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Ergonomics and Tri Hita Karana on Balinese Traditional Houses Building

I Nyoman Artayasa

Interior Design, Faculty of Art and Design
Indonesia Institute of the Art Denpasar

Tri Hita Karana is the concept of three things that can lead to happiness, which consist of the relation of human beings with God, amongst human beings, and the relationship of human beings with the environment, which is embodied in the circulation, the design space forming element, the supporting build a room, design of facilities, utilities and decoration. The study of ergonomics on traditional residential houses in Bali focuses on task elements, organization, and environment. The task examines how the facilities were created based on anthropometric and activity flow. Organization study about traditional Balinese buildings layout in terms of space organization resulted in a large scale, function space, and circulation space. Environment review the two sides, firstly is the physical environment, namely: the use of circulation, lighting and handling the current season every year, and secondly is the social environment, namely: religion, beliefs, norms, and others. There are similarities between Ergonomics and *Tri Hita Karana*; therefore, this study intends to it. It is conducted by using qualitative descriptive analysis with Tri Hita Karana concept on traditional Balinese buildings and accompanied with ergonomic values based on the subject of the task and environmental organizations. This writing aims to observe whether the ergonomics and *Tri Hita Karana* have similar views in the embodiment of traditional Balinese houses. At the end of the discussion, we can conclude that the embodiment of traditional Balinese residential buildings has to be considered on the relationship of human beings with God and the relationship between human beings and the environment. It also includes a consideration in ergonomics consists of task, organization, and environment; and it is found out that the concept of *Tri Hita Karana* has similarities with the idea of ergonomics on traditional Balinese houses.

Keywords: ergonomics; Tri Hita Karana

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Introduction

The study aims to observe traditional Balinese buildings pattern, which is analyzed from an ergonomics point of view with the concept of *Tri Hita Karana*. *Tri Hita Karana* is the concept of three things that can lead to happiness, which consist of the relationship of human beings with God, amongst human beings and the relationship between human beings with environment, which is embodied in the circulation, the design space forming element, the supporting space building, facilities design, utilities, and decoration. The study of ergonomics on traditional residential houses in Bali focuses on task elements, organization, and environment. The task will examine how the facilities were created based on anthropometric activity flow. Organization study about traditional Balinese buildings layout in terms of organization of space, which resulted in a significant, function and circulation space. Environment review the two sides, firstly is the physical environment, namely: the use of circulation, lighting and handling the current season every year, and secondly is the social environment, namely: religion, beliefs, norms, and others. There are similarities between Ergonomics and *Tri Hita Karana*; therefore, this study will intend to it. It is conducted by using qualitative descriptive analysis with the application of *Tri Hita Karana* concept on traditional Balinese buildings and also accompanied with ergonomic values based on the subject of the task and environmental organizations.

There are many similarities of both mentioned above. Therefore, this study will review several matters that relate to the two concepts, such as the need for ergonomics on traditional Balinese residential houses, the similarities of *Tri Hita Karana* concept application with the concept of ergonomics application Traditional Balinese houses. It is conducted by using qualitative descriptive analysis with *Tri Hita Karana* concept on traditional Balinese buildings and accompanied with ergonomic values based on the subject of the task and environmental organizations

Methods: Library research Discussion

Ergonomics comes from two Greek words, namely “ergon” and “nomos,” which means work and rules. Ergonomics is an interdisciplinary science that studies the interaction between human beings, objects used, and environmental conditions. Ergonomics is also concerned about the adjustment between the design of equipment and work with human ca-

pabilities and limitations. (Mechanical Engineering/Institute of Production Engineering, Work Science/ Ergonomics, 2005). Ergonomics, known as science, technology, and art, associate tools, methods, and the environment with human ability, skill, and limitations, obtain the working conditions and a healthy environment, safe, convenient, and efficient to achieve the highest productivity.

Tri Hita Karana is the three causes that lead to happiness or harmony, which can be achieved if there is a harmony of human relationships with God, amongst human beings, and human beings with the environment. *Tri Hita Karana* is the trilogy concept of life in which God, man, and nature stood at each corner as the fundamental elements of the implementation of universe breath. The world universe is divided into three parts of nature. First, *parahyangan* character, which is known as God nature. Second, *pawongan* character is known as human nature in which men hold her life in physical and spiritual dimensions. The third is the *palemahan* character that is the universe under the degree of a human highway, as the world of plants and animals. Implementation of the harmony within human life is the absolute harmony of the three-dimensional natures. Man must obey and comply with the rules and laws of nature that have been outlined to him through religious teachings that God has revealed. Religion derived from *Sanskrit a-gama*, *a* means no, and *gama* means chaos. So *agama* refers to an instrument or methodology for managing all aspects of human life to avoid confusion in life. Instead of harmony, tranquility and peace of life can be achieved. Violation of norms and rules of the religion which God has outlined will result in the degradation of human morality that will make man followed the desires to satisfy all the wishes of his life regardless of the rules of the norm of life so that it will cause a variety of social and environmental problems. The environment will be exploited arbitrarily without considering environmental governance that resulted in deterioration of the environment on human carrying capacity, and the result will be disaster arising everywhere as revenge against human nature.

