Toward sustainable building designs and the environment in Denpasar city: lesson learned from Bali Aga concepts

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Abstract. The concept of sustainable development is widely known as an improvement towards the quality of buildings and the environment. Thus, this concept improves the comfort, health, satisfaction, and work performance of people. The city of Denpasar-Bali experienced very high population growth and decreased the quality of the environment and the balance between economic, social, and environmental factors. On the other hand, indigenous villages named Bali Aga villages that spread out across Bali island have building design and settlement concepts that always maintain harmony between humans, nature, and God. This concept has been proven to effectively respond to social, economic, and environmental problems for years. The aim of this paper is to discuss the suitable concepts and criteria for sustainable design and settlement of Denpasar city in the future by learning from Bali Aga concepts. The qualitative content analysis was applied to this study. Interviews with several professional architects in Denpasar were undertaken to explore the common approaches and barriers to sustainable design. Detailed information on indigenous design and settlement concepts gathered from surveys to selected Bali Aga villages. The result shows that Bali Aga’s building and settlement concept is fundamental to create suitable building and settlement concepts for the future development of Denpasar city to maintain economic, social, and environmental balance.

Keywords: Bali Aga, building, concepts, design, sustainable

1. Introduction
Denpasar is the capital city of the island of Bali, which is a densely populated city. With a population of 962,900 people (BPS Denpasar, 2020) and an area of 124 km², this city is said to be a relatively dense city. The increasing population of the city of Denpasar is caused by the flow of migration and urbanization. Urbanization and migration are the causes of increasing urban population and increasing anthropogenic activities, which then results in a climatic, environmental problem known as an urban heat island (Kikegawa et al. 2006). The increasing flow of urbanization is the source of the increase in urban center population in Asian countries, which also directly increases the world’s population (UN, 2000). In 2030 it is estimated that the population in the city will reach 60% of the total population (Mirzaei & Haghihat, 2010, Lo & Quattrochi, 2003). The density of buildings and the lack of green open land make this city even hotter, and various other environmental problems arise. The density of the city of Denpasar, accompanied by high pollution due to traffic and the use of air conditioners in buildings, also adds to global warming, which is getting worse. Maru & Ahmad (2015) state that the larger the
green land that is built, the more warming will increase and play a role in the urban heat island phenomenon.

Judging from this phenomenon, architecture plays a very important role in helping to minimize the urban heat island and global warming. This paper aims to discuss the importance of sustainable design for the development of the city of Denpasar in the future so that it does not aggravate the current climate change conditions. Discussions were carried out on the architectural concept of the Bali Aga Traditional house that has existed since ancient times and is still sustainable today. This paper also discusses the role of professional architects in Denpasar related to the concept of sustainable architecture in their designs, as well as the constraints and benefits of designing with the concept of sustainable architecture. This study discusses the concept of sustainable architecture that has been used by professional architects in Denpasar by comparing the concept with Bali Aga architecture. This paper produces a basis for the concept of sustainable architecture design and criteria that can be applied as a guideline for development in the city of Denpasar in the future.

2. Method

This study used a qualitative content analysis method involving interviews and observation survey. Content analysis is one of the analysis types that is considered as a comprehensive approach to data analysis. According to Schilling (2006) and Kohlbacher (2006) that qualitative analysis provides useful tools to analyzed interview transcripts and help the researcher to minimize unnecessary words, paraphrase the words to enhance the understanding of people views about the topic, and this process really helps the researcher to validate result and reliability of the topic with logic manner. Qualitative content analysis is defined as an empirical approach (Marrying, 2000) and has the ability to control the methodology, and then the analysis could be done by the combination with other qualitative analysis procedures. This approach also helps the researcher to understand social problems and reality by testing the data through theoretical issues within content-related categories words in a subjective but scientific manner (Elo & Kyngas 2007; Hsieh & Shannon 2005 in Prajnawrdhi 2015). Bryman (2001) and Corbetta (2003), Legard et al. (2003), David & Sutton (2004) mentioned that structured interview makes it easy for the researcher to control the interview activity, this also directs the participant in answering questions according to questions list that has been prepared before the interview conducted, and each respondent in the same group have the same questions related with respondent’s motivation; beliefs; views and experiences of certain issues in more detail; also asking about specific issues to minimize distorted answer. A structured interview was conducted with 20 professional architects in Denpasar to gain their views about using sustainable design concepts in their design. The interview was also conducted with local communities in seven Bali Aga villages to gather information about the concepts of their architecture. An observation survey was conducted in seven Bali Aga villages to gather primary data about the Bali Aga architecture. Gorman and Clayton (2005) explain that observation is a research method that involves systematically recording phenomena and behaviors in a natural setting. This study uses NVivo 12 to analyze and coding all data in qualitative method from the interview. NViVo is an analysis tool that helps the researcher to do coding from an interview a micro-level of text, such as in a particular sentence (Durian 2002). From the interview and observation, all primary data were analyzed using NViVo 12 qualitative analysis. Then this coding result was transcribed and discussed with architecture theory to find sustainable architecture design guidelines and criteria for future building design in Denpasar.

