International Journal of Cultural Inheritance & Social Sciences (IJCISS)
Vol. 2 Issue 3, March 2020, ISSN: 2632-7597
Journal Homepage: http://ijciss.com/, Email: journal.ijciss@gmail.com
Double-Blind, Peer Reviewed, Refereed & Open Access International Journal

Architecture shaped by socio-cultural influence and climate: Lessons learnt from study of vernacular architecture of Kerala.

Dr. Janmejoy Gupta (1), Naushaba Jameel (2) & PushpitaPadhy (3).

(1) Associate Professor and HOD, Deptt. Of Architecture, School of Planning and Architecture, Vijayawada, AP-520008.
(2) B.Arch. (Birla Institute of Technology, Mesra, Ranchi, Jharkhand, India-835215.) Presently Architect at SWBI Architects.
(3) B.Arch., Pursuing M. Arch (Landscape Architecture, School of Planning and Architecture, Vijayawada, AP-520008.
Corresponding author: janmejoygupta@spav.ac.in/janmejoygupta1980@gmail.com

Abstract.

The vernacular architecture of any place is evolved through ages by consistent and continuous effort for more efficient solutions. Housing typologies though a result of multiple determinants, climate and culture are the two most important determinants. Materials, construction, and technology are best treated as modifying factors, rather than form determinants. This paper studies the evolution of vernacular architecture of Kerala in response to climatic conditions and varied cultural influences it has been subjected to. The orientation of buildings', internal arrangement of spaces, the presence of internal court-yards, use of locally available materials and other socio-cultural factors have combined together to create the vernacular architecture as it exists today. Other than improved thermal comfort, the vernacular architecture of Kerala also gives a number of pointers towards betterment of architectural quality in modern architecture with respect to planning principles, aesthetics and building materials used in built form. Alongside, this paper also looks at the different architectural lessons that can be learnt from the vernacular architecture of Kerala to be applied to modern architecture practiced in Kerala to make it more culturally and climatologically contextual to Kerala.

Key Words: vernacular, architecture, culture, materials, technology.

1. Introduction.

The word 'vernacular' is derived from the Latin word "*Vernaculus"* meaning local or native. Hence vernacular architecture refers to "native science of building". Many architectural publications advocate that traditional and vernacular homes form the basis of environmentally conscious design. In developing countries, where most of the population remains in rural areas using traditional buildings and technologies, the only feasible way to provide them with better living conditions is to upgrade traditional and vernacular homes. **(Meir and Roaf, 2006)**

Vernacular buildings record lifestyles of the past when people had to find a sustainable way of life or perish, just as we will have to now. The new importance of vernacular building is that it has vital ecological lessons for today. **(Pearson and Meeson, 2001)**

1.1. Vernacular Architecture of Kerala.

Although housing typologies are a result of multiple determinants, climate and culture are the two most important determinants. Materials, construction, and technology are best treated as modifying factors, rather than form determinants. They make possible the enclosure of a space organization decided upon for other reasons, and possibly modify that organization. They facilitate and make possible or impossible certain decisions, but never determine form. **(Rapoport,1969)**

Broadly speaking, however, vernacular architecture of a region is primarily influenced by the following characteristics:-

- Climate.
- Locally available building materials.
- Indigenous Construction Techniques.
- Local customs and Social Traditions also influence and mould vernacular architecture of a region. Thus there is a need to study social and cultural influence on built form.**(Susilo, 2010)**

The role of each of the above-mentioned four aspects in shaping the vernacular architecture of Kerala is discussed in the following section.

1.1.1. Climate.

Through the years, amazing skill has been shown by primitive builders in dealing with climatic problems, and their ability to use minimum resources for maximum comfort. One is repeatedly struck by the knowledge and discrimination of such builders in selection of sites and materials suitable to the specific local microclimate. The traditional requirements for placement on site and form which may sometimes have a climatic rationale often become too rigid, not allowing for adjustments of the model for specific local requirements. **(Rapoport, 1969)**

Figure 1: Location of Kerala in India. (**Source**: www.mapsofindia.com)

Kerala is situated at the south most tip of India between latitudes 8°.17'30"N and 12°.47'.40"N in the northern hemisphere and longitudes 74°.27'47"East and 77°.37'.12"East. (**Figure 1**)The mean daily temperature fluctuates from 26 to 27.5 degree Celsius over the course of a year. The mean daily maximum temperature ranges from 29 to 32.5 degree Celsius. Humidity fluctuates through a considerable range. For the same day humidity may range from 70-80%at 9 am and 50-60% at 6 pm. Thereby, humidity plays a major role in determining the strategies for achieving comfort. The tropical heat and humidity are the main guiding factors behind the climate-responsive design of vernacular dwellings.

1.1.2. Local building materials.

Limited materials and techniques, used to their ultimate, must be used to define place. Typically, under such conditions, builders will work up to the technological limits at their disposal. Vernacular builders are able to conserve their materials because they have detailed and precise knowledge of the behavior and characteristics of materials, not just in terms of climatic response and construction, but also in regard to weathering- how the materials and building fabric will stand up to the ravages of time and weather. Vernacular builders always use materials most conveniently available and often the nature of local materials determines form**. [3]**

The common building materials used for vernacular construction in Kerala are mud, laterite, granite stone blocks (in foundations), lime mortar, wood, bamboo, clay roofing tiles and coconut palm leaves. Clay is used in many forms - for walling, in filling the timber floors and making bricks and tiles. Palm leaves are used for thatching the roofs and for making partition walls. Timber, abundant in the state, is the other most important structural element used in Kerala.The natural building materials available for construction in Kerala i.e. stones, timber, clay and palm leaves have anchored and guided the acceptance or rejection of outside influences.

