closely linked to the culture, are the other factor to consider when creating the forms of the traditional Balinese house. The changes in its physical configurations followed by the increase of its building density affect many components of the environmental aspects in the house. The aim of this paper is to demonstrate this environmental implication in the rural-urban interface areas. This paper will discuss energy consumption in the transformed houses. This aspect in a number of houses transformed for tourist facilities have been investigated through utility meter data collection. Architectural investigation and interviews were then used to consolidate memory and to reconstruct the spatial stories of the house. The transformed houses were selected randomly. This study states that the transformation has affected the use of natural resources in the house. The transformed houses are the owner's attempts to demonstrate the improvement of their social status.

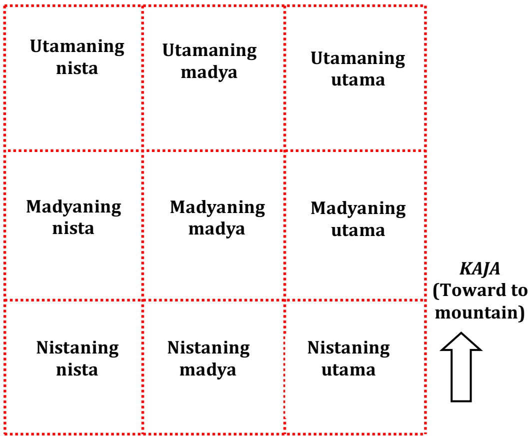
This paper investigates and explores environmental implication in the rural-urban interface areas that has been reconfigured as a response to address the specific challenges of the tourist economy. Initially, however, some theoretical considerations of how traditions in general are transmitted are presented. This is followed by a detailed description of the elements of the traditional Balinese house in relation to environmental implications. In subsequent sections, the paper explores how the implication of tourism activities on environmental conditions of the traditional Balinese house. Some conclusions are presented in the final section.

2. The Configuration of the Traditional Balinese House

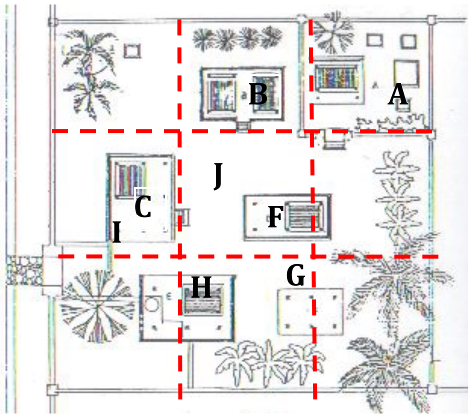
The traditional Balinese house is perceived and interpreted through the religious and spiritual concepts. The head is the most sacred area. In this part, the people build shrines and pavilions in such a way that the spaces are able to accommodate many ceremonial activities dedicated to God and ancestors. The body is the intermediate sphere where the people build many pavilions (*bales*) to accommodate domestic and ceremonial activities. The legs are the *nista* (below) area, also called *lebuh*. The legs consist of a backyard called *teba* and a front part of the house consisting of *telajakan*, wall, *angkul-angkul* and *aling-aling*.

Variety of social status and roles of the owners in their communities influences the variety of the form of the house. Geographical factors and historical events have also produced a diversity of cultural practices, including physical images of the house (Hobart, Ramseyer & Leeman 1996; Geertz 2004). The variety is inspired by the *desa-kala-patra* concept, where a house is built based on the condition of the land and the location, the time and the circumstance. This concept represents a flexibility of the Balinese culture that determines the approach to the construction of the house (Meganada 1990).

