

# Concepts and Principles of Implementation Sustainability of Balinese Architecture: Interpretation of the Lontar Asta Kosala Kosali Manuscript

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## ABSTRACT

Architecture in the context of sustainability is an effort to preserve and preserve all the resources used, with the aim of ensuring the availability of resources to be utilized by the next generation. Balinese architecture is one form of Nusantara architecture that was born from architectural activities using the manuscript of the Asta Kosala Kosali (AKK) as a guide. In this AKK script contains several requirements that must be fulfilled as an effort to present an architectural formation that guarantees sustainability. This means that the sustainability aspects of Balinese architecture are an important part of being applied in architecture. The question is how are the concepts and principles of sustainability of architecture, according to the AKK script? This study was conducted to answer these questions, using an architectural perspective in the context of construction. In this case, placing the text as the main object of study is placed as text. Because the text is handled, this study uses interpretation methods as a way to uncover the sustainability principles embraced by Balinese architecture. This study produced several findings related to the sustainability of Balinese architecture, where the continuity of Balinese architecture conceptually according to the AKK script is a building process that is based on achieving harmonious relations between nature, humans and architecture with the aim of ensuring the existence of Balinese architecture from time to time and from generation after generation. And in general there are four principles for implementing the sustainability of Balinese architecture as indicated by the AKK e-text, namely; 1) the principle of utilization and processing of building materials in this case is wood as the main material, 2) the principle of natural and building alignment, 3) ethical principles for humans in the building process, and 4) the principle of respect for the creator of nature.

**Keywords:** concepts, principles, sustainability architecture, Balinese architecture, interpretation

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## I. INTRODUCTION

Architecture is a building that is realized through a building process. Each development will certainly affect the environment in which the building was built. The impact caused by the building process can be either positive or negative. The solution to the problem of negative impacts from the building process in architecture is overcome by carrying out development based on the principle of sustainable architecture. Pitts (2004), states that sustainable architecture is a manifestation of human consciousness to manage the environment and utilize natural resources responsibly to ensure the occurrence of a sustainable development process. [1] The fundamental principle of sustainability is minimizing negative impacts on the environment and maximizing the use of natural resources. Sassi (2006), states that buildings, their construction processes, their use and disposal, have significant impacts on the environment. [2] The application of the principles of sustainable architecture in architecture will produce architectural forms that have the ability to respond to the environment in harmony.

Knowledge of the concepts and principles of sustainable architecture can be explored through the existence of architecture (in) Nusantara, one of which is Balinese architecture. Balinese architecture was built using written guidelines or references which were poured into the form of a text known as the Lontar Asta Kosala Kosali (AKK). Historically, the manuscript of the ejection of the AKK is estimated to have existed since the sixteenth century, which is a record of the constructions process of the Semarapura kingdom based in Klungkung. [3] The existence of the AKK ejection script was inseparable from the influence of the Majapahit kingdom, which at that time was called the Bali Arya period. Thus what is meant by Balinese architecture in this case is the Balinese Arya architecture. In this manuscript, AKK contains philosophical, ethical and technical knowledge. Related to the technical aspects of the construction process, there are matters concerning the basic principles of the construction process, size and measurement, wood as the main material for construction,

layout, assembly procedures and calculations. In the process of realizing Balinese architecture, AKK ejection has been used starting from pre-construction, during construction to post-construction.

Basically, the AKK ejection script contains the principle of constructing buildings, based on the principle of harmony. In the text it is mentioned '... .. kawruhakne de sang maulah gina tingkah urip ing wood ring sariranta ....', which means that the life of wood lies within human body. This manuscript statement shows how humans should treat nature, in this case wood represents nature and human body refer to humans. The message to be conveyed is that humans should treat nature as they treat themselves. This indicates that the AKK script wanted a form of harmonious relationship between nature and humans in architecture. The harmony of relations between humans and nature is a basic concept of architectural sustainability. Thus, in the manuscript of the AKK, the principles of architectural sustainability are contained. The question is how are the concepts and principles of the continuity of Balinese architecture according to the AKK script? This question is to be answered through a study of the interpretation of the AKK script.

## **II. SUSTAINABILITY OF ARCHITECTURE**

Sustainable architecture is an architectural principle that places its attention on the management, use and processing of natural resources or responsible environment with the aim of achieving a harmonious relationship between humans, nature and sustainable architecture. Sustainable Architecture is an architecture that meets current needs, without jeopardizing the ability of future generations, in meeting their own needs. The needs differ from one community to another, from one region to another and best if determined by the local community. [4] Brutland in Sassi (2006), emphasizes that there are two main objectives of sustainable architecture, namely; First, sustainable buildings must be metaphorically 'light sites on earth' by minimizing the environmental impacts caused by the construction process, their use until the end of usage. Sustainable buildings must have ecological footprints. Second, the building must contribute positively and in accordance with the social environment of the community, by meeting the needs of the community while increasing the quality of the environment, psychological and physical community.