From the limitations of the materials, a mixed mode of construction was evolved in Kerala architecture. (**Figure 2**) The stone work was restricted to the plinth even in important buildings such as temples. Laterite was used for walls. The roof structure in timber was covered with palm leaf thatching for most buildings and rarely with tiles for palaces or temples. The indigenous adoption of the available raw materials and their transformation as enduring media for architectural expression thus became the dominant feature of the Kerala style.The availability of granite -a strong and durable building stone is restricted mainly to the highlands and marginally to some hilly zones. Accordingly, the skill in quarrying, dressing and sculpturing of stone is scarce in Kerala. Laterite stone however, is abundantly found as outcrops in most zones. Soft laterite available at shallow depth can be easily cut, dressed and used as building blocks. It is a rare local stone that gets stronger and durable with exposure to the atmosphere. Block of this stone may be bonded in mortars of shell lime; – the classic binding material used in traditional buildings.The major building material used was a locally available inferior variety of laterite stone, locally known as '*cheekkal*'. Timber remains the prime structural material abundantly available in Kerala, in many varieties – from bamboo to teak and rosewood. The skilful choice of timber, artful assembly and delicate carving of wood work for columns, walls and roofs frames are the

unique characteristics of Kerala architecture, using accurate joints. Clay was used in many forms – for walling, in filling the timber floors and making bricks and tiles after firing in kilns, tempered with admixtures. Palm leaves are still used effectively for thatching the roofs and for making partition walls. Along with mud walls it is still the poor man's construction material.

The unique features of Kerala's style of architecture are largely due to the peculiar features of the production materials obtained there. Abundant use of red bricks and wood are the essential features of native architecture. It is largely due to the use of these production materials that carpenters gained prominence in the domestic architecture in Kerala.

Figure 2: Varied typologies of traditional vernacular dwellings in Kerala.
(Source: https://en.wikipedia.org/wiki/Architecture_of_Kerala.)

1.1.3. Socio-Cultural Practices & Traditions.

The different forms taken by dwellings are a complex phenomenon for which no single explanation will suffice. All possible explanations are variations on a single theme: people with very different attitudes and ideals respond to varied physical environments. These responses vary from place to place because of changes and differences in the interplay of social, cultural, ritual, economic and physical factors. These factors and responses may also change gradually in the same place with the passage of time. However, shunning of rapid change and persistence of form are characteristic of primitive and vernacular dwellings. The influence of kinship and caste as the prime social influences can be seen in villages near Cochin in Kerala, and as a result the village here has little social unity. Caste distinction results in a low community spirit in these villages. The arrangement reflects the importance of religious sanctions and contempt for manual work. Only the rich landholders have substantial houses. Lesser householders and tenant farmers live in simpler houses of mud brick, while labourers, artisans, and most of the population, who have no group property and no internal cohesion, live in one-or-two room huts of mud, bamboo, palm-leaves, or straw.

In a typical settlement, the houses of the well-to-do Brahmins and Nayars stand apart, each in its own compound, loosely grouped around temples and ceremonial bathing tanks. The huts of the low caste artisans form one or more separate hamlets, while those of the agricultural labourers are scattered among the paddy fields. The houses of the Brahmans and Nayars are laid out according to the religiously sanctioned rules for that caste. The compound is divided into four sections by north-south and east-west lines. The house itself lies in the north-east part and is of four blocks around an open rectangular court, with a verandah on all sides. The west block is for sleeping quarters and stores, the north for kitchens and dining. The east and south blocks open to the court where visitors and guests are received. **(Susilo, 2010)**

Like caste prejudices, discriminations in the dwelling places according to the occupant's caste were also predominant in the past and some of the traditions continue till today. Each dwelling place is known by different names depending on the caste of inhabitants. The Blacksmith, the Goldsmith, the Carpenter and the Toddy driver inhabit in houses called *Pumor Kudy*. The temple servant dwells in a *Wariam* or *Pisharam;* the Nayar abides in a *Vidu* or *Bhavanam*, while the man in authority of their caste dwells in an *Idam*, the king resides in *Kottaram* or *Kovilakam*, the Namboodiri (The Hindu Brahmins) stays in an *Illam*, while his fellow of higher rank calls his house as a *Mana* or *Manakkal.* The analysis of Kerala's vernacular architecture shows how the living culture in Kerala include the non-hierarchical communal governance and acknowledgement of linear settlements, exterior living, and single hall multifunction house. Kerala's traditional-vernacular architecture enhances the discourse of eclectic architectural design before the western influence formalized colonization and its monopoly over the Asian trade network. The architectural designs of the period suggest an intermingling of cultures that happened ingenuously. Kerala architecture in general has shown cross boundary and multi-cultural architectural styles and gestures. **(Susilo, 2010)**

1.1.3.1. Social & Cultural influence on built form.

Given a certain climate, the availability of certain materials, and the constraints and capabilties of a given level of technology, what finally decides the form of a dwelling and moulds the spaces is the vision that people have of the ideal life. The environment sought reflects many socio-cultural forces, including religious beliefs, family and clan structure and social organization. The houses and the villages are symbolic of the fact that societies share generally accepted goals and values. Vernacular dwellings are more a result of the aims and desires of an unified group for an ideal environment. **(Rapoport, 1969)**

