Summary

The persistence and growth of poor shelter conditions, particularly in the developing countries, is a worldwide stumbling block to socio-political stability and economic development (UNCHS, 1990). The causes and nature of these problems differ from country to country, depending on local social, economic and political contexts. The multidimensional nature of this issue has been the focus of this research and addresses the following main question within the context of Kerala (India).

*How to develop an integrated framework to analyze (both for the evaluation of policy and building process) the housing problems of the poor (from their own perspective), and which sustainable materials or technological options could be suggested along with policy recommendations to achieve sustainable-affordable housing in Kerala?*

This thesis integrates different perspectives to understand the housing problems in low-income countries, and to develop improved strategies leading to sustainable-affordable housing. These perspectives combine a technological view, mainly concentrating on building materials, with non-technical aspects such as the socio-cultural view of the beneficiaries, the economic aspects of the building process, and policy aspects as seen from a government perspective. This research combines conceptual analysis, tool development, technical analysis and innovation in such a way that it has both theoretical and practical relevance.

These objectives have been approached and achieved by addressing a number of subquestions. The succeeding sections summarize this under five heads.

1. **Housing issues: a framework for conceptualization**

*How can the housing problems be evaluated from the perspective of the users, in such a way as to contribute to sustainable development?*

![Figure 1 Basic concept for sustainable-affordable housing](image)
Sustainable-affordable housing development has been conceptualized as a combination of four equally significant aspects of sustainability, namely socio-cultural, economic, technological and environmental (Fig. 1).

Social and cultural factors determine the primary requirements of housing. The financial capacity or affordability by an individual or family has the immediate effect of transforming this need or requirement into a sound reality. Technology acts as a catalyst to help realizing this, by providing affordable options suiting individual requirements and changing circumstances. The environment is the carrier of the above and should be sustained for future generations as well as accomplishing present demands. This framework is a modification of the three pillar concept of sustainable development (UN) incorporating an additional technology factor. Sustainable-affordable housing for the poor can thus be defined as “housing which is accessible and affordable to satisfy the housing needs of people whose income does not enable them to afford their housing suitable to their needs in the formal housing market, having a minimal impact on the environment”.

A hard-core policy framework is inevitable for the efficient working of implementation systems, optimizing limited resources and integrating the demands and requirements of various actors in accordance with changing circumstances. It is also essential to create a ‘pull’ from the side of beneficiaries rather than being a ‘push’ from the authorities in achieving the development of sustainable housing. The conceptual framework for sustainable-affordable housing developed in this thesis is a combination of these objectives and strategies for sustainable-affordable housing.

The ‘objectives for sustainable-affordable housing’ have been defined using a methodology resembling that of Value Focused Thinking (VFT). It helps in identifying the needs of the households from the perspective of households based on the principles of sustainable development. The objectives were used to construct an evaluation framework, which have been applied and tested within the context of Kerala for the evaluation of housing issues. Based on the analysis and evaluation of the Kerala cases, strategies are formulated in accordance with the requirements of sustainable-affordable housing.

2. Evaluation of public housing schemes: Kerala

What were the various policy approaches in the previous years in India (Kerala) addressing the shelter problems of the poor and how far have the different schemes been successful in achieving sustainable housing development and what is the real housing situation of the poor households in Kerala?
The housing situation in Kerala is quite different from other parts of India. Despite the positive trend (diminishing quantitative housing deficits) in the housing conditions, a close analysis shows that the poor and lower segments in society often do not get the necessary assistance for the actual construction and completion of houses. Visible slum-like areas occur in human settlements in rural parts of the state, with many inhabitants still deprived of basic facilities like drinking water and sanitation. Though the poor manage to get support, government sponsored projects often fail to meet the initial goals.

The review of the evolution of the present housing policy in Kerala reveals a reflection of global policy changes during the corresponding periods, but with minor modifications to cope with the interests of political leaders and policies of the respective governments. State government intervention in public housing was pioneered by the launching of the so-called One Lakh Housing Scheme (OLHS), with the role of the government partially as a ‘provider’ of public housing (Phase I). Even though by that time (1970s) the International agencies that were constantly advocating public housing had already shifted their focus from this approach, the government of Kerala promoted this with a few modifications.