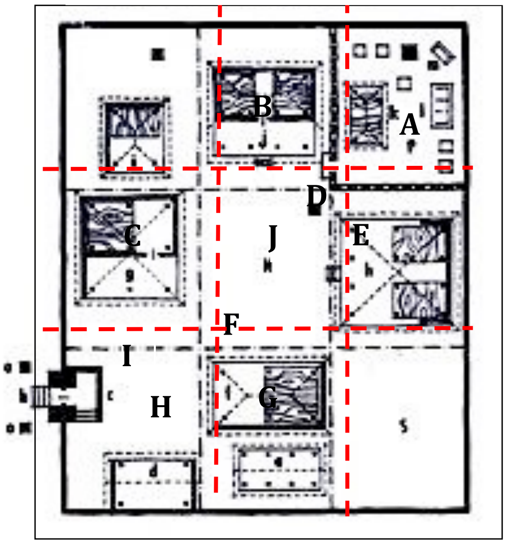
Such variations can be seen in many detailed drawings of the typical traditional house including the drawings by Tan (1967) and Budihardjo (1986), as well as the drawings by local writers such as Gelebet (1986) (Figure 1). However, the formations of the pavilions still represent the implementation of the *sanga mandala* concept, which has been considered as a template and standard record accompanying architectural discussion of Balinese architecture (Figure 3.8A). It can be seen in three example houses that are the result of previous studies. In every house, the family temple (A) is in *utamaning utama* zone, the bale *meten* (B) is in *madyaning utama* zone, and the *bale dauh* (C) is in *madyaning nista* zone. The differences of the pavilions are related to the size of the pavilions. The *bale meten* in House Plan 2 has a veranda, whereas House Plans 1 and 3 do not have a veranda (Figure 1). The variation of the family temples (A) is related to the number of the shrines. The more shrines there are, the wider the family temple. The other difference is the location of the family temple's gate, where the gate is optionally located in the west and south of the family temple wall directly entering to the *natah*. The *natah* located in the middle of the zone *(madyaning madya)* has different shapes because of the differences of the form and setting of the pavilions.



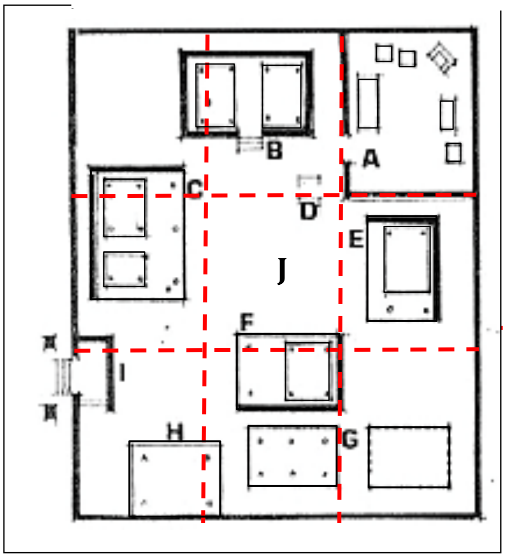
A. Schematic *the sanga mandala* concept



B. House Plan 1
Source: Gelebet 1986



C. House Plan 2
Source: Tan 1967



D. House Plan 3
Source: Budiharjo 1986

Legend

A. Family temple (*merajan*)
B. Northern pavilion (*bale daja*)
C. Western pavilion (*bale dauh*)
D. Shrine in the *natah*
E. Eastern pavilion (*bale dangin*)
F. *sumangen*)
G. Granary *(jineng/ klumpu)*
H. Kitchen (paon/*perantenan*)
I. Aling-aling
J. Courtyard (*natah*)

Figure 1: The variation of the traditional Balinese house configurations but still applying the *sanga mandala* concept

3. Human Beings and Natural Relationship in the House

The form of a traditional house differs from place to place and is a complex phenomenon that involves socio-cultural and environmental aspects. The environment, including resources of building materials and differing climates across different regions also play a role in creating forms of architecture (Kostof 1995; Fletcher 1975; Rapoport 1969). The environmental considerations in a built environment are not new in building design. People used this approach and realized that the environment is an important thing in their life. Therefore, they had a responsibility to preserve the natural world and other living things (Lusser 1995). This tradition is based on knowledge in a society and is shared as a local wisdom over generations. The local wisdom is a process of perceiving, thinking, acting and further knowing about the importance of the natural world (Cajete 2000; Nelson 2008).

In the traditional Balinese house, people plant vegetation, including coconut, jackfruit and bamboo, in the backyard called *teba* that provides many materials to support their activities. The coconut tree is used for a roof structure, the trunk of the jackfruit tree for columns called *saka* and the bamboo for rafters and partitions. Such trees are popular in Bali because they have many functions, not only for building materials but also for raw materials of offerings and for the needs of everyday life. The people also plant other trees including banana and many kinds of fruit and flowers in the *teba* so that they are easy to obtain when required. Besides that, the vegetation is seen to beautify the house, and importantly serves to reduce the internal temperature.