The culture and life that developed within some of the settlements were entirely different from those seen in the traditional indigenous settlements. The matriarchal system of family led to the joint family system, where the members of a family lived together under the same roof. In some settlements, the principle of living together and sharing each other's space got reflected in their planning of the settlements and it zoomed down into the architecture of their houses. Castes played a dominant role even in the selection of building site during those days. Kerala is known to have only three castes; it does not have the Vaisya (business) caste. Yet this idea seemed to be based on the narrations of Hindu agriculture tradition as a predominating living culture. These narrations did not consider the immense development of the coastal area which was developed by traders whose lives depended on maritime trading and fishing. They roamed the coast and river canals. Yet usually these people belong to a non-Hindu Malayali or foreign culture, such as Gujarati, Kongkani, Jewish, and Arab. Some of their settlements took alien forms different from the Kerala type, such as those found in Cochin and in Matancheri, Central Kerala. In the district of Kottayam there is a traditional strip of canal-settlement with a couple of rows of traditional-vernacular houses facing the river and the boulevard flanking both sides of the river. These strips mostly belong to traders and merchants who are Muslim and Christian Syrian. The house types are popularly considered Christian Syrian and perform the eclectic vocabulary of Kerala, Southeast Asian, and Portuguese styles. The seashore settlements, especially those around the ancient trading ports, show the most extreme eclectic features compared to those in inland Kerala**. (Susilo, 2010)**

1.1.4. Indigenous Construction Techniques.

Since the number of solutions, at least in principle, is limited, it can be said that every form of construction can be found in vernacular dwellings, including many innovative structural concepts**. (Rapoport, 1969)** Indigenous Construction Techniques, developed over years, by acquired and disseminated skills by locals, are also a deep-rooted component of the cultural influence on built-form of a region.

Due to the limitations of building materials, a multi modal approach of construction evolved in Kerala. Roofing is done using thatch or clay tiles (fish scale tiles and Mangalore tiles). The thatched roof demands periodic care as it has to be renewed every year; this consequently ensures the proper maintenance of the roofing system.Stone work was restricted to the plinth even in prestigious buildings including temples and palaces. The indigenous adoption of the available raw materials for architectural expression thus became the dominant feature of the Kerala style.The sculpturing of the stone was mainly molding in horizontal bands in the plinth portion (adhistans) whereas the carving of timber covered all elements - pillars, beams, ceiling, rafters and the supporting brackets.

Roofing was done using thatch or clay tiles (fish scale tiles and Mangalore tiles). The thatched roof demands periodic care as it has to be renewed every year; which ensures the proper maintenance of the roofing system. Roofs in Kerala houses reflect the outstanding features of shingle and bent roof construction. It reflects the logic of tropical sloping as seen in the shingle, hip, saddle roof and the span of eaves of the roof slopes. (**Figure 3**)Kerala's roof structures have three dimensional space frames. The basic structural elements consist of pairs of kazhukol (rafters) resting on an uttaram (wall plate). Pairs of kazhukol will meet on a montayam (ridge) to make the hipped roof. Pairs of kazhukol (rafters) would be bound by horizontal rods going through other pairs of kazhukol. This rod is called vala. Thus, the vala, kazhukol, montayam and uttaram become one unit of roof construction. The path of the vala determines the roof construction of Kerala houses as a three dimensional rigid space frame. Expressions of Kerala's roof construction include various designs of the pitched gable or mukhapu, especially in South Kerala. (**Figures 4 and 5**) The kazhukol-vala (rafter-rod) construction was originally a simple rope-tied construction which is usually utilized in humble bamboo huts. **(Pillai, 2006)**

Figure 3: Typical sloping roof of Kerala vernacular hut in coastal region nearby to Kanyakumari. **(Source:** author**)**

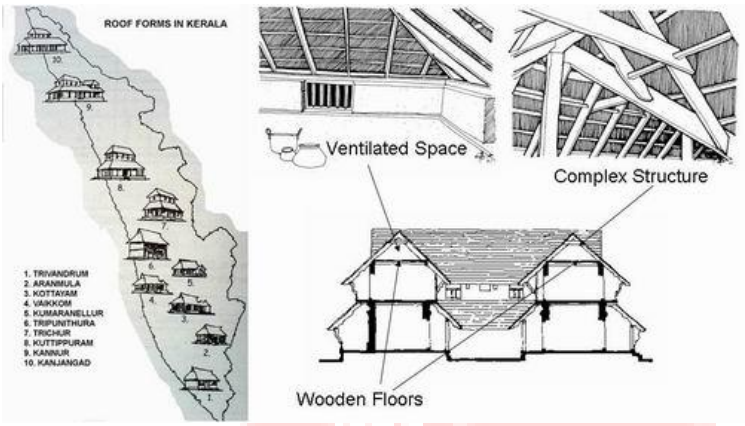

Figure 4: Different roof forms found across Kerala.
Source: Pillai, H. (2004) in http://www.archiestudio.in/. (Accessed in July 2016)

Figure 5: Roof of Padmanabhapuram palace, Kerala- a palace done in the vernacular style for the erstwhile ruling family of Kerala.
(**Source:**http://arkistudentscorner.blogspot.in/2012/01/padmanabhapuram-palace.html.)

2. Prevalent Architectural Styles of Kerala.

Kerala had developed its own housing concepts from time immemorial, which is unique in the sense that it is highly scientific, technical and adaptive to the environment.