Williamson, et al (2003), explained that sustainable architecture contains five basic principles, namely; environmental sanitation, natural energy utilization, use of renewable materials, site processing and architectural forms that are responsive to the environment and climate, and realize architecture that encourages physical quality improvement, spirituality and history. [4] In this case environmental sanitation is an effort to present an architecture that guarantees the quality of health for users or residents. As much as possible utilizing natural energy, such as the application of a natural aeration system and natural irradiation. Processing and utilizing sites without causing many negative impacts on the environment and nature. Consider natural and climate conditions in realizing architectural forms, such as; the potential for disaster threats, earthquakes, floods and so on. And responding to climate issues, such as rain intensity, humidity, temperature and wind speed. And the realized architecture is expected to be able to improve the quality of the environment both physically and socially. These five principles, in architecture, have been applied since the planning, design and development stages.

Architecture is not only an activity to create a building that is able to accommodate various activities in it, showing aesthetic charm and expressing meaning, but also an activity to manage the natural environment becomes a built environment that is needed by humans. In this case the natural environment is a container and architecture as its contents. In order for a realized architecture to function properly, the container and content must form a harmonious and balanced relationship. And because of that the principle of sustainable architecture is a solution that can encourage a balanced and harmonious relationship between the natural environment and the built environment.

## **III. BALI AND ARCHITECTURAL LONTAR ASTA KOSALA KOSALI ARCHITECTURE**

The process of building in Bali, especially during the development of Balinese Arya culture, was carried out in three main stages, namely; 1) pre-construction, 2) construction and 3) post-construction. In the process of building, the position and use of AKK throwings have been started since the pre-construction stage, especially in the activities of makarya, nyanggra, and ngurip gegulak and following and ngruakkarang, to the construction stage in the form of nglakar and nasarin, ngakit and ngerabin and ngaug. Each activity is preceded by the holding of rituals (upakara) and the determination of good days (mature adults). In the process of building in Bali, lontar AKK is located as a guideline and reference, relating to the basic concepts of AKK, utilization and processing of wood as building material, layout, size and measurement, calculation and assembly, development actors and rituals.

Asta Kosala Kosalai (AKK) manuscript is one of the legacy of past writings written in letters and in Kawi language (a mixture of ancient Javanese letters and languages, ancient Sanskrit and Balinese) on lontar leaf strands, known as lontar. It is estimated that written culture developed in Bali since the XVI century, after the arrival of Danghyang Nirartha around the XV century. Especially for the manuscript of the Asta Kosala

Kosali, it was estimated that it was written at the time of the construction of the Semarapura kingdom which was based in Klungkung in the year of 1622 or 1700 AD. This copy of the AKK is a record of the development that occurred at that time. The entire process held at the time of construction was recorded, which starts from the ritual procession at each stage of construction, material collection, material processing, assembly, until the inauguration. In accordance with the history of the development of Balinese culture, at this time it was called the development of Arya Balinese culture. And therefore the architecture that developed at that time was also called Balinese Arya architecture. [5] The use of the AKK e-script as a guideline for development in Bali was first applied during the construction of Puri Gede in Karangasem around 1705 AD. After being implemented in Karangasem, the AKK e-text then spread its use to several areas in Bali, such as; Gianyar, Denpasar, Badung, Bangli, parts of Tabanan and Buleleng. The spread of the use of AKK e-scripts to various regions in Bali, because it is evident that the buildings built using the AKK as a guide are able to overcome the seismic problems that often occur in the Central to East end of Bali. Areas in Bali that have the potential to experience earthquake disasters, especially volcanic earthquakes caused by volcanoes, can be traced through the history of the existence of volcanoes. In the historical exploration, there have been seven volcanoes in Bali in the past, namely; gunung Agung, Batur, Lempuyang, Batukaru, Beratan, Pejeng and Andakasa. [6]

AKK script is not just a record of the development process, but also a consensus and commitment of all levels of society with all forms of strategy to organize buildings in the center of the kingdom. [5] Therefore the AKK ejection script contains the norms in traditional development in Bali. On this basis it can be stated that the AKK ejection script was applied not only for the construction of puri, but also for the construction of garya, jero and umah, including holy places such as sanggah or pura and public facilities such as bale banjar or wantilan. This means that the AKK ejection script is generally applicable to anyone. Gelebet emphasized that the designation of the AKK ejection script was to regulate the structure of buildings to realize the environment or area of the royal centers (settlements) that were orderly, orderly and organized. [5] In other words, the AKK ejection is a guideline or reference in terms of traditional building and environment in Bali.

