MAJOR FINDINGS, CONCLUSIONS AND SUGGESTIONS OF THE RESEARCH
6.0. Introduction

This chapter aims to discuss the major findings of the study in view to develop suggestions for updating traditional techniques, local technology and modern engineering to develop sustainable cost effective techniques in rural housing.

Part A of this chapter discussing about the major findings of the study in three subheads such as;

1. Current scenario of rural housing in Kerala

2. Findings of traditional house survey and;

3. Findings from the assessment of traditional books on Vāstuvidya.

Part B of this chapter discussed about the suggestions derived from the assessment for updating traditional techniques and local technology. It also discusses the suggestions for modern engineering towards the cost effective techniques and methods derived in the assessment.
6.1.1. Current scenario of rural housing in the study area.

Ernakulam district is the economic capital of Kerala state has its own uniqueness than other districts of Kerala. The modern trends become immediately absorbed by the people who reside in the cities and also reflect it in the rural area more or less similar period. The rural people also adopted the changing trends in construction sector, even though, the traditional building science (Vāstuvidyā) occupies a significant place in the contemporary residential building practices. Incorporation of traditional building traits is an unavoidable part in the very beginning stages of construction process. The orientation of the building, positions of different rooms and utilities, perimeter measurements of the whole construction, etc. are depends much on the vastu principles.

The major findings of the study on current scenario of rural housing are as follows.

- In the surveyed houses 70% of the building constructed during the period of 2008 to 2010 and remaining 30% houses built in between the years 2011 to 2014
• Majority (45%) of the houses came in the category of 1001 to 2000 sq ft area. 25% of the rural houses have a built up area between 501 to 1000 sq ft and 20% have below 500 sq ft. Only 10% of the houses have the built up area above 2000 sq ft.

• The study reveals that 72.5% of the houses constructed with the consultation of a vastu expert before or during the period of construction.

• The study result shows that 72.5% of the newly built houses kept the basic principles of Vāstuvidya in design part.

• Majority (80%) of the house construction begins after the ceremony of stānam kānal by a well known stapati or a priest who is well known for the same.

• One important finding is that 52.5% of rural houses constructed after 2008 are designed by engineers and other 47.5% by somebody else including vāstu practitioners.

• 87.5% of the foundation of the houses constructed by using rock (pāra stone) which is locally available by local mason. Only 7.5% of
the foundations are RCC pillars and other 5% foundations by laterite which is also locally available.

- A good majority (88%) of the rural houses are built using modern materials such as cement, iron, metal sheets and RCC roofs.

- Only 12% houses are used wood and roofing tiles alone for roofing.

- The opinion of the rural people that, even though the cost of roofing in traditional materials are less than RCC roof the current trends and security reasons they are selected RCC for roofing.

- The conclusions from the interview with different category of people involved in the current house construction reveals that even though the drawbacks and higher level cost incurred in the prevailing techniques and materials they are not ready to change their mind set and accept the traditional techniques and materials as well. The statuesque within the society, security reasons and easy availability of imported materials etc are the reasons behind it. The privacy factor also discussed by many.

- Majority of the house owners asking the possibility of cost effectiveness with the key persons but finally only few of them select
the cost effective methods. The methods developed by Lauribecker and Nirmithi Kendra got attention earlier but the current scenario not accepted the same due to many reasons. The cost of burned bricks becomes very high and not affordable. The cost of skilled labour in these techniques also high and the drawbacks of already constructed houses etc are the reason.

● Thus it is clear that there is a need of cost effective techniques and materials but the alternatives are not matching with the needs of contemporary rural housing.

● Thus a cost-effective technology should be met the qualities of social acceptance, cost reduction, security and other requirements may only accepted by the rural house owners.

● The other factor is even if the modern engineering and materials are very familiar and accepted a good majority of them including the traits of Västuvidya in their houses. Thus an alternative from tradition can easily be accepted by the rural folk.
6.1.2. Major findings of Traditional House Survey

A detailed study on the traditional houses existed considered as the important part of the study. The findings from the traditional construction method are an added input to develop the strategies and techniques possible in the contemporary rural housing.