Plants have the potential to increase the thermal comfort in order to achieve energy efficiency in warm humid tropical climates including Bali (Trimarianto & Dudek 2011). The shade around the pavilions provided by vegetation reduces the heat from solar radiation that influences the internal temperature of the building (Trimarianto & Dudek 2011). The temperature outside and inside the building is reduced and a cool air motion entering the building creates thermal comfort for the occupants. The leaves of plants filter dusty wind into the building so that they create a healthier condition in the house. The roots of the plant and uncovered land in the *natah* or other spaces between pavilions are potential catchment areas in order to protect the ground water (Vikas 2001).

The abovementioned conditions show that the house has been a self-sustainable, which provides many materials needed by occupants including raw materials for building, daily demands and offerings. Over the last decades, some people change the courtyard when they need more rooms for their family members or obtaining economic benefit. This transformation has reduced biodiversity in the house and therefore, this condition has reduced the people's opportunity to obtain raw materials for building, offerings and daily basic needs in their house easily (Widja 2004). This study focusses on whether this condition occurs in the traditional Balinese house due to the transformation for tourist facilities.

4. Becoming an "Incomplete" House in the Transformation of the Traditional House

The investigation found that the transformation is not restricted to particular parts of the house, such as the potential economic areas including the front of the house. Rather, the transformation has spread to all parts of the house, including the profane areas where people perform domestic activities.

The front wall and the *telajakan* have changed enormously due to tourism development in the villages. Some of them have now vanished or transformed. The other front component of the house is the traditional gate (*angkul-angkul*), which is the visual identity of the house. Even though the house is hidden behind the tourist facilities, the *angkul-angkul* is a sign to recognize the house as a traditional Balinese dwelling. This phenomenon can be seen in Ubud where most traditional gates still exist. From the gates, people can easily identify the presence of a group of traditional houses among the tourist facilities. On the other hand, without the *angkul-angkul*, the presence of the houses is hard to recognize such as most houses in Kuta and Sanur. The entrance of the house is a space between the tourist facilities and from the street, it is hard to recognize the presence of the houses behind those facilities.

Every division has undergone different levels of transformation. This variation is due to each division having different cultural values and functions. The head constituting the most sacred spaces, where God and occupants' ancestors reside, underwent fewer and more limited transformations. Only a few family temples have been relocated to other parts of the house, or elevated to the higher level of a new structure. On the other hand, the expansion and multiplication of new structures has occurred in the body of the house, causing a reduction of open spaces. This increase of new structures for domestic and tourist activities has extended to the legs, the backyard. The backyard, which was a small forest without pavilions, has now become a site for accommodating domestic and tourist facilities. The limitation of space has forced people to live in the most profane areas of the house, which was a place for vegetation, animals and garbage processing, based on traditional guidelines.

From the perspective of the cosmological framework, the body is getting bigger while the legs are getting smaller and, in many cases, have disappeared. The house is likely to become disproportional and even incomplete. The house becomes like a human who still has a head with an enlarged body but without legs or with very small legs. The traditional house pattern undergoes an ongoing process of the loss of some components, its cultural expression and traditional functions but economically, the house becomes more valuable than it was before the transformation.

However, the main function of the house is still residential with the addition of tourist facilities. In some cases, the economic benefits of tourism have caused the house now to be occupied by more than one family unit so that the number of occupants has increased. They share the spaces in the house to accommodate domestic and religious activities and to gain economic benefits from tourism by constructing new structures in the house. Since the transformations have caused the incompleteness of spaces in the house, the stages on which to perform traditions and maintain the continuity of religious activities, social practices and indeed how to perform them, have been adjusted.