#### **IV. SCOPE AND RESEARCH METHODS**

This study puts the manuscript of Asta Kosala Kosali as the main object, where this text is a guideline or reference used in Balinese architecture. The assessment will be carried out using the architectural scientific perspective and the context of the construction process. The main problem that will be studied is answering questions 'how about the concepts and principles of sustainability of Balinese architecture according to the manuscript written by Asta Kosala Kosali? '. Thus there are two aspects to be studied, namely; the concepts and principles of sustainability of Balinese architecture. The concept relates to aspects that underlie the sustainability of Balinese architecture, while the principle relates to aspects at the level of implementation. In this case the manuscript will be positioned as text, so that the interpretation of the meaning of the text can be made relating to the sustainability of the architecture.

Considering the main object of this study is a text that is positioned as text with the aim of revealing the concepts and principles of sustainability of Balinese architecture, this study will use a qualitative approach using interpretation as the method. Interpretation is basically an attempt to interpret something to reveal the meaning behind what is read, seen, and felt from the real appearance of something. Disclosure of the meaning of something is done in order to find out what, why and how something exists and / or is held. [7] Interpretation or interpretation which is positioned as a tool and method of exploring or finding understanding, contains the meaning of expressing, interpreting and translating. [8] These three dimensions have significant differences in terminology, but at the same time the operational interpretation of the three is a unity of the process sequence.

This study will be held by taking three stages in the method of interpretation as the technique, which is to say, interpret and translate. At the said stage, the textual text substance will be described. Menterangkan stage is an effort to explain the substance of the text contextually in accordance with the objectives of the study. And the translating stage is the stage of moving the contextual meaning of text into the architectural domain.

#### **V. INTERPRETATION OF THE CONCEPT AND PRINCIPLES OF BALI ARCHITECTURE SUSTAINABILITY IMPLEMENTATION**

Interpretation of the script written by Asta Kosala Kosali is done to find answers to the question "how are the concepts and principles of sustainability of Balinese architecture, according to the manuscript written by Asta Kosala Kosali?". The concept referred to in this case is a building of knowledge that underlies the sustainability of Balinese architecture. Whereas the principle in question is the aspects applied in architecture to achieve architectural sustainability, according to the manuscript written by Asta Kosala Kosali. Methodological interpretation is done by expressing, interpreting and translating texts that are positioned as text.

### 5.1. The Concept of Sustainability in Balinese Architecture

The earliest part of AKK states that "urip ing kayu ring sariranta", which means the nature of wood life is in humans. An analogy that represents how humans should behave towards wood (read: nature). The meaning that can be found in the text is, that the nature of life of nature and humans point to the existence of similarity or in other words that nature is human itself. Therefore destroying nature means to destroy humans. This is stated in the text, given that building activities are activities that have the potential to damage nature. Cutting down trees for building materials, digging soil for foundation is an example of building activities that can damage nature. Maintaining and caring for nature is a human obligation, to ensure the sustainability of human life. In the text mentioned 'uriping kayu kayu ika, ulihakna maring pradhana, nga. Prathiwi' dan 'kapatyaning kayu kabeh, ulihakna maring purusa. Purusa, nga Akasa'. It means returning the life of wood to the ground and the death of wood returning to the sky. The return of wood life to the land, means re-management, in an effort to maintain the availability of wood. The return of the death of wood to the sky, means optimizing the use of wood, even though it's useless (read: die) for anything. To be returned to the sky the only way is to burn it. The use of wood by burning can be used in its use as firewood, for cooking, burning citakan (a square mold in the shape of a square that has not yet become bricked) or changing its shape into an adeng (charcoal) that can be utilized by the Pande (people who have the skills to make equipment from iron / metal) in his work. Thus the wood will not be in vain, all can be utilized and even after being grayed out it is also useful, such as for soil mixtures in making citakan, adhesive additives citakan for walls in buildings, or plastering on floors and walls of buildings and penyengker (border-walls of house yards).