3. Result and Discussion

In the discussion section, we will discuss the results of the analysis that has been carried out using qualitative content analysis through NViNo 12 software. The discussion section will be divided into three parts, namely: (1) The results of the analysis of interviews conducted with local communities on six village case objects Bali Aga in Bali is related to the architectural concept that is owned and is still maintained until today, the area of the village: Desa Pedawa, Desa Sidapata, Desa Cempaga, Desa Tigawasa, Desa Banyuseri (these five villages located in Buleleng District), Desa Pinggan and Desa Sukawana (these two villages are located in Kintamani regency), (2) the results of interviews conducted with twenty professional architects in Bali regarding their opinions and experiences in designing using the sustainable architecture concept, (3) results in discussion between the concept of the architecture of the Bali Aga house with the concept of sustainable architecture which is understood by the two different
groups of participants to produce an understanding of the concept of sustainable architecture that is suitable for the city of Denpasar.

3.1 Bali Aga houses concepts

The Bali Aga community is known as the Bali Mula, who are the indigenous community of Bali island before the arrival of the population from Java during the Majapahit kingdom. They usually live in mountainous areas and highlands. In contrast to the Balinese Apanaga people who are known as the Bali Dataran who lived in the mainland are the population who originally come from Java. Bali Aga traditional houses called Umah Adat is the architecture which has been inherited from their ancestors and still preserved until now (Prajnawrdhi, 2018). The house of the Bali Aga community has a simple form with a single building. Balinese traditional houses provide several functions to their residents, which include: social, symbolic, morphological, and functional purposes (Parimin 1986, Sulistyawati 1985). Figure 1 shows Bali Aga houses.

This is very different from traditional Balinese houses, which are located on the mainland which consist of several buildings, and have a larger land area. Bali Aga house is a single house that can accommodate all the activities of its occupants. Bali Aga house has an open plan and very flexible to accommodate several different activities, both private and public. This house is an old house that has existed since ancient times and is still preserved today. Interview conducted with several villagers related to the concept of their houses and their understanding of sustainability regarding house design. The coding result of the interview with the local communities in seven Bali Aga villages can be seen in Table.1 below. This result is based on ‘word frequency’ from the interview. Brysbaert and New (2009) explained that word-frequency is seen as a very important variable in cognitive processing. Thus it can be seen that word frequency has more important, efficient, and valuable than low-frequency words.