4.1. Energy Consciousness in the Traditional House Design

A traditional house is usually designed and based on the environmental conditions, as a response of the people (Knapp 1989). The architecture of the traditional Balinese house responds to the warm humid climate by installing cross ventilation and shading components in the house to create thermal comfort for the inhabitants (Silaban 1991). Such a house has passive environmental properties that optimally utilises the potential of the local nature, to protect against and respond to high temperatures, high humidity and high solar radiation. According to this condition, proper ventilation and air movement are the requirements of the house setting in order to provide thermal comfort for the occupants (Antaryama 2000, cited in Trimarianto 2003). They are regarded as a popular passive cooling resource in hot and humid summer climates where the houses are designed to utilise the wind as a natural cooling source (Kusuma 1999). Using computer simulation, Kusuma further suggested that the setting produces the air circulation that easily moves around and enters a building. In the *natah*, the wind flows from the space between pavilions in the southern part and the gate to other parts of the house. This is a potential air motion to reduce high temperature, humidity and solar radiation. The motion also plays a role for air movement in the building through the ventilation between the wall and the roof in the pavilions (Figure 2).

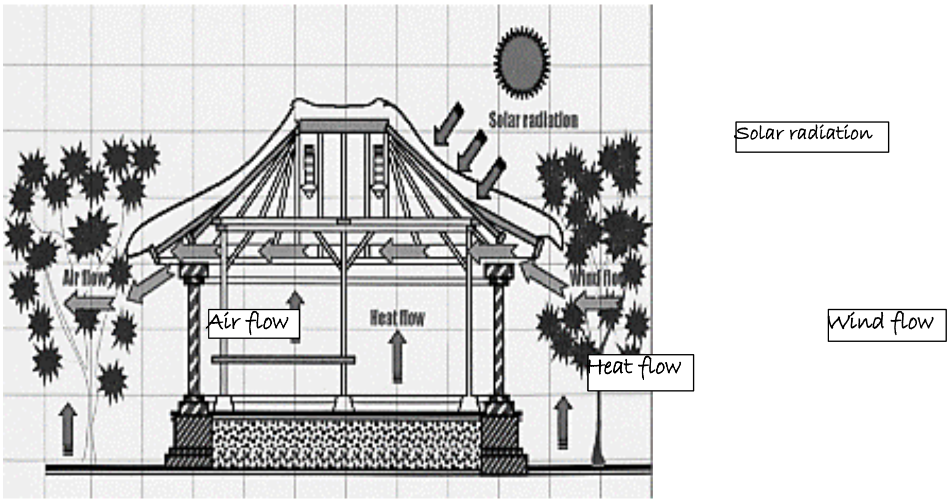


Figure 2**:** Air circulation in the traditional Balinese house
Source: Trimarianto 2003

The cooling air enters the room where traditionally the room is a single room and transfers the heat from the room to the outside. This circular flow will increase the thermal comfort in the room that is supported by the trees that function to reduce the outside temperature. Therefore, the thermal comfort that is created by this cooling air motion eliminates the need for artificial devices. The house is naturally comfortable for the occupants.

The house is regarded as an economical house, which is cheap in its development process and is a thrifty in energy use in its operation (Widja 2004). Over time, because of many factors such as an advance of technology, an increase of household size and family income, the house has been transformed. New structures have been built by demolishing walls and pavilions, and adjacent to pavilions and in the backyard by cutting down trees and no longer raising animals. These new constructions have changed the setting of the house and have caused an increase in house size. This enlargement reduces open spaces and the distance between pavilions in the house so that it decreases cross ventilation in the building and the opportunity for natural lighting (Sueca 2003). Therefore, people also want artificial lighting and air conditioning, which increases the use of energy (Trimarianto & Dudek 2011; Gill et al. 2011; Sullivan & Ward 2011; Dalem et al. 2010). If the transformed house in urban areas face problems related to energy consumption, do the same problems also occur in the transformed house in tourist destination?

4.2. Energy Consumption

The energy consumption for residential purposes in Indonesia in 2000 was 1,738 PJ. It was 39% of the total energy consumption in Indonesia (Sugiono et al. 2013). In 2010, this consumption increased to 1,820 PJ (Syahrial et al. 2012), equal to 0.3 TWh. More than 61 million households consumed this energy where the estimation of the total floor area of dwelling units was 4 billion m^2 (BPS 2012). Based on these data, the average annual energy consumption per metre square of dwelling is approximately 70 kWh/m^2 or 5.8 kWh/m^2 per month. Since specific data for the standard of energy consumption in settlement areas is currently limited, this average intensity is used as a benchmark to calculate and compare the level of energy consumption.