Asta kosala kosali also includes the classification of wood and its use in the type of building and / or part of the building. The script mentions 'nyan cacakan taru, kang wèngang mangge ring parhyangan' dan 'muwah kang wèngang manggen ring bale', meaning that wood may be used for shrines and wood that can be used as a place to live. The arrangement of timber at the implementation level is not only limited to regulating its designation in the type of building but also regulates its designation in parts of the building. This is indicated by the text through the use of terms in the classification of wood, such as: prabhu, patih, arya, tumenggung, ranga and demung. These terms are taken from the hierarchy of positions in the system of royal government at that time. The higher the position or position according to the term, the higher the position of the wood in its use in parts of the building. For example, wood classified as prabhu is used for building head parts, while demung wood is used for complementary (decorative / decorative) parts that are not structural or decorative parts of buildings. Classification of wood on the basis of the type of building (based on function) and its use in parts of the building, shows an effort to regulate and control the use of wood. If not regulated, it is feared that one type of wood will be used in large quantities. Thus the availability in nature will be much reduced and even exhausted. As a result, if there is a damage or defect when processing or there is a construction failure in a building that has stood, it will be difficult to find a replacement for the same type of wood.

The implementative efforts of the relations to build buildings with nature are shown by the article relating to the calculation of the length of iga-iga of the roof truss of a building, by including additional skeletal parts jutting out which are called grantangan. Besides that, it is also indicated by the article concerning the placement of paon (kitchen). The use of the calculation of the length of iga-iga according to the AKK accompanied by additional roofs that jut out, is an appropriate way of solving problems related to natural conditions, especially weather or climate, such as; intensity of rainfall (precipitation) and solar radiation. Setting the location of the building is a solution to the problem of wind movement patterns. AKK only talks about the bataran of the building (floor), saka (pillar) and raab (roof) of the building and does not talk about walls at all, this indicates that the building that occurs is in the form of an open building. This form of open building is an attempt to overcome moisture. This illustrates that natural conditions become a calculation in realizing the building. Attention to precipitation, solar radiation, wind and humidity, are important factors in areas that have a humid tropical climate, such as Bali and Indonesia in general. Treating nature as treating the human body, protecting and caring for nature by replanting and optimally utilizing and overcoming construction wood waste, regulating the use and use of wood through classification and classification of buildings, and attention to weather or humid tropical climate, is a form of awareness that wise from AKK to nature.

According to Kormondy (1969), human awareness of the nature of nature, and positioning nature as a place to sustain life and livelihood are the basis of ecological emergence, as referred to by Ernst Haeckel (1869). [9] It is also stated that etymologically, ecology comes from Greek, oikos which means residence or household and logos means science. So literally ecology means the knowledge of residence or household. The fundamental characteristic of ecology according to Odum (1971), is the existence of relations between humans and nature in a single unitary scope (macro or micro). [10] AKK places nature as a place of life, life and human livelihood, becoming an arena for human interaction with nature. The use of natural resources and human responses to natural conditions is a form of interaction that occurs in the context of building housing. Thus, fundamentally, it can be stated that knowledge builds up in the AKK based on ecological fundamentals. It means that Balinese architecture which is in the process of building it using AKK as a guideline, will present an ecological



architecture. This is demonstrated through a method of building based on the creation of harmonious relations between nature as a material provider, humans as users and architecture as an artificial environment. On the other hand, putting the AKK script as a guideline in implementing development in Bali is a manifestation of awareness of the sustainability of architecture. This awareness is shown through the consistent implementation of the procedures for the implementation of development in accordance with the directions in the AKK text from generation to generation. Thus the continuity of Balinese architecture conceptually according to the AKK script is a building process that is based on achieving harmonious relations between nature, humans and architecture with the aim of ensuring the existence of Balinese architecture from time to time and from generation to generation.

## 5.2. Principles of Sustainable Architecture in Bali

Balinese architecture is built based on the rules in the manuscript of Asta Kosala Kosali, which is based on the goal of achieving a harmonious relationship between nature, humans and architecture. Based on this, the rules of building procedures contained in the AKK ejection script are basically a manifestation of the architectural sustainability concept. Thus the principle of implementing the continuity of Balinese architecture can be seen from the substance contained in the AKK ejection script. In accordance with the substance of the AKK ejection script, the elements of sustainability of Balinese architecture consist of; material, natural, human and ritual.