A total number of 40 houses constructed at least 30 years back from AD 2014 had surveyed by the scholar to find out the cost effective methods adopted. These houses are constructed using locally available raw materials rather than the imported materials. The houses constructed by locally well known masons and supported with carpenters and viswakarmas. The major findings are as follows

- 57.5% of the surveyed houses were constructed 30 to 40 years back, 30% of the houses constructed 40-50 years back and the remaining 12.5% of the houses constructed more than 50 years back.

- Majority of the houses are in ekasala that constitutes 80% of the total houses. Two faced houses come to 7.5% and 10% are nalukettu model. Only 2.5% that is 1 sample is surveyed in trisala type
A good majority (85%) of the houses is single storied and only 15% of the surveyed houses are multi storied model.

70% of the traditional houses serve its intended purpose of housing. Another 17.5% of the houses are using as a second house or storage space because they have built new houses in the same property.

Traditional houses are still capable to serve its residents well and this alone proves the cost effectiveness of the houses built by using traditional techniques and materials.

80% of the houses are constructed after a thorough examination of site selection process as per vastu guidelines.

95% of houses oriented in to a particular direction as suggested by Vāstuvidya. In that the detailed analysis shows that 84% of the houses are oriented to east or north direction, which help the right utilization of the energy sources available in the location.

85% of the buildings kept a better perimeter recommended by Vāstuvidya.

80% of the rooms constructed in compliance to vāstu measurement system. Another 12.5% of houses kept the measurements partially.
• A good majority (95%) houses roof top is constructed by wood and roofing tiles.

• 57% of the houses have basic structure as the method of *thaippura* in the main structure and extensions to sides for utilities. This reduces the cost of construction.

• A total 60% houses were altered or extended during the usage. In that 35% houses altered the utilities of the house without affecting the basic structure of the building and another 25% houses altered with addition in the built up area.

• The verandah in the front and back sides of the *thaippura* got multipurpose use in the earlier times but now some of them covered or partitioned and using as a hall or bed room etc.

• 65% of the foundations and 90% of the walls are constructed using laterite (*Chenkallu*) which was made available in the compound/locality itself.

• The major imported material used is cement which used as a binding or plastering material only which constitute less than 10% of the total materials used.
The concept of *thaippura* is a very good cost effective approach used in the traditional houses. The basic structure of the house is *thaippura*. The construction of *thaippura* is based on vastu measurements. The extensions to four directions become cheaper than the *thaippura*. But all other utilities could be attached to this main structure. The first floor construction in multi storied houses is built only in this main structure.

The site selection process of majority houses were done as per vastu principles. It reduces the cost of construction in a way.

The materials used for construction were from the locality itself. The laterite quarried from the locality or from the same land, the timber collected from the locality or from the same land. The mud used as binding materials was also from the same land. Only roof tiles and plastering cement is required to collect from some other sources. Major expenses for construction were met from local resources. The doors and fittings are mainly constructed using timber which is also available locally.

Some incorporations such as chimney, attached bathroom etc in later also provides opportunity to the additions as per the requirement of the ages going on.
All the materials can be recollected without having much breakings or damages and can reuse for construction purpose. The thus reuse of the traditional materials are possible and currently there is a good market for the used materials. Now the owner will get more than the amount spent for the construction.

The concept of verandah is a good cost effective design for a residential building. A verandah is using as a sit out, prayer hall, in harvest time store area, when more people come- bed area, a common gathering area, self-employment area, etc. The multipurpose verandahs are now coming back to the contemporary designs of residential buildings.

6.1.3. Findings from the assessment of traditional books on Vāstuvidya.

Major Vastu texts such as Mayamatam, Manasaram, Brahtsamhita, Samaranganasutradara, Vāstuvidya, Manusyalayacandrika, Silpratna, etc are analysed with regards to cost-effective techniques. The vastu principles are analysed mainly in two dimensions such as 1. Design and techniques and 2. Materials suggested for construction.
6.1.3.1. Design and techniques

The design part is very important and critical for the cost effective construction of a residential building. The utility of a building depends on the effective utilization of the available space for maximum convenience and safety. It starts in the very beginning from the proper selection of the site for the construction.

6.1.3.2. Site selection.

The traditional building science promotes a set of methods and techniques for the selection of a suitable site for residential as well as other types of buildings.