The major styles of Kerala's architecture are classified into two major styles as mentioned below:-

- *Chatussala* and *Thravad* style.
- *Agraharams.*

The types of Traditional Houses can also be broadly classified into four types depending on the number of blocks contained in the dwelling:-

- *ekashala*(a single unit block)
- *dwishala*(an assemblage of two blocks)
- *trishala* (three blocks)
- *chatussala* (four blocks with courtyard)

2.1. Chatussala.

Chatussala is the most primitive form of Kerala house. *Chatussala* means the assemblage of four blocks with a courtyard or an edifice of four halls. The four blocks are individually called as *Dikshalas*, each oriented to a cardinal direction. They join together, enclosing a central courtyard or *anakanam* or *nadumuttam*, to form a *Nalukettu*. (**Figure 6)**

The free flow of air and the pressure system are vital in the designing of *Chatussala*. Similarly the triangular shaped roof follows the Pythagoras Theorem, whereby, the 3-4-5 arithmetical systems fulfill it.

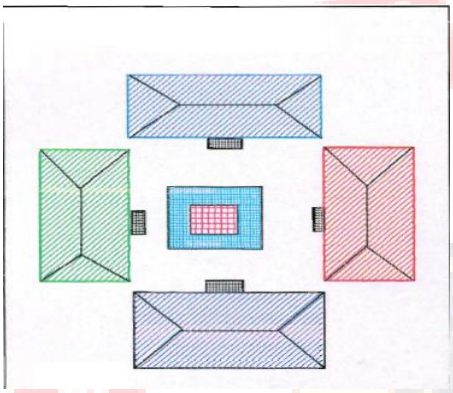

Figure 6: Chatusala planning. (**Source**: co-author)

2.2. Thravad Style

The traditional homestead in Kerala is the *'tharavadu'*, a complex built unit comprising of many sections with specific usages. It has evolved from the basic *Chatussala form.*The basic units of these houses were square or rectangular structures where four blocks are joined together with a central courtyard open to the sky. The four halls on the sides are named *vadakkini*(northern block), *padinjattini*(western block), *kizhakkini*(eastern block) and *thekkini*(southern block). (**Figure 7**)

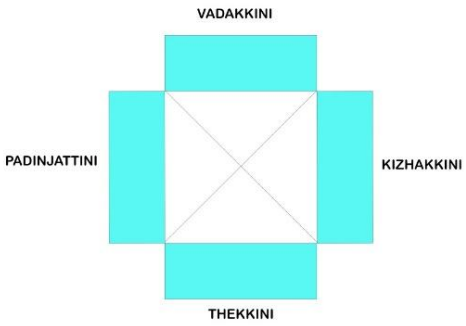

Figure 7: Different names of the blocks in Thravad Style. (**Source**: co-author)

Based on the number of courtyards, the Thravad Style House has been broadly divided into following three types as mentioned below:

1. Nalukettu-one courtyard with four blocks in cardinal directions.

2. Ettukettu-two courtyards with eight blocks in cardinal directions.
3. Pathinarukettu-four courtyards with sixteen blocked structure.

2.2.1. Nalukettu.

Nalukettu is the traditional homestead of Tharavadu where many generations of a matrilineal family lived. The four blocks are individually called as *Dikshalas*, each oriented to a cardinal direction. They join together, enclosing a central courtyard or *anakanam* or *nadumuttam*, to form a *Nalukettu*. The architecture was especially catered to large families of the traditional tharavadu, to live under one roof and enjoy the commonly owned facilities. Among those architectural strategies a few are, as follows: [**Source:** Choyimanikandiyil,K. (2018)]

1. That at the middle of the *padnijatini(western block)*, there will be the *pooja muri*(placeof worship) and '*nellara*' (room for keeping paddy).

2. On both the sides there will be two bed rooms *Thekkini* and *kizhakkini* are meant for receiving the guests.

3. *Vadakkini* is for cooking and dinning. (Kitchen and dining room).

4. In the middle of the structure there will be the central yard which will be in arectangular shape. '*Nadumuttam*' (central yard) will be useful for getting lightand air into the house.

5. Moreover there will be an underground cave for storing the rain water that falls in the '*Nadumuttam*'. **(Figures 8, 9 and 10)**

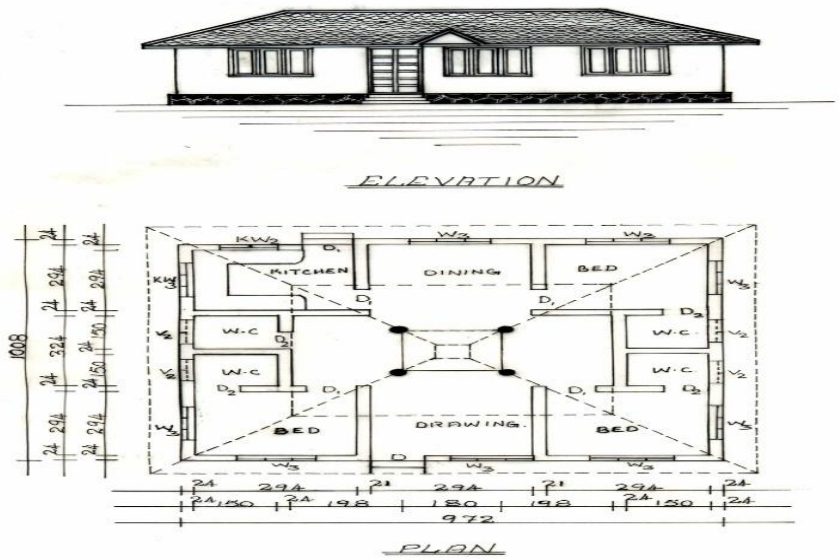

Figure 8: Elevation and Plan of a Traditional Nalukettu. **Source**: Adapted from Choyimanikandiyil,K. (2018).