### 5.2.1 Principles of Utilization and Processing of Wood as Building Materials

Talks about wood in the AKK ejection script have been started since the beginning of the manuscript, in article 1 stated that ‘Iti tutur krama ring aji Asta Kosala Kosali, nga. kawruhakne de sang maulah gina tingkah ing urip ing kayu ring sariranta,.....’, which means it is aimed at people who will build, that wooden life is in you. This article 1 statement shows that the main concern of the AKK ejection text is on wood which is the basic material for building. Therefore, the AKK script is only regulated in detail the procedures for the utilization and processing of wood. On the other hand article 1 can also be interpreted that the characteristics of wood must be truly recognized as humans recognize themselves. Recognizing the nature of wood both physical and mechanical properties properly and correctly, will greatly assist in the processing and utilization of wood as a construction material. For example, in choosing the type of wood that can be used for construction, determining the size and dimensions of wood, and the construction system that can be applied. Thus it will guarantee the construction of buildings and buildings themselves can stand firmly and structurally functional wood.

Subsequently, in Article 2, it is stated that ‘Nang hing urip ing kayu ulihakna ring pradana, nga. Prethiwi Jati.’, which means that the life of wood trees must be returned to the earth which in this case is land. This statement in Article 2 shows that returning wood to earth or land means replanting wood trees. This is done to maintain the availability of wood in nature so that it can be utilized by the next generation, both for the construction of new buildings and for the purpose of maintaining existing buildings. Article 3 states that ‘Kapatyaning kayu-kayu ulihakna maring purusa. Nga, Akasa.’, which means that the wood dies back to the sky in this case the sky. The meaning of article 3 is wood that cannot be reused, both wood with physical and wood defects left over from processing must be destroyed so as not to pollute the environment. The method of destruction taken is by burning as indicated by article 3 by stating the return of the death of wood into space. However, in practice, the destruction of wood by burning is done by utilizing wood waste into firewood and combustion residue ash can be used as a mixture of soil to strengthen its adhesion.

The AKK ejection script also regulates the classification and norms of the use of wood species, which are contained in articles 110, 111 and 112. Article 110 regulates the classification and use of types of wood for shrines, article 111 for residences and article 112 for kitchens and barns. Based on the contents of each lot above, the classification and use of wood in buildings can be tabulated as can be seen in table 1. Each wood as table 1 has different characteristics, so that its use in parts of the building is also different. The characteristics both physically and mechanically of each of these woods are used as considerations in classifying and using them in parts of the building. Other considerations are the availability and physical properties of the diameter and odor of wood, which in principle is wood which has limited availability with a small diameter and smells good, used for building sacred places. Article 112 also states “mwah yan hana taru mawoh tanpa kembang. Tan wenang anggen papawonan”, which is the prohibition on the use of wood originating from fruiting trees without being preceded by the existence of flowers to be used as construction material for kitchen buildings (pawon). Some of the wood samples mentioned as above are included in the gymnospermae plants, for example cycads, pine, cypress, melinjo, and so on. Judging from its physical properties, in general this type of wood has coarse (large) fiber, is not solid, and contains oil so that when dry it is crisp and very flammable. [12] The kitchen is the dominant place of activity using fire and causing smoke, this will accelerate the drying of wood

and therefore wood which is coarse and hollow and contains oil is not used for kitchen buildings because it will be vulnerable to burning.

**Table 1.** Wood Classification in AKK Manuscripts

No	Fungsi Bangunan	Nama Kayu	Klasifikasi	Keterangan Penggunaan Pada Bagian Bangunan	
A	Parahyangan (tempat suci) Pasal 110	Cendana	Prabhu	Rangka Atap	
		Menengen	Patih	Kolom	
		Cempaka	Arya	Kolom dan/atau Balok	
		Kwanditan	Tumenggung	Balok	
		Suren	Rangga	Dinding	
B	Bale (tempat tidur) Pasal 111	Nangka, Kwanditan, Kampwak	Prabhu	Rangka Atap	
		Jati, Juwet	Patih	Kolom dan/atau Balok	
		Benda, Gentimun	Arya	Dinding	
		Timbul, Kaliasem	Tumenggung	Bale-bale	
		Sentul, Boni	Rangga	Pelengkap Bagian Atap	
		Sukun, Bulwan	Demung	Ornamen	
C	Jineng dan Paon (tempat makanan) Pasal 112	Wangkal	Prabhu	Rangka Atap	
		Kutat	Patih	Kolom	
		Blalu	Arya	Balok	
		Buu	Tumenggung	Lantai	
		Endep	Demung	Bale-bale	
		Catatan :			
		<ul style="list-style-type: none"> <li>• Bila ada kayu berbuah tanpa bunga, tidak boleh dipakai dapur.</li> <li>• Bila berbuah berasal dari bunga itu boleh dipakai dapur, Wreksa namanya.</li> </ul>			

Source: Arthana, 2018

Classification and regulation of wood use in parts of the building is intended to utilize wood effectively and efficiently. On the other hand, the regulation of wood use is an effort to avoid and control the use of a large number of wood species, considering that wood requires growing time to fulfill the requirements as a construction material in a relatively long term. This is an implementation of the concept of sustainable materials, which will ultimately guarantee the sustainability of buildings and development (sustainable buildings and constructions). Both the sustainability of buildings (sustainable buildings) and sustainable development (sustainable constructions) both require material in the process, in this case wood. On the other hand the prohibition on the use of wood from trees that are fruitful but not flowering for kitchen buildings, aims to maintain the security of kitchen buildings from the threat of vulnerability to fire hazards. This confirms again that sustainable buildings and constructions, are principles that are conceptually adopted by the AKK.