The Nirikshana and Parikshana methods suggested by Vāstuvidya helped to find out suitable location to construct a home. A place having moderate climate, availability of enough water, ordinary vegetation, good characteristic of soil, cool climate, beautiful landscape, sufficient air, shape of square or rectangle etc. recommended by Vāstuvidya. When we find out a suitable site as per vastu techniques, will reduce the cost of construction and helps us to construct a sustainable building. The following are some cost effective advantages;
• Reduce the cost for basement construction both material and manpower

• High level strength and low risk to natural calamities such as earthquake.

• The orientation and slope of the land provides good energy flow and comfortable use of the building.

• Will get sufficient water, which is the basic requirement for life.

• The mud and timbers available in the land can be utilized for construction which will reduce the cost of construction.

• Khandavibhajanam provides opportunity to select the required area from big plots. This helps us to utilize the remaining area in future. This is a cost effective concept for utilizing available area in an effective way.

6.1.3.3. Vāstupurushamandala

Vāstupurushamandala provides an ideal opportunity to design a building according to Vāstuvidya. This grid is the basis for generating the form of a building. The Mandala is basically in a shape of square or rectangle. There are about thirty two types of mandalas discussed in the
major books. It consists 1 x 1 cell to 32 x 32 cells. Each cell is named with deities and given spirituality to give importance for positioning of different utilities to particular position in the grid. The whole madala should take for construction. The reduction from any one or two corners is not supported by Vāstuvidya. This is a cost effectiveness concept. The VPM helps to fix a cost-effective design with positioning of utilities in a systematic way. This will lead to generate a sustainable and cost-effective design to build a house.

6.1.3.4. Length-width ratio (Gunāmśavistāram)

The breadth to length ratio suggested by Vāstuvidya has to be discussed well in the cost effective analysis. The pada-adhika or sama (length and breadth equal) is suggested by Vāstuvidya and the padaña ratio, (length more than twice of breadth) shall be avoided. The rectangular plots and buildings are given priority for construction. Square also suggested. The proposed ratio should be between 1:1 to 1:1.5. If the ratio is higher than 1:1.5 it will reduce the area available for utilization and the required volume of materials become remain as same.
So let the analysis concludes that the principles of Vāstuvidya suggest cost effective methods from the very beginning design stage to the finite end of the house construction. And if we follow these principles we have to reduce the cost of construction and assure the sustainability of the building.

6.1.3.5. Materials as per vāstuvidya

The cost effectiveness of that particular material/s depends on the availability and suitability of that material/s with the consideration of its workability, strength and durability and which leads to the selection of that particular material for construction.

Depending on the material used for the construction the buildings are classified in to Suddha, Misra and Sankirna.

- *Suddha* means pure with using one type of material

- *Misra* means using two or three types of materials

- *Sankirana* is using different types of materials.

The cost effectiveness of a buildings is highly depends to the selection and use of materials. The traditional building materials are broadly classified in to five categories. Such as stone(*Sila*), timber(*Daru*),
mud (mrt), mortar(sudha) and metal (loha). When we compare the modern building materials some more additions developed in the material categories such as plastic, glass etc but its uses are limited to interior/finishing modifications only.

6.1.3.6. Stone (sila)

Kalllidal (foundation stone laying) is one of the first and important rituals related to house construction in Kerala. This alone explains the importance of stone in the construction process and the place of stone among the materials using for construction.

In Kerala stone is extensively used for the construction of residential buildings both the sub structure and super structure. There is no other cost effective material using/innovated to substitute stone till date. The cement blocks using the blend of rock products and cement also costs equal to traditional materials. The stone both rock and laterite are locally quarrying and available in major parts of Kerala and still continuing as the cost effective material for structure.
6.1.3.7. Mud as a raw material for rural house construction

Mud can also be considered as a primary construction material for building houses since it is ubiquitous (present everywhere) and almost free. We have an unbroken tradition of architecture that stretches over 4,000 years. The largest number of houses in rural India is still build with mud. Most of these houses have been built by those who live in them, with the assistance of persons skilled in the use of mud as a building material. The construction of mud houses begins first with the process of selecting the soil and the location/site of building proposed and describes how to arrive at the best possible site and clay. The Vāstuvidya provides a series of different and very simple tests by which an average person can check for himself whether a particular soil is appropriate for the purposes of construction or not.

The traditional technology provides various methods for testing the quality of mud. The following are the traditional testing methods which are relevant till dates and cheap compared to any modern testing methods.