Task, Organization, and Environment

As a multidisciplinary science, which integrates the various elements of science, such as physiology, anatomy, health, technology, design, and other disciplines related to the job, ergonomics is aimed at (Manuaba, 1998) (a) the improvement of physical and mental prosperity; (b) the improvement of social welfare, (c) the rational balance between human or human-system equipment with the technical as-

pects such as economics, anthropology, and culture.

To implement the above objectives, need rests on the capability, skill, and human limitations, with consideration to the task, environmental organizations, and the effect caused to the body. The ideal objective is to regulate these activities are within the limits where people can tolerate them without causing disorder (Manuaba, 1998).

Task or activities in the interior will result in others facilities. Activities in traditional Balinese society when it is connected with lounge facilities embodied in traditional Balinese buildings will be facility buildings that form the nine pillars of Balinese building (*bale tiang sange*), Balinese buildings with four pillars (*bale sakepat/bale sumanggan*), and (*umah meten*) bedroom. Three buildings (*bale tiang sanga*, *bale sakepat*, *bale sek-enam*) is an open building. In the middle of the house, there is *natah* (court garden) which is the center of the house. The inside of the house is for the family head's bedroom or the daughters. The bedroom is a building that has four walls, in accordance with the functions that require high security compared to other spaces (where essential goods & guards), *jineng* (Balinese rice granary) to store rice and *paon* (Balinese kitchen) as the place of cooking activity. Padmanaba (2006) explained that the building of traditional houses in Bali is used during the Hindu ritual such as *Panca Yadnya* like activity such as *Manusa Yadnya*; *Rsi Yadnya*; *Pitra Yadnya* and daily activities of other every day.

Facilities can be found in the building, eg on the bed inside of *bale meten*, cooking stove in the kitchen, or *paon*. The measures of those tools are highly adapted to the size of the user, so the attitude of forced or unnatural postures can be reduced. Similarly, in another section, such the steps to the bedroom and the height of opening the door are using the anthropometric measurements of the user. As proposed by Kagami (1988), a researcher of Traditional Balinese Architecture (TBA) from Japan in Padmanaba (2006) revealed that TBA had implemented ergonomics 'human factor' in the planning process of building homes.

Organizations in ergonomics discuss how things are organized activity, whether time, place, and others. Organizing activities on traditional Balinese buildings are very clearly referring to the basic concept of *Tri Loka* (the three-part of natures) or *Tri Angga* (the three parts of spaces). *Tri Loka* is about the idea of the hierarchy of space; *Nawa Sanga* or *Sanga Mandala* concept of orientation is about cosmology; *Manik Ring Cucupu* cosmology

is the concept of balancing human proportions scale; concept courts, open water; the concept of honesty of construction materials. At the same time, *Tri Angga* is the basic concept closely related to the planning architecture, which is the origin of *Tri Hita Kirana*. The idea of *Tri Angga* divides nature into three parts or spaces, namely: 1) *Nista* (bottom, dirty, feet); 2) *Madya* (middle, neutral body); and 3) *Utama* (top, head). Three axes are used as guidelines for the arrangement of buildings in Bali, the axes were among others: 1) The ax of cosmos: *Bhur*, *Bhuwah*, and *Swah* (hidrosfir, litosfir, and atmosphere), 2) The ax of rituals: *Kauh Kangin* (the rising and setting of the sun), 3) The ax of natures: *Kelod Kaja* (mountains and sea). The physical transformation of these concepts in architectural design refers to the arrangement of a typical residential room in Bali. Thus, by the structure of the regions north for sacred building, *Utamalulu* (primary) and the east/ west or *teben* is in the area of rebuke; the place is for pets.

The environment is a very concern in the discussion of ergonomics. Suppose the activity in environment does not meet the requirements. It may affect occupational health, leading to accidents (occupational accidents), diseases due to labor, and employment due to illness (occupational disease and work-related diseases). The work environment that needs to be considered is temperature, humidity, where the work is carried out, consisting of a slope, the height of the workplace, and others. Besides, the physical environment to be aware of the social environment also must obtain the appropriate portion. In addition, the social environment is about customary, customs, norms, taboos, and so forth.