Located in the tropical zone of the southern hemisphere, Bali has a warm humid climate all year round with seasons that can only be distinguished as wet and dry. The wet season falls between October and April, and the dry season occurs between May and September. With the warm humid climate, the temperature throughout the year averages between 25° to 30°C with high humidity that averages about 82%. The hottest months of the year in Bali are between November and March, with an average temperature around 30°C. On the other hand, the coolest months of the year are June, July, August and September with an average temperature around 25°C (BPS 2011). These conditions have influenced the use of energy in the building sector in Bali where there are no significant differences throughout the year (Permana & Kumar 2008).

The traditional Balinese house is a building adapted to the warm humid climate and optimally utilising the potential of nature (Silaban 1991) to use energy effectively (Trimarianto 2003; Yeang 1987; Yuan 1987). The house is environmentally friendly and is low cost and thrifty in its operation (Widja 2004). A veranda, a shallow overhang, and cross ventilation between the roof and walls are essential building elements to moderate the tropical climate (Gelebet 1986).

Traditionally, most energy use in the house occurred in the kitchen where women cooked every morning and prepared food for animals, especially pigs. In this place, the daily life of Balinese began when the mother lit the first fire for the day's cooking (Covarrubias 1974). This activity, which used firewood as fuel, was the main source of energy consumption. At night, people used limited light from a traditional lamp called a *damar* made from cotton and coconut oil on a coconut shell or small piece of pottery. In Kamasan, a *damar* was put in a little niche excavated in the wall of a *bale dauh* so that it produced charcoal used for drawing traditional paintings. For that reason, people in Kamasan kept a *damar* burning until the morning.

Along with the advance of technology and information, people started using kerosene for cooking and electricity for lighting and other household devices such as televisions, radios, fans, washing machines and refrigerators. When gas stoves were introduced, some people used these devices and abandoned kerosene stoves for cooking because the gas stoves were cheaper and cleaner than the kerosene ones. After the Indonesian Government launched the program of conversion from kerosene to liquid petroleum gas (LPG) in 2007 (KESDM 2011), most people used a gas stove for cooking.

In the transformed houses in the four villages, energy was supplied by electricity, LPG and a small amount of firewood in some houses. Since the energy consumption is similar throughout the year, the consumption of electricity and LPG was collected from the monthly electricity bill and information from the owners. These data were then divided by the total floor area. In the case of LPG, the numbers of gas bottles that were used monthly were then converted into kWh. These energy resources and the floor size for residential and commercial purposes were collected and compared to investigate their pattern.

4.3. Building Density and Energy Consumption

The relationship between building density and energy consumption in housing commonly constructed in Bali[1], was established by Trimarianto (2003). He suggested that high-density houses needed more energy to improve the comfort of occupants. The houses need artificial lighting even on a sunny day because the sunlight is not enough to illuminate the rooms. The houses also used AC more often to provide the comfortable indoor temperatures.

In parallel to Trimarianto's arguments, this investigation found that the higher the density of a house, the higher the energy intensity. This phenomenon can be seen in Figure 3 that shows a comparison between BCR (Building Coverage Ratio) and monthly energy intensity. The monthly energy intensity in Sanur (4.47 kWh/m^2) and Kuta (5.09 kWh/m^2), which had higher BCR, was higher than Kamasan (2.65 kWh/m^2) and Ubud (3.89 kWh/m^2).