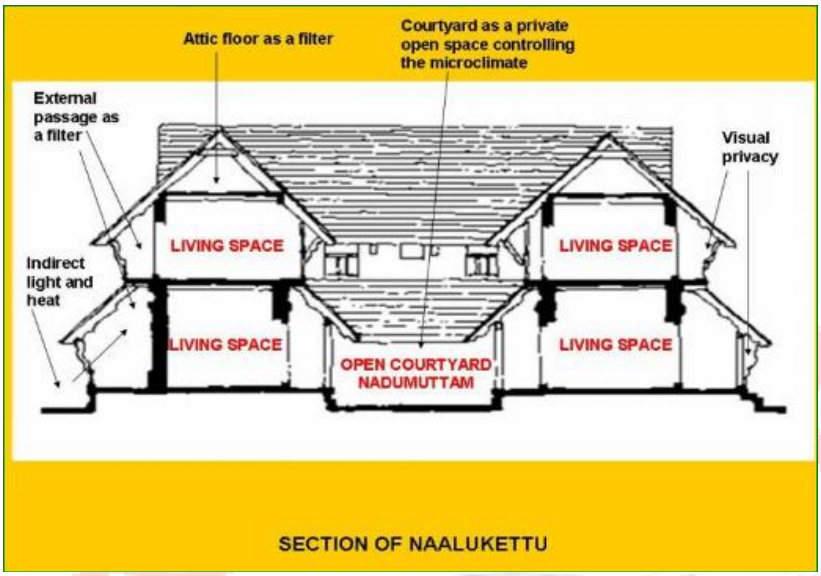

Figure 9: Section of a typical Nalukettu. **Source**: Pillai, H. (2004) in http://www.archiestudio.in/. (Accessed in July 2016)

Figure 10: View of a Nalukettu cluster. (**Source**: author)

2.2.2. Ettukettu

An '*Ettukettu*' is that which is joined by two '*nalukettu's*. An '*Ettuketu*' will have two *nadumuttams*. (central yard)For larger homes and wealthier families, there are more elaborate forms of the *Nalukettu*, called the *Ettukettu* (eight halls with two central courtyards). **(Figure 11) (Fuller and Narsimhan, 2010)**

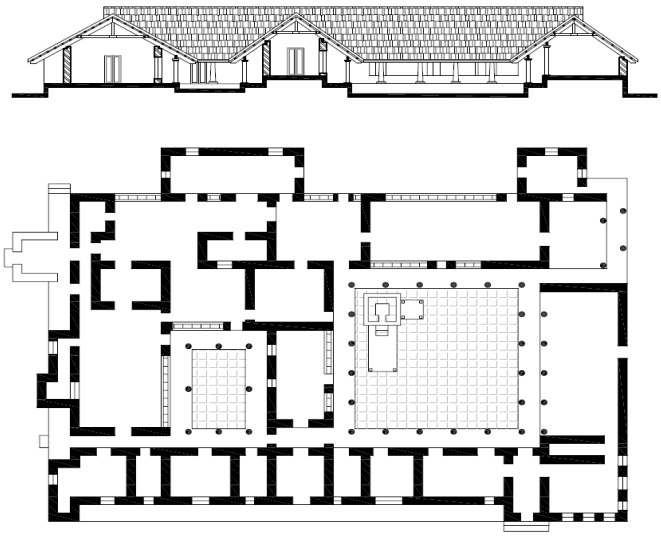

Figure 11: Elevation & Plan of a typical Ettukettu. **Source**: Pillai, H. (2004) in http://www.archiestudio.in/. (Accessed in July 2016)

2.2.3. Pathinarukettu

Pathinarukettu is elaborate buildings characterized by sixteen halls with four central courtyards. They belong to the wealthier people of Kerala including the royal families. (**Figure 12**)

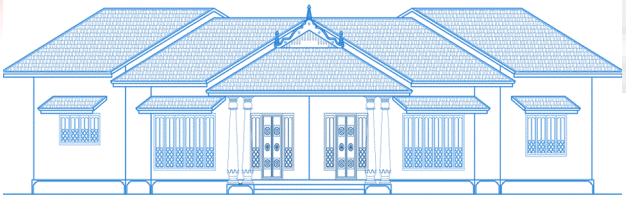

Figure 12: Elevation of a typical Pathinarukettu. **Source**: Pillai, H. (2004) in http://www.archiestudio.in/. (Accessed in July 2016)

2.3 Agraharams.

The *Agraharams* of Kerala is the standing vestiges of the history of a group of people who were basically Brahmins who had migrated to this land and made it their abode. The name originates from the fact that the *agraharams* have rows of houses on either side of the road and the temple to the village god at the centre, thus resembling a garland around the temple.