![Figure 1. Bali Aga houses](image-url)
From the coding results, there are thirty main important words were mentioned during the interview, reflecting the concern of the respondent. It can be seen that the concept of sustainability, which is understood by the people of Bali Aga Village, is related to several different aspects. From NViVo 12 coding result of word frequency then divided into three priority based on the participants understanding of the issue, as can be seen in Figure 2. Their first priority of sustainable design is related to the use of natural materials such as bamboo and wood. Then the second priority is accommodating their rituals in their house as one implementation of their respect to the ancestors and environment. The third priority is building openings and structures with the use of simple openings and structures as an implementation of respect to the environment and minimize the use of energy. The universal concept based on Hinduism in the Balinese Bali Aga architecture, which has been passed down from generation to generation, known as *Tri Hita Kharana*, which means maintaining harmony between natural humans and their creators, is a concept applied by this community. The Balinese Aga traditional house is a reflection of the life and culture of the local community with all the statutory rules. Therefore, development is based on local beliefs. Norms, values, patterns, activities are some of the characteristic local cultures that have become the reflection in their traditional houses (Broadbent et al. 1980). From the table, it can be seen that shrines and rituals also within high-frequency words. This indicated that the beliefs of local communities are strong, and it’s reflected in their houses. The shrine as a place of rituals plays an important part in their houses. In a particular social order, the ritual function is a cultural attribute, is a very important factor in producing a setting both public and private, and produces a specific spatial structure (Knowles, 1996). Therefore, rituals also play an important part in preserving their traditional houses. As Schulz (1979) also mentioned that a center of orientation and identification for humans in the form of spatial structure could be a sacred space that is usually used for ritual activities. Rituals also become a high hierarchy as self-actualization; therefore, a house should be able to accommodate all levels of human needs from the lowest to the highest Maslow (1943).
From the results of coding can be seen how the understanding of the Balinese Aga community to the concept of sustainability applied in their homes. Their understanding of the concept of sustainability through a point of view that has been passed down from generation to generation by their ancestors. Meanwhile, when viewed from a text search, it can be seen the results of the coding interviews with the Bali Aga villages, which are as shown in Figure 3. Stanfill and Kahle (1986) explained that ‘text search’ is defined as the important word to find within an interview based on keyword and theory required. The result shows that ‘bamboo’ is the main keyword found in the text search sustainable concept. Bamboo is the main material for construction in Bali Aga houses. This material is used for the main structure, from the body to roof structure combined with wood. Instead of making many openings on the walls, these traditional houses are using a bamboo mat for the walls with several holes to let the air circulate in the building and also to catch natural lights into the building. Bamboo is a sustainable material that is easy to renew rather than wood. Bamboo is also applied for kitchen appliances and furniture in Bali Aga houses. Therefore, the local community of Bali Aga villages has already applied the sustainable concept to their houses by using renewable material and using a structured system that is not harming the environment.

### 3.2 Sustainable architecture practice in Denpasar

To find out how to implement sustainable architectural concepts in the city of Denpasar so far, interviews with 20 professional architects were conducted. Participants were male and female architects with experience ranging from 9 to 25 years as building designers. From these results, it can be seen that most architects understand the concept of sustainable architecture in their design. Coding results from the interviews with professional architects in Denpasar based on word frequency as seen in Figure 4.
Based on the results of the coding of the word frequency by NVivo 12 qualitative analysis, there are thirty important words that mentioned by participant according to their understanding of the issue. Then it is categorized into three priorities. The first priority from the keyword is the importance of the sustainable concept in design for most projects with the consideration of using natural material. This priority explains the application of sustainable architecture concepts that have been carried out so far by professional architects in Denpasar city. The understanding of professional architects in Denpasar is also shown in the second priority of coding results. The use of natural materials and proper ventilation is important for a better future. Most of the architects in Denpasar understand and apply this concept, although still partially at the moment. Sustainable concepts applied were using bamboo as building materials, applying cross-ventilation concepts, big openings for natural lighting during the day, rainwater treatment concept, and using natural-environmentally friendly building and construction material as many as they can afford. All participants mentioned that the application of the concept of sustainable architecture is very important for human life and ecosystems and the environment in the future. The third priority is about the challenge they faced during designing with the sustainable concept are related to the cost of natural and durable material and owner budget. Since the cost of materials is high then it hard to use natural or durable material for design development.

Coding results from professional architects based on text search can be seen in Figure 5. This text search is based on the keyword of sustainable concept. The result shows that few architects cannot apply this concept due to a lack of understanding of the concepts and other constraints. The constraints faced by architects in applying this concept is the budget factor. This is because durable materials are relatively expensive and difficult to find in Denpasar, so they have to be imported from other regions and even abroad. As the cost of design with sustainable architecture concepts is higher than conventional ones, then it is often contradicted with the budget of the building owner. Further, the other constraints are the building owner’s less understanding of the implementation of the sustainable architecture concept, so they often do not accept the architect’s idea to apply the concept to their building design. This is, of course, a challenge for architects in Denpasar to face. The need for understanding how important is this concept from all levels of society in development is urgent. All participants hope that development in Denpasar can be developed based on this concept for a better future and could reduce the global warming effect.
3.3 Sustainable architecture concept for building development in Denpasar