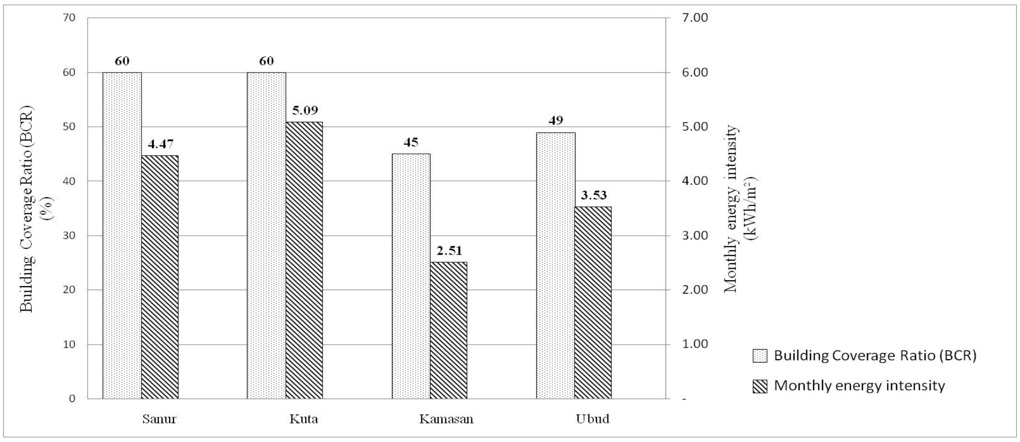


Figure 3. Monthly energy consumption and the average BCR in four villages

However, BCR is not the only factor that influences the energy usage in the house. The influence of building density on energy intensity and the other factors that influence the increase can be seen in Figure 4. In this figure, the level of building density based on the inventories and texture of the transformed houses that are explained in Chapter Five, is divided into four categories. The first category represents the house that still has an ideal *natah*, a family temple, traditional pavilions and a low transformation of *teba*. The second category represents the house that has an ideal *natah* and a family temple and has transformed pavilions and *teba*. The third category represents the house that has the original family temple but transformed *natah*, pavilions and *teba* and the fourth category represents those where there are changes in all parts of the house. The first category has the greatest open spaces and the lowest building density while the fourth has the smallest open spaces and the highest building density.

The scatter-plot within each category and the regression analysis (R^2) in Figure 4 indicate the extent to which energy intensity depends on the level of building density. The trend displayed in the figure confirms the trend of an increase of monthly energy intensity as the level of building density increases. However, the R^2 – value is weak (0.0194), and there are considerable variations of energy intensity pattern within the categories, therefore a clear dependence between these variables is not seen.

[1] Trimarianto examined two house models that are commonly constructed in urban area Bali. The models are the 36 m^2 dwelling type on a 108 m^2 plot and the 240 m^2 dwelling on 294 m^2 plot.