### 5.2.2. Principles of Harmonizing Nature and Buildings

Articles 27 and 28 of the AKK script are substantially related to the arrangement of the building layout, in this case one of them is a building that functions as a kitchen. Both lots regulate the good and bad location of the kitchen in accordance with the direction of the wind. In article 28 it is mentioned, ‘Yan ring daksina unggwanya, rahayu kita, bhoga katemu phalanya. Yan ring neriti unggwanya, rahayu ika, bhoga katemu jenek, sih amukti waras phalanya.’ This article states that the kitchen is best placed in the South and Southwest. Setting the layout of the building, especially the kitchen, considers one of the natural factors, namely the direction of wind gusts. Geographically the island of Bali is located 803'40 "-8050'48" South latitude and 114025'53 "-115042'40" East longitude, in this position the wind generally blows from the Northwest in April-October and from the Southeast in October- April (BMKG Region III Denpasar, 2017). By paying attention to the direction of this wind blowing, the kitchen which is a source of smoke resulting from the cooking process, should be placed in the South or Northwest direction, with the aim of minimizing the presence of smoke disruption to other buildings.

In the AKK ejection script, it is not regulated at all about the walls of the building, the parts of the building that are arranged are only height of the building from the ground, called bebataran, dimensions of building pillars, called sesaka and roof truss construction is called raab. Bebataran is part of the foot of the building in the form of a foundation, as long as the body part of the building in the form of columns and raab is part of the building's head in the form of a roof. The arrangement of the building height from the ground is found in article 115, which mentions ‘nyan wawilangan yan angwangun babataran, wilangkna trapanya, lowirnya, candi, watu, sagara, gunung, rubuh.’ In relation to the dimensions and heights of the building pillars, article 8 states ‘iti sikut ing yasa, kaweruhakna de sang amangun yasa, pawitan sasaka ika...’, meaning this is the size of the building, should be known by people who will build the building, starting from sasaka (pillars). And arrangements regarding roof truss construction are regulated in article 42 concerning determination of roof

slope and article 117 concerning calculation of roof truss construction. Article 42 states that ‘...pet usuk-usuke, asirang sasaka, nĕnĕm-nĕm, ngalih ka papurus menek, amĕnĕng ring pacung usuk-usuke, maurip apaduraksa, tĕgak grantange, grantang petang rain sasaka, tĕgak pacung bĕcik, nga.’, that the length of the roof frame is calculated from the diagonal of the six building pillars. Article 117 states ‘...malih wawilangan anggawe iga iga, luwirnya; Sri, Wrĕddhi, Hyang, Naga, Mas, Pirak.’, which means the calculation of roof truss using the order sri, wredhdi, hyang, naga, mas and perak. This indicates that, buildings that will occur or materialize are open buildings without walls, consisting only of foundations, columns and roofs, such as an umbrella. The form of this open building is a response to climate conditions, where the island of Bali is located in coordinates close to the equator has a humid tropical climate.

Bali has a humid tropical climate, with temperatures between 23oC - 31oC, humidity reaches 67% - 98%, with an average wind speed of 0.15 - 0.31 m / sec and rainfall intensity 17 - 487 mm / year. In humid tropical climate conditions with relatively high temperatures and humidity, to achieve the convenience of doing activities in buildings, the only way is to bring open buildings without walls. With the form of an open building will overcome discomfort due to high temperature and humidity, by utilizing the potential for high wind gusts. Moving air will freely cross or exit and enter open buildings, so that air with high temperature and humidity inside the building can continuously change with fresh air. This air flow system will keep the temperature and humidity in the building comfortable. Another problem related to this humid tropical climate is the high intensity of rainfall throughout the year. Regarding the issue of rain intensity, in the AKK ejection text it is regulated about the slope of the roof, oversteak length and the shape of the roof frame using faults or the difference in the slope angle between the top roof and the oversteak roof. Based on the method of calculating the length of the roof frame ribs, the slope of the upper roof is obtained around 40° and the slope of the lower roof is around 30°. With this slope combination, the high intensity of the rain can be overcome, thus the building is completely protected by the roof. On the other hand the problems related to the high intensity of the rain are also shown by the AKK e-text through the height setting of the building or the foot part of the building in the form of a foundation. With this height setting, each building will have a height that is different from the ground level. This is intended to overcome the water level during the rain so that it does not enter the building and also to protect wood material, especially the building pillar from the capillary power of ground water, so that the building pillars do not experience rapid destruction caused by water absorption.