The physical environment in a traditional Balinese building almost has the same attention to the ergonomics point of view, emphasizing the social environment, where taboos, customs, and beliefs are placed. Ergonomically activity and the demands posed facility would never be realized if it is contrary to the traditions, taboos, and views in one place. Moreover, it has developed a participation ergonomics study that means the involvement of any individual or team, which expected not only physical but also thoughts and feelings. The task of this team begins with the search of the implementation issues and evaluation of the existing shortcomings. So we will get an optimal solution, systems, and products of human labor, high quality, competitive, and sustainable under the wishes of all parties. In this case, the whole team will be actively involved in solving problems and discussing time, types, the best way of application, amount, and cost of interventions to be implemented. Through

the method, a local reference that appears, in this case, can be either customs, beliefs, or religious background concept, which eventually became the guidelines in the activities and ultimately manifested in the facility or any other embodiment.

Human relationships with God, neighbor, and the Environment

The three relationships in the interior are applied to the circulation. There are three alternatives: the elements that formed the space supported space of the building, facility, utility, and decoration. The human relationship with God can be seen clearly by the three alternatives that lead to the posting of the sacred building or temple on the main areas, which lies in the northeast region, followed by other facilities that lead to the area southwest site. There are three alternatives horizontally which refer to the concept of *Tri Mandala*, which consists of *Utama Mandala* (holy place), *Madya Mandala* (the area of doing activity), and *Nistha Mandala* (the area of public services). In the matter of the linkage portion of the building, low height is related to horizontal or hierarchy of a building that refers to *Tri Angga* consisting of head, body, and legs. It can be seen clearly that the circulation is directed to areas to facilitate a relationship with God. In this case, the circulation is so constructed that residents can easily carry out religious rituals every day. For example, the circulation is so built on the access from the kitchen to the shrine so that easy and no obstacles in ritual purposes called *me-banten saiban*, which is conducted every morning. Walls, windows, and door openings are not made perpendicular to the other openings exist, moreover, with the family temple entrance. It is closely related to eliminating undesirable cross circulation and the arrangement of circulation and the access, which did not match the opening of the sanctuary area, which is purified. The facilities and decoration will always consider sacred right as a reference, for example, that the bed placement will put the head in the direction in which religious or temple area, and not vice versa. Utilities, in this case, are represented by more dirty water disposal is also placed opposite the shrine. So the unclean water discharge leads to the southwest region.

Relationships amongst human beings are represented by the friendliness of the opening in the middle of a residential area called *natah* (court garden) which is the center of the dwelling. And the door (*angkul-angkul*) gives an impression invited to entrance, but there are also walls called *aling-aling*, which functions as a filter to the direction of view to provide more privacy in the areas. To these

two points in a row as it serves to build relationships with fellow residents, with welcome marked with entrance to attract attention, and the presence of open spaces in residential centers, which signifies an openness and man's relationship with one another, from the concept of *Nawa-Sanga* point of view *natah* located in the area of *Madya-Ning-Madya*. This very human region is the orientation center and the center of circulation. In *natah*, all human activity converged, such as what Ashihara analyzed as a centripetal order. Where *natah* is an ample space that unites the pillar of *uma meten* (bedroom) on one side and *bale sanga* (Balinese building with nine posts), *bale sakepat* (Balinese building with four pillars), *bale sekenem*, and *natah*, as well as an appropriate house, the same house as presently where *bale-bale* is a bedroom, *natah* as a place of gathering could be called the family room. When linked to it further, the *paon* (kitchen) activity can be equated with cooking and dining, so the traditional Balinese house, apparently identical to the form of West flats.

Human relationships with environments are characterized by the utilization of environmentally positive potential maximum. For example, the maximum utilization of the activity on the sun terrace, which can enter *umah meten* (bedroom) through an entire day without the glare and the lack of light. Air circulation is done by placing wall openings so that the circulation can lead comfortless. The placement of space between the building's mass is very concerned on the rainy and dry seasons in each year so that airflow can be utilized effectively.

Conclusions and Suggestions

Based on the study, we can conclude several things as follows: 1) during the embodiment of traditional Balinese houses building, things to be considered are the relationship between human beings with God, amongst human beings, and the relationship between a human being with the environment. It also has consideration in ergonomics which consisting of task, organization, and environment; 2) in general, the concept of *Tri Hita Karana* has similarities with the idea of ergonomics in traditional Balinese buildings. Once the world's influence on traditional communities is increased, we need a wise and prudent action from all parties to get involved in protecting the wealth passed down by generations, as the concept of traditional Balinese buildings should be maintained and preserved.

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