According to the traditional Hindu practice of architecture and town-planning, an *agraharam* is held to be two rows of houses running north-south on either side of a road at one end of which would be a temple to Shiva and at the other end, a temple to Vishnu. The

design and layout of the Brahmin *agraharams* are in contrast to the traditional architectural style followed in Kerala. **(Ayyappan, 2000) (Figures 13 and 14)**

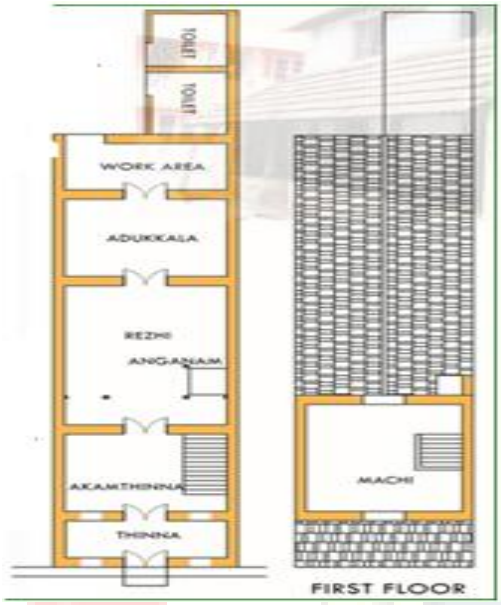

Figure 13: Planning of Agraharam.

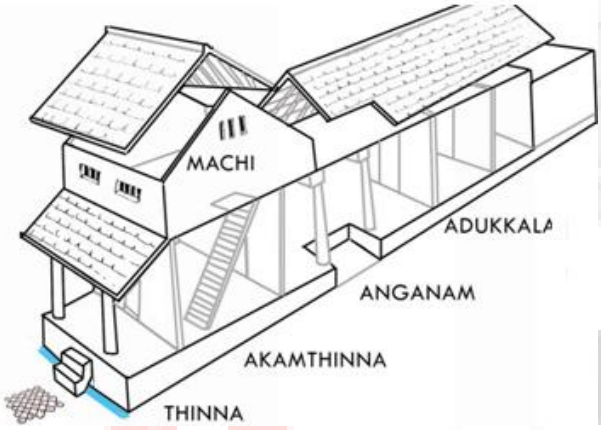

Figure 14: View of an Agraharam.

Source: (Fig 13 & 14): Ayyappan K.A. (2000).

2.3.1 Features of Agraharams. *(Based upon study done primarily by Fuller and Narasimhan, 2006 and later studies)*

- Followed a Linear Planning.
- Grid Iron Pattern or Concentric Ring- with temple forming the main focus.
- Rows of Houses – single or double storied – with traditional pitched roof form striking a significant profile against the sky.
- Narrow streets forming an integral extension of living space.
- Water bodies were always in the vicinity of the settlements as the Vedic life recommended.

The spatial planning of the *agraharams* follows a linear pattern with rooms arranged one after the other. The spaces inside have special purposes, and among them privacy of the occupants is of the least concern. The various components of the *agraharams* are the following:

2.3.2. Components of Agraharams.

1. *Puramthinna* – the long corridor/verandah running in front of the agraharams. This space also acted as a community gathering place where the men assembled for religious discourse.
2. *Akamthinna*– the small room next to *puramthinna*, this room incorporates the *konippadi*(stairway) leading to the upper storey.
3. *Rezhi*– this is the central room in an agraharam which acts as the living/bed room, the important religious ceremonies and rituals associated with the Brahmin community are also performed in this place.
4. *Thalam*– it is the space around the courtyard, the *homakundam*or the place for the sacrificial fire is located here.
5. *Mittam*– the courtyard is a part of the *rezhi* itself and often there is no separation between these two spaces.
6. *Adukkala*– this is the kitchen.
7. *Kuchil*– these are the rooms located at the extreme end, where the private quarters of the women are located.
8. *Machil*– *Machil*is the attic room. The stairway from the *akamthinna* leads to the *machil*. This room is assigned for the use of newly wedded couples.
9. *Kottil*– the independent structure located at the extreme end, it is often used as a cow shed or as storage space. (**Figure 15**)

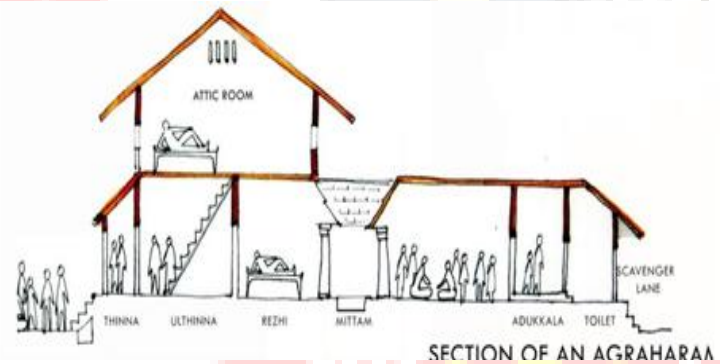

Figure 15: Typical section of Agraharam.

Source: https://peacocktrail.wordpress.com/2016/04/27/agraharam-kitchen-history-samayalkattu. (Accessed on December 2016)

3. Discussion: The various facets based on which the existing types of vernacular architecture are analyzed are as listed below. These facets are selected based on the general criteria which contribute to making a building functional, thermally comfortable inside and aesthetically good.

3.1. Site Planning.

The houses in Kerala have a pre-conceived notion as to the sites to be selected and rejected for the welfare of the inmates of the dwelling places. Lands having circular, semi circular and triangular shapes, hexagonal trident shapes, winnow-like shapes, land sites having the shape of the buttocks of fish, elephant and tortoise were totally abandoned by the locals of Kerala. Besides these, landholdings in which one end is wide and the other side tapering like the face of a cow; places where ash, charcoal, chalf of grain, bones, hairs, worms, etc., are seen or dug, land having termite hills, or caves, and soil having nasty smell and directed towards a comer are considered to be unacceptable for the purpose of a dwelling place.