The arrangement of the building layout, the shape of the building that is open, the difference in the height of the floor of the building with the surface of the ground and the roof design, as stipulated in several articles in the AKK script shows that there is an effort to overcome natural conditions without causing negative impacts on nature. This effort is a manifestation of the effort to achieve harmony between nature and buildings. Achieving a balance and harmony between nature and buildings is a way to achieve the continuity of Balinese architecture, as set out in the AKK script.

### 5.2.3 Ethical Principles for Humans in Development

Basically, architecture is an activity to realize the buildings needed to accommodate human activities, complete with aesthetic charm and certain meanings. Thus in the architecture of human position is as a maker and as a user. [13] As a maker of human architecture organizes a construction process that starts from the preparation, processing and assembly of materials. As human users use architecture as a place to carry out their activities. In the AKK text, the ethical aspects are related to these two human roles. In Article 18, which ‘kaweruhakna dharmmaning undagi...’, which means it is intended as a rule or law of undagi. Another article that mentions Undagi in it is article 32 by stating "... ‘...kengetakna de sang anglakwana undagi...’, it should be remembered by those who pursue the work as Undagi. In addition to the article in the AKK manuscript indicated by article 129 which states ‘Iti dharmaning tukang, kawruhakena, kadadening tukang, ...’, which means this rule or law about the tukang, is intended for people who become tukang. Likewise, it is found in article 151 which mentions ‘Malih hana kasihnya, wenang glarakane de sang tukang,...’, which means again a gift that must be carried out by tukang. The articles described above show that in the position of humans as makers of architecture, humans act as undagi and tukang. Undagi has the duty to plan, design and supervise during the construction process. The tukang in charge of carrying out what has been planned and designed by the undagi. Ethically, the undagi is in charge of maintaining the order in the construction process in the form of values adopted as stipulated in the AKK script. Whereas the tukang is in charge as the field implementer, processing the material until carrying out the assembly under the supervision of the undagi. Thus the nature of the duties and authority of the tukang ethically is to implement the norms set by the undagi.

As an architectural user, according to the AKK ejection script, its role has been started since determining the unit size of building components. In several articles, for example in article 69 it is stated that “yan anikut karang paomahan, wanglangnya, adepa asta samusti, nanging depaning sang adrewe umah juga anggange, nora wenang wong len”, meaning that if the measurements are taken, the owner must not other people. The type of unit of measurement used in the AKK ejection script is based on the size of the body

members of the owner and user of the building, including; guli, rai, nyari, kilan, musti, segema, lengkat, hasta, depa, dan tampak, the term used is entirely part of the human body, especially the hands and feet. By using limbs as the basis of size, the size produced is an anthropometric measure. [14] The use of this anthropometric measurement unit shows the role of humans as users and users of architecture. On the other hand, using this unit of anthropometric measurement is also intended to adjust the dimensions of the building and its components with the user's posture. So that in carrying out activities in buildings, human users will feel comfortable because the building has ergonomic conformity with its users. Ethically this is a representation of the concept of the relationship between humans and buildings, where in this case the building is positioned as well as living creatures. In this context Frick said that the building is the third skin of humans, where the first skin is the skin that is attached to the human body and the second skin is the clothes worn. [13] By positioning buildings as living things, humans must treat buildings like living things. Human ethical treatment of buildings in the context of buildings as living things is done by maintenance efforts to maintain the existence of the building as long as needed.

Humans as makers or builders who in this case are undagi and artisans, in principle must pay attention to what has been regulated in the AKK script. Undagi implements the values of the AKK script into plans and designs, while the builders who carry out construction work are guided by predetermined norms. As a user and owner of a building, ethics that must be done is to maintain and maintain buildings such as treating themselves, which in this case the building is analogous to living things. The arrangements contained in the AKK script relating to ethics for humans both as builders and building users, shows an effort to maintain the existence of Balinese architecture in a sustainable manner.