The housing schemes implemented during the Fifth Five Year Plan (1974-79) addressed the issue of rural housing. The basic principle of shelter provision under this scheme can be said to be one of ‘aided self-help’ (Phase II), whereby the government selects the potential users (beneficiaries), arranges for financing and administrative procedures, and the users provide the entire or part of the labor input. This new shift in policy was in line with the international policies based on aided self-help and mutual help marking the second phase.

The 1990s witnessed significant changes in housing policy. The National Housing and Habitat Policy of 1998 addressed the issues of sustainable development, infrastructure and strong public private partnership for shelter delivery. This was a true mirror image of the whole sector development concept of UN and World Bank (Phase III). In 1996, with the decentralization movement, local governments started getting involved in different development activities in Kerala. The ‘Total Housing Scheme’ (1998) was introduced during this period with the concept of whole sector development with the local or self government as the implementing agencies.

Three government housing schemes [One Lakh Housing Scheme (OLHS), Indira Awaas Yojana (IAY) and Total Housing Scheme (THS)] were identified for detailed evaluation on the basis of their representative nature in policies with those of the international agencies, their uniqueness in implementing agencies and other particular characteristics (Table 3.3, chapter 3).
The sustainability analysis has been carried out in three stages (from different perspectives) using the criteria derived from the conceptual framework. The first stage of analysis (Analysis I) has been done to evaluate the goals of the government programs and the second as well as the third stages (Analysis II and III) to assess the real situation of the beneficiary households. Analysis I is based on information provided by government reports and government officials. Analysis II has been done based on the researcher's observations from the field, and Analysis III based on information from household surveys. Fig. 2 (a to d) presents the results on various aspects of sustainability of the selected schemes based on the analysis. Irrespective of the different policies of the government, the representative schemes selected for evaluation from each phase of policy do not show significant differences between the end results, and all of them seem to have partially failed in achieving their goal of sustainable housing.
The mismatch between the perceptions (goals) of government and the real situation of the beneficiary households (results) is clear from the evaluation. This shows the ineffectiveness of the different policies and need for effective policies for proper implementation.

In general the evaluations show that Analysis I (from the perspective of government) is systematically more positive than the evaluations by the researcher and the beneficiaries (Analysis II and III). The evaluations show the lack of integration of the four main aspects of sustainable-affordable housing, namely socio-cultural, economic, technological, and environment factors and how it has contributed towards the failure of implementation strategies. The overlooking of socio-cultural and environmental factors in the housing programmes, poor accessibility to resources, improper awareness of the building process as well as the availability of innovative technological options, and insufficient basic services are identified as the main obstacles for the poor households in Kerala. The low affordability by the households and lack of consistent income further added to their problems.

3. Evaluation of present building process: Kerala

*Does the present building process in Kerala contribute to sustainable housing? If not what are the recommendations for modifying it?*

An evaluation of a selection of sustainable building alternatives suitable to the requirements of Kerala was carried out using the conceptual framework. A grading of basic building materials and popular technological options based on embodied energy was also done to add a semi-quantitative refinement. Basically this grading only plays a decisive role when two alternatives score equal points in the comprehensive analysis to make the most appropriate choice. The outcomes of this evaluation acknowledge the traditional building technology with laterite walls, Mangalore pattern tile roofing, and mud mortar as the most sustainable technological options for affordable housing in Kerala, where laterite is locally available. Locally produced hollow concrete block masonry is suggested as an alternative technological option to replace laterite in other places. These findings illustrate the sad failure in implementing cost-effective and environmentally friendly (CEEF) technological options in Kerala compared to the market success of the prevailing ‘modern’ energy-intensive building process. It leads us to the conclusion that none of the technological alternatives can be feasible in practice, if they have not enough support and acceptance from society.
The evaluation of the building process in Kerala underlines the need for
- the popularization of the cost-effective and environmentally friendly technology alternatives and dissemination of technological innovations through proper strategies.
- the demonstration of technological innovations to the public so that they can experience the advantages.
- the formation of stakeholder groups including technical experts to deliver environmentally friendly technology and post delivery services to ensure proper implementation and usage of new innovations.
- innovative technology options, which demand unskilled, labor, renewable resources and decentralized production.