There are methods available which use stabilizers to help stabilize weak soils. Even though the selection criteria discussed above to find out
best quality mud for construction the traditional science provides various methods to treat the mud for proper use before construction which is also cost-effective with modern techniques.

The use of mud in housing and construction projects leads to enormous cost savings, not just for the individual developer, but for the country as well. Mud construction requires only locally available resources like mud and water which are available at little or no cost. Mud housing is also a centuries-old phenomenon, while modern housing using modern materials is not even a century old. The principles of construction are simple to explain and the techniques equally easy to work with.

The assessment of cost effectiveness compared to traditional and modern substitutes shows that the mud is still a cost effective construction material in majority of the criteria taken for consideration.

6.1.3.8. Cost effectiveness of Wood/Timber

The traditional science supports the maximum use of timber for constructing a home. The assessment of roof proves that in Kerala the timber was extensively used for construction since it was a local material and plenty availability. Now the cost of timber becomes little bit high as
now it is an imported material in Kerala context. But there are chances to get timber from the locality itself and possibility of using various kind of timber based on the availability.

Timber used in many parts of house such as pillar, door, windows, utharam, ceiling, roofing skeleton and even as wall structure and flooring material.

The cost of timber comes to RCC if it is fully purchased and assures minimum quality standards. If it is available in the locality or in the land itself the cost of construction comes to very low.
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6.2. Suggestions for updating traditional techniques and local technology

As analyzing the findings of the research there are opportunities to develop suggestions and alternatives to the modern construction scenario in focus of cost-effective housing, especially in rural areas.

Majority of the rural people seriously looking in to cost-effective techniques but very few of them practicing the methods due to socio-cultural, safety reasons and lack of confidence.

Even the most modern technologies and developments occurred in the field of construction, a good majority of the rural house owners considered the basic principles of vāstūvidya and we have to take this as an opportunity to develop confidence of those who wish to construct a house and to meet the socio-cultural hindrances to adopt cost effective techniques.

If we prove that the traditional building materials are still equal or more sustainable than the modern substitute’s through quality examples and also provide necessary propaganda and develop sufficient skilled
labours. The treated mud can easily substitute with cement using as 
binding material as well as plastering material. We can also use cement mixed mud for the same.

Regarding the use of timber, we have to prove that it is very good 
cost effective material even though it’s cost near to or equal to RCC roof.

The traditional roofing using leaves and grasses are also recommended for temporary and short term construction.

Even though the availability of land as per vastu suggestions difficult in the current scenario, those who purchase a new land they have to keep vastu principles which supports the cost effective approach.

We have to include many of the cost effective approaches in the 
design part because majority of them at least have a discussion on vastu. But the vastu expert who provides suggestion also needs to be well aware of the cost-effective aspects. Thus an initiative in this regards to be required.

The traditional methods and materials are eco friendly and reusable and less energy intensive which shall be prompted well to keep our enviourment life supportive and safe.
As the study reveals that the current building scenario not accepting the recently developed low cost construction techniques and substitutes, a sustainable cost-effective methodology only can tackle the real issues in rural housing.

6.3. Opportunity of further researches

As this is an assessment of current and traditional building techniques it has used explorative and descriptive methodologies to reach the objectives of the study. Thus there is a vast opportunity of experimental research through which we can experience the real output.

The area is vast and the in depth study on certain areas such as, techniques of construction using wood in each steps, Ayadisadvarga etc., are to be provided opportunities for further research in this regard.

Further studies on the socio-economic approach on the attitude and concept of people, possibilities of developing a cost-effective and sustainable approach among rural people etc., also to be initiated. Further researches including experimental researches with a view to include possibility of incorporating modern techniques based on the requirement of the period shall be initiated.
6.4. Conclusion

The finishing outlook using mechanization and high level energy intensive imported raw materials and its popularity in the current building scenario is of course a threat to substitute traditional low energy intensive materials and techniques. The changing concept on housing, trend on materials and attitude of people will also increase the depth of the issue. But this can be definitely shifted as an opportunity to incorporate the traits of our traditional building science because the traditional building techniques uses low energy intensive materials and cost-effective building method in relation with the major cost-effective criteria adopted.

The research findings supported the hypothesis that there is a vast opportunity to incorporate the traditional techniques for the construction of houses especially in the rural area to reduce the cost of construction and improve the quality of living.