#### 5.2.4 Principle of Appreciation for the Creator of Nature

The AKK ejection text in article 1 mentions '...tingkah ing urip ing kayu ring sariranta...', which means that the characteristics of wood life are in humans body. The statement of article 1 can be interpreted that between nature represented by the word wood and human being represented by sarirantahas a close relationship, one with the other cannot be separated. In natural architecture is the container, while humans are the contents. As content, humans are very dependent on the container, namely nature. On the other hand the existence of nature was created by certain forces that were unknown to humans. Therefore in the AKK script also contained aspects relating to respect for the creator of nature as a provider of place and material in architecture. Appreciation towards the creator of this nature, in the text of the AKK, is shown through articles governing the ritual procession in development as well as the accompanying mantra or holy prayer.

In accordance with the text of the AKK release, in each stage the building process is always preceded and ended by the existence of a ritual ceremony accompanied by holy prayers. The stages of the building process mentioned by the AKK ejection script begin with the determination of the unit of measurement in the form of gegulak (unit of measure made of bamboo), followed by the stage of nglakar or processing building materials, then the stage of ngakit or assembling building components into one unit until finally a building is realized, and finally the mlaspas stage or inaugurates the building so that it can be used. For example, two chapters will be quoted in the text of the AKK ejection which relate to the mantra making a unit of measurement and a mantra to formalize the building. Article 24 concerning mantras or holy prayers for mlaspas (inaugurating) buildings, '...Om̐kara namaste ya namah swaha. Om indah ta kita bhatarā Sangkara, kita kinon kita den anjanma denira bhatarā Guru mandadi po kita kayu, tumurun ta kita ring Ibu Prethiwi mawod mabungkah, masemi ta ge lemah, Siddhir astu astu tatha astu astu...', which means respect to Om̐kara. Om̐ hear thou, Sāṅkhara Bhāṭara, you are commanded by the Guru Bhatarā to transform into a tree. Come down to Mrs. Perthiwi, rooted and superior. Look on the ground, ... Good luck until the end. Hopefully organized. Hopefully. And chapter 124 about the mantra makes gegulak (unit of measure), '...Iti payoganira, Bhagawan Swakarma, angewetwang gegulak wadah, anggawe gagulak, tur mananggetnangget, mantranya;Om wana giri taru, teka suddha...', which means that this is the yoga of Bhagawan Swakarma who created a gegulakr, made a circle, then incised it. The mantra: "Om̐ forests, mountains, trees, reach purity. In the quote from chapter 24 and chapter 124, it appears that the elements of the mantra or holy prayer are elements of nature. The natural elements contained are land as a place for living wood trees from building materials, woody trees, forests, and mountains.

The content of the ritual aspects and spells which are a unity in the manuscript of the AKK is a representation of the belief that nature was created by an unexplained force. The creation of nature with all its contents is utilized by humans to live their lives and lives. Therefore the creator of nature has the right to get appreciation, respect and glorification through the conduct of rituals. [15] With the implementation of rituals at each stage of development, humans will always be reminded that the existence of nature must be maintained and preserved, so that it can continuously provide for the needs of human life, especially the availability of building materials. The availability of building materials in nature will ensure the sustainability of the architecture, because building materials are the main elements that must exist to realize the architecture.



## VI. CONCLUSION

AKK's ejected text in principle regulates the relationship between humans, nature and architecture, in this case nature and architecture are also treated as living things like humans. Nature is positioned as a container of architecture and humanity in the context of the macrocosm. Whereas in the context of microcosms architecture is the container and human contents. AKK's e-text attempts to harmonize these three elements, through values and norms that must be carried out in the building process, with the aim of realizing human, natural and architectural sustainability. Thus the continuity of Balinese architecture conceptually according to the AKK script is a building process that is based on achieving harmonious relations between nature, humans and architecture with the aim of ensuring the existence of Balinese architecture from time to time and from generation to generation.

Article by article in the AKK e-text, detailing the concept of sustainability of Balinese architecture through various rules, directives and guidelines to be able to implement it in the building process. In general, there are four principles for implementing sustainability of Balinese architecture as indicated by the AKK e-text, namely; 1) the principle of utilization and processing of building materials which in this case is wood as the main material, namely; maintaining availability in nature, processing and optimally utilizing and managing material waste so as not to pollute the environment, 2) principles of natural and building alignment, namely; consider natural conditions in laying or positioning buildings in accordance with their functions and realizing buildings that are responsive to humid tropical climate conditions, 3) ethical principles for humans in the building process, namely; as builders, humans must adhere to the values and norms set out in the AKK e-text and as users, humans must treat buildings such as treating themselves and 4) the principle of respect for the creator of nature, namely; carry out ritual ceremonies using offerings and holy prayers at each stage of development.

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