The *agraharams* were usually following a linear planning, quite in contrast to the arrangement of rooms around the courtyard seen in the traditional Kerala houses. The planning and architecture of these two housing patterns have evolved over time taking into consideration various parameters like the local climatic conditions, availability of local building materials and the skills employed in construction.

3.2. Planning Principles.

The selection, orientation and location of the house in traditional Kerala concept were greatly influenced by the concept of *vasthu purusha mandala,* the methodin Indian tradition based on solar passive design and related geometric ways of spatial planning ,which formed the primary resource of Hindu architecture. According to *vastu,* the site is divided into nine *veedhis* or paths by concentric squares. The design and layout of the Brahmin *agraharams* are in contrast to the traditional architectural style followed in Kerala. As explained before, the settlement pattern followed by the traditional Brahmin settlers was guided by certain parameters like the social position of the community, their association with the temple and of course, the patronage of the royals. The linear pattern of *agraharams* cannot be overlaid on the *vasthu purusha mandala*.

3.3. Climatically responsive vernacular architecture of Kerala.

The planning and architecture of the vernacular housing patterns have evolved over time taking into consideration various parameters like the local climatic conditions, availability of local building materials and the skill employed in the construction. The courtyard houses of Kerala show a direct response to the climatic conditions of the place. In the hot humid climatic conditions of this region, the courtyard ensures easy ventilation. Traditionally, the sloping roof of the houses lets in a little sunlight to the interiors of the traditional Kerala houses; this is compensated by the presence of the large courtyard. The courtyard has some religious association too, as traditionally, the open courtyard in a Kerala house is considered as the '*deva sthana'* -the most sacred place assigned to the gods and hence construction is not allowed there. The presence of highly insulative building envelop for thermal protection, provision of verandahs for protection of external walls from solar radiation and the pitched roof for protection from heavy rain together are highly effective for a passive environment control system in Kerala's vernacular residential architecture. **(Chani, 2013)**

3.3.1. Various strategies for indoor thermal comfort in domestic structures of Kerala.

In the traditional vernacular house types, the roof is not exposed to direct sun for the whole day, whereas in terraced buildings, the flat roof is exposed to sun throughout. The permeable tiled roof cools down faster owing to its low thermal mass. The traditional roof system of the region consists of wooden rafters overlaid with Mangalore tiles over wooden ceiling. The enclosed attic space acts as insulation in itself improving the performance of the roof up to three times. Fish clay tiles, laid in an overlapping pattern also successfully modulate the indoor environment mainly because of the pattern of laying the tiles. Rain water drains off faster through the sloping roofs.

Walls are painted in light colors so that it reflects radiation. Walls have rough texture causing self-shading for walls. Openings are fewer towards the exterior and more towards the courtyard taking in less radiation and facilitating air circulation. The Traditional houses have smaller windows with wooden shutters which admit just the required amount of sunlight based on the function of the space under consideration. Convective heat gain through such windows can be ignored as outside ambient temperature are higher than indoor temperature during daytime. External verandah and internal courtyard protects the building from rain and sun. Roof slopes are inclined at an angle of 45 degrees and gables are provided at the ends of roof to enhance ventilation to allow warm air to escape. The walls made of porous laterite helps to cool the building. The thickness prevents radiation from penetrating. The clay plastering provides further insulation. **(Chani, 2013)**

The wet tropical environments of Kerala create typical architecture with the following characteristics:

1. Use of shingle roofs and protruding eaves as response to tropical rain, wind and other natural elements
2. Use of grilled windows and porous walls as response to tropical sun glare
3. Significance of the rectangular I-shaped building mass and,
4. Open lay-out living spaces. **(Dilli and Varghese, 2010)**

Classical Kerala architecture incorporates a bamboo frame topped with thatch or shingled terracotta tiles. Structurally the roof is supported by the pillars on walls resting on a plinth which is raised from the ground. This affords protection against dampness and insects in the tropical climate. Gable windows at the two ends of the home provide attic ventilation. This creates a ventilated, sandwiched space between the ceiling and the roof, which conducts heat away from the ceiling and in turn from the inside of the home. The flooring is made out of Indian patent stone, which is usually colored black to keep the interior space dark and cool. The home itself is built around a central open-to-sky courtyard space, which provides ventilation and light. The courtyard in a traditional Kerala home commonly features a shallow pool of water, which helps to cool the home by continuous evaporation under the hot skies. The differential heating of spaces creates ventilation inside the house by pulling cool air into the home. Most daily activities occur around this courtyard. The roofline projects out to shade the walls from rain and sun and also creates large shadows preventing direct sunlight on the home's walls. (**Figure 16**)

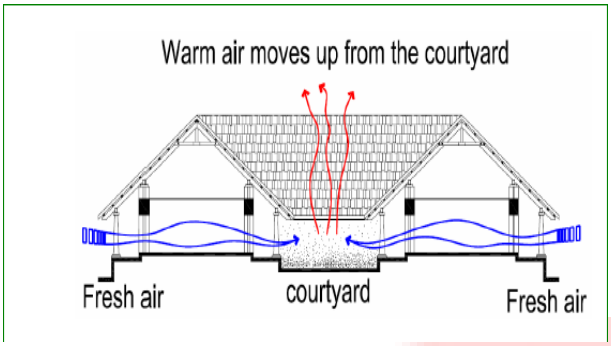

Figure 16: The influence of internal courtyard of Kerala traditional residential buildings in providing a comfortable indoor environment. **Source:** Dili, A.S., Naseer,M.A., Varghese Z.(2010).