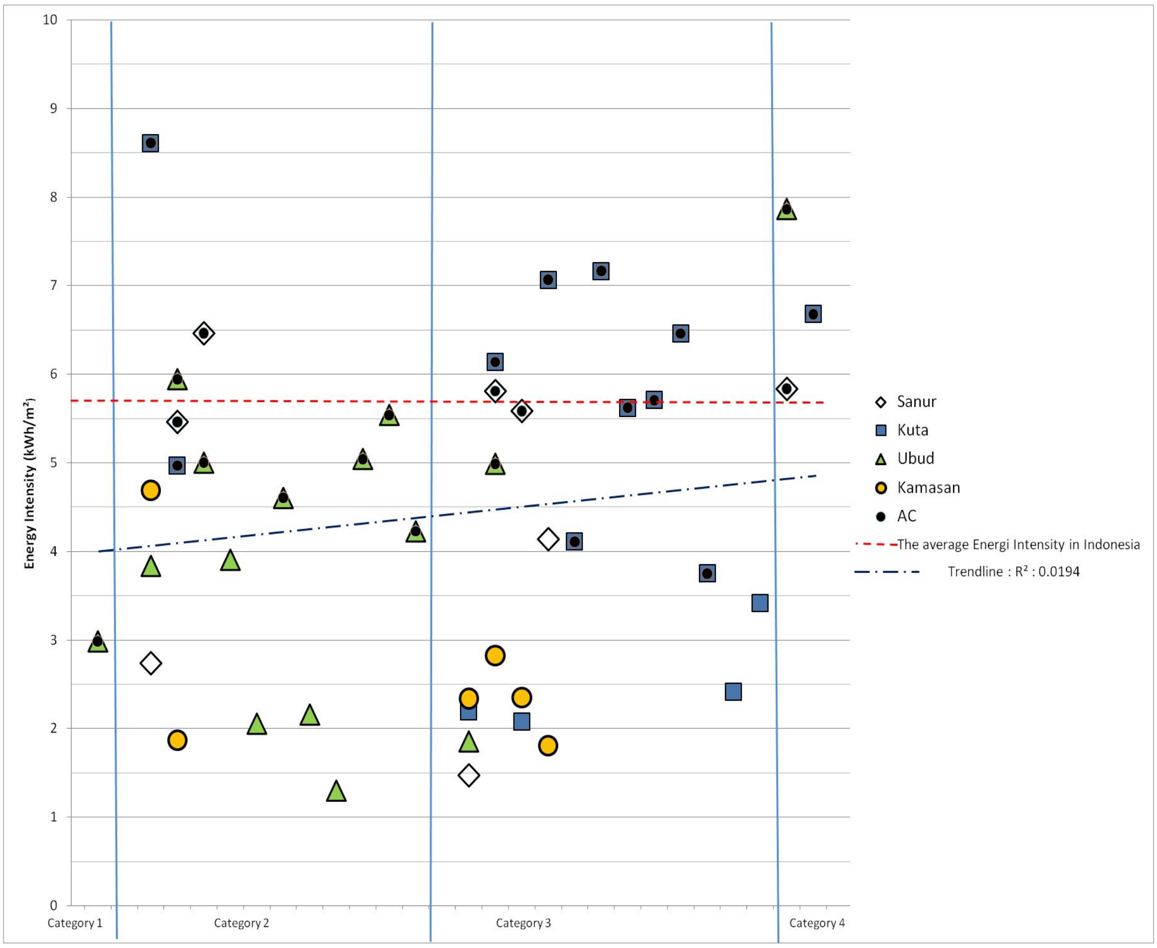


Figure 4: Energy consumption in the four villages

The clearer dependence in relation to energy consumption in the transformed house is displayed by the correlation between the installation of air conditioning (AC) and energy intensity (Figure 4). A different set of groupings, especially in the Category 2 and 4, emerges for monthly energy intensity, in which the houses equipped with AC show greater energy intensity than those without AC. This figure also shows that the houses without AC used less energy than the average energy intensity in Indonesia (5.8 kWh/m^2) while the houses equipped with AC approached and were above the average energy intensity in Indonesia. This figure implies that the installation of AC significantly increases the energy intensity compared to the houses without AC.

As suggested by Trimarianto (2003), this device was installed in the house as a response to the increase of building density and reduction of open spaces. However, in the house transformed for tourist facilities, the installation of AC was distributed within the four house categories that represent various levels of building density. This phenomenon implies that there were additional variables, which govern the preference to install AC and lead to the increase of monthly energy intensity, other than level of building density. To demonstrate possible explanations for the additional variables, twelve transformed houses that are representative of each category in the four villages were explored by interviewing the owners. The house in Category 1, for example, which has low building density, ideal pavilions, and vegetation to create thermal comfort for its inhabitants, is also equipped with AC. In this house, AC is utilised to entice tourists. Three houses in Category 2 and 3 that have relative lower energy intensity (around 4 kWh/m^2) amongst the houses equipped with AC use such a device not only for creating thermal comfort but also for attracting tourists, showing the prestige and luxury of their house and presenting the occupants' lifestyle. This figure indicates that in terms of the use of AC, creating a modern image is more important consideration than the density of the houses.

5. Conclusions

The energy and water consumption in the transformed house has been investigated. The investigation found that the tourist facilities increase the energy and water consumption especially in the facilities that use electrical devices and water to serve tourists such as home stays, cafes, restaurants, salons and laundries. The use of the advanced technologies is an attempt of people to provide a better service and to fulfil the demands of tourists for convenience in the transformed houses. The electrical devices are likely to be beneficial in terms of attracting tourists, and possibly even to create luxurious, prestigious and comfortable facilities.

The construction of tourist facilities and new structures for accommodating domestic activities has increased the building density in the houses. The high building density influences energy consumption used to increase the comfort of the occupants. Despite low correlation, building density represented by BCR tends to influence energy intensity in the transformed houses where the higher the BCR of the houses, the higher the energy intensity. The clearer correlation is displayed between installation of air conditioning (AC) and energy intensity. Transformed houses equipped with AC have greater energy intensity than those without AC.

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