From the discussion in the previous section, it can be seen that both the Bali Aga community and professional architects understand the concept of sustainable architecture in design in their own way. Although the people of Bali Aga cannot clearly mention the definition, their understanding of the issues discussed is in accordance with their abilities and includes elements of sustainable design in general. Bali Aga community concern with sustainable design and development based on the use of local materials, proper openings, and rituals. The understanding and design implementation of professional architects in Denpasar is also based on the use of natural material and durable material, proper ventilation to reduce the use of energy in a building design, allowing fresh air and natural lighting into the design. Based on the above discussions, it can be seen that building envelope is important in sustainable design. Therefore, the concept of building envelope for design in Denpasar plays an important part in the development. Buildings with good building envelope planning play a very important role in the use of energy in the building and the durability and age of the building itself. Therefore planning an envelope design for the building is needed (Depecker et al., 2001, AlAnzi et al., 2009). Good building envelope planning will provide a close relationship between the inside and outside of the building, provide good air circulation into the building and be able to provide good natural lighting (Beita, 2010). Traditional architecture that prioritizes natural openings for air circulation and natural lighting is one of the strategies that architects can use to design contemporary architectural buildings so that they are able to design sustainably (Nabavi et al., 2012). Hence the concept of envelope design in Bali Aga houses has already been proven as a sustainable concept since it allows natural light and air into the building. New house design in Denpasar could adopt the concept of envelope design of Bali Aga in a contemporary design based on the designer’s creation. Further, the Bali Aga envelope design would be suitable to apply for a new design for houses. Therefore new building design in Denpasar can
use the envelope design concept of Bali Aga houses. Architects can make adjustments to the building envelope design of Denpasar, taking into account the natural and environmental conditions in the city of Denpasar, which have the different conditions of the Bali Aga’s villages. Architects play an important part in designing a proper opening such as ventilation that can be suitable with the relatively hot and humid temperature of Denpasar.

The interests of the residents change over time, so the planning of a house must consider these changing needs. A design that is flexible and able to accommodate changes will give residents the freedom to make the desired changes in the interior of the house so that it can be re-usable, can be used for the next generation because it has a good level of flexibility (Pulhan & Orcunoglu, 2005). Bali Aga house with open plan design can accommodate several different activities of the owners, both public and private. All activities from birth, life, and death of human life can be accommodated in this house. House concept in Denpasar also can accommodate this concept in more contemporary. A design that is flexible and affordable is essential in sustainable development. A good design can accommodate the needs of different users as well as different types of occupants (Friedman, 2002). Land price in Denpasar is higher than other areas in Bali and considered higher than any other big cities in Indonesia, and then a simple and open design is needed. House affordability has become one important factor for Denpasar residents. Therefore small houses are one suitable option. The concept of a simple and open house for new design could adopt the concept of Bali Aga house with some considerations due to the house owner need would be able to accommodate the resident’s need for longer-term.

Eicker (2009) states that one of the sustainable building concepts is a building that digs up the ground as little as possible. Hence, this sustainable concept is already applied in Bali Aga houses. The Bali Aga house does not use a foundation. The base of the house is above the ground using the Umpak structural system, and it is very safe from an earthquake. Therefore, development in Denpasar could apply is a concept as well to minimize the negative impact of development on the environment. The use of umpak for the new design will minimize the risk of negative impact from the earthquake. Many buildings in Denpasar, especially commercial, have also implemented this base structure system, then the professional architect of Denpasar have already understood that some of Bali Aga concept is applicable to contemporary building in Denpasar.

4. Conclusion
To sum up, it is clear that Bali Aga houses have applied a sustainable concept for a long time ago. The concept of sustainable architecture design in these houses is simple and easy to adopt for development in Denpasar. The important point of sustainable design based on the above discussion is the use of local and durable materials; simple and open plan for design, proper openings to reduce the use of energy; and the use of simple structure. These are the important points that should be considered for design guidelines and criteria for development in Denpasar. Sustainable development includes sustainable architectural design, requiring architects to design buildings that are more energy-efficient while still paying attention to the aesthetic quality and function of the planned buildings (Schlueter & Thesseling, 2009). Architects play important roles in development; therefore, the application of sustainable architecture concept is a must for a better future. Further, government and all society also have important roles in promoting sustainable development. With good coordination between all societies in Denpasar, then the negative impact of global warming can be minimized.

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