Figure 17: Manifestation of vernacular architecture of Kerala in modern day residence. **Source**: http://www.vernarch.com/projects.htm

3.4. Aesthetics.

Kerala had developed its own housing concepts from time immemorial, which are unique in the sense that they are highly scientific, technical and adaptive to the environment. The location and the panoramic view of the site for the building and the surroundings of a Kerala house are exemplary. The outer gateway of a Kerala vernacular dwelling place is the first eye-catching sight of a person who visits such a home. It is constructed quaintly and neatly.

Roof systems of traditional architecture of Kerala complement the space system of planning through a complex and well articulated combination of material and construction system using timber as the main material (**Figure 17** above).

From a functional point of view it is observed that in these roofs wherever there is an attic space created above the wooden floor, the space is ventilated with floor level openings that allow fresh air to flow in, trapped by the overhanging sloping roof externally. This has the dual advantage of keeping the attic space ventilated, while removing the stack built up from spaces below, by promoting wind movement through convection to apex openings called '*mukhappu*' at the crown of the roof. In modern houses in Kerala often the entire roof proportions are replicated in the form of reinforced concrete sloping slab with traditional features but do nothing to take care of trapped hot air below the slab (**Figures 18 and 19 below**).

Figure 18: Traditional timber frame roof. **Source:** Pillai, H. (2004) in http://www.archiestudio.in/. (Accessed in July 2016)

Figure 19: Modern Day interpretation of the Traditional timber frame roof in concrete in Kerala. **Source:** Pillai, H. (2004) in http://www.archiestudio.in/. (Accessed in July 2016)

3.5. A Comparative Analysis between Chatushala and agraharams based on architecture attributes.

PARAMETERS	CHATUSHALA	AGRAHARAMS
SITE PLANNING	COURTYARD PLANNING WITH RECTANGULAR BLOCKS.	LINEAR PLANNING WITH ROOMS IN A ROW.
PLANNING PRINCIPLES	BASED ON TRADITIONAL INDIAN PASSIVE SOLAR DESIGN PRINCIPLES.	NOT BASED ON TRADITIONAL INDIAN PASSIVE SOLAR DESIGN PRINCIPLES.
CLIMATE RESPONSIVENESS	DIRECT RESPONSE TO CLIMATIC CONDITIONS.	MINIMAL CONSIDERATIONS WITH RESPECT TO THE ROOF.
AESTHETICS	ATTRACTIVE & EYE-CATCHING.	SIMPLE
BUILDING MATERIALS	TIMBER, GRANITE STONE BLOCKS	LATERITE STONE, MUD MORTAR.
INFLUENCE ON BUILT FORM	VARIED COURTYARD PLANNING BASED ON FAMILY SIZE.	INTROVERTED SETTLEMENTS-NOT TOO MANY VARIATIONS OF COURTYARD PLANNING.

Table 1: *A Comparative Analysis between Chautala and agraharams based on architectural attributes.*

It is seen from above comparison, that both chatushala and agraharams are based on traditional indigenous building materials. Also, whilst, the chatushala are more responsive to traditional Indian passive solar design principle agraharams are not so. Also, the planning typologies followed in both the above differ and so do their overall building aesthetics as pointed out in the above table.

4. Conclusion: Lesson learnt from tradition to take forward.

Traditional Indian way of living was inherently energy cautious. A multi-faceted life-style with strong linkages to the environmental and climatic context, appropriateness of materials and technologies used, and functional distribution of space clearly depicts the energy consciousness prevalent in the society. Many of the traditional features are replicated in some modern buildings, but the functional utility of the buildings are lost while replicating them. Traditional materials and techniques can be analyzed in terms of energy consumption, in future studies. The Vernacular strategies in existence in Kerala, irrespective of the fact that not much quantitative studies have been done in the field, possess immense potential in this regard and need further research to make energy efficient strategies and materials available at reasonable cost. There is also need to create awareness among people and adapt their aesthetics sense in a more culturally-contextual and nature appropriate way. Architects should take lessons hidden in the vernacular architecture of Kerala and works towards incorporating the beneficial vernacular elements in contemporary buildings, in form, cultural essence as well as in function. Appropriate planning devices like courtyards, suitable orientation, envelope design, responsive roof design and appropriate fenestration design should be employed. (**Figure 20**) Stress on locally available materials without major modifications in their organic states along with encouraging the use of local crafts and skills should be done.

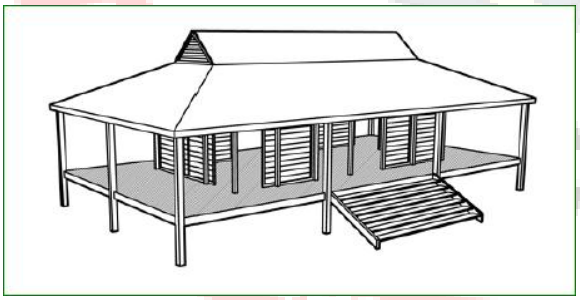

Figure 20: Traditional homes in warm-humid climates using light-weight construction with openable walls and shaded outdoor porches, raised above ground.(Drawing generated by climate consultant software.) (**Source**: www.climateconsultant.com)

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