4. Rice husk ash pozzolana as a sustainable alternative to cement

How can rice husk ash pozzolana be developed locally as a sustainable alternative to replace cement for the primary building applications in Kerala?

The search for new environmentally-friendly affordable materials has led to the experimental research on the pozzolanic activities of rice husk ash (chapter 6). It has been done to explore the possibilities in the production of a reactive pozzolana in rural environments with minimum infrastructure and utilizing the limited skills of poor households. An in-depth characterization of rice husk ashes has been conducted as the first phase of this experimental technical research to identify the optimum conditions for producing a reactive ash from rice husk. The rice husk ash produced after an incineration for 12 hours at 500°C and subsequent quick cooling by directly removing it from the oven is identified as the most reactive sample. This is in agreement with earlier investigations by Mehta (1978) and Hamad et al. (1981) who have identified the temperature range of 500°C to 700°C as optimum for reactive ash formation. At the same time, these findings disagree with a few other investigations (cited by Bui, 2001) regarding the formation of crystalline silica at lower temperatures. The present research thus makes a contribution in solving the dispute regarding the crystallization temperature of silica during the incineration of rice husk.

The second part of this experimental technical research was carried out to identify an affordable incinerator to produce reactive pozzolana for rural building applications in Kerala. Rice husk ash samples from three different types of field ovens were examined. We came to the following conclusions:
- rice husk ash samples from the annular kiln enclosure (RHA A) produced better results (higher mortar strength) in all the mix compositions compared with those from other field ovens. Therefore the annular type of oven is suggested as an affordable and simple option for the small-scale production of rice husk ash in rural areas. A modification of the annular enclosure with bricks instead of weld meshes
is suggested as a long-term solution considering the limited life span of weld meshes.

- rice husk ash pozzolanas from the brick ovens (RHA B) also gave reasonably good strengths with lime and cement in different proportions though those were inferior in strength compared to that from the annular kiln enclosure.
- the lower strength values of mortars with the ashes from the pit burning (RHA C) compared to the other samples can be due to a longer period of incineration and slow cooling rate. Reducing the depth of the pit can modify this arrangement to ease air supply and result in better ash.

5. Strategies and Recommendations for sustainable-affordable housing in Kerala

What policy recommendations can be proposed (particularly for the economically weaker sections) for sustainable-affordable housing so as to contribute to sustainable development?

Based on the evaluation, a number of strategies for the development of sustainable-affordable housing are proposed:

Policy measures for achieving socio-cultural sustainability:
- Stimulate participatory housing through involvement of households and with community support.
- Promotion of core housing concepts (basic units adaptable to changes according to future requirements) instead of rigid type designs.
- Fostering equality between citizens through careful neighborhood planning to allow the mixing up of different income levels of society in the same locality, and to ensure adequate infrastructure facilities and community services.

Strategies for economic sustainability should include measures to
- ensure steady income for poor households
- ensure accessibility to resources such as land tenure, supplementary loans, building materials, labor and infrastructure facilities.
- improve accessibility to credit services by promoting micro-finance institutions and flexibility in loan services depending on the needs of the household and their ability to make repayments.
- ensure a minimum level of housing facilities.

Strategies for technological sustainability should include measures to
- ensure timely guidance and technical supervision in the building process
- ensure the availability of materials and skilled labor
- empower the beneficiaries to acquire minimum skills for the building process
- promote technological innovations
- promote the use of renewable and local materials

Strategies for environmental sustainability should include measures to
- integrate basic infrastructure facilities as vital component of housing
- adopt proper regulatory measures for the conservation of agricultural land and against uncontrolled land reclamation, for clay mining, housing and other development activities.
- ensure conservation of resources through energy efficiency in household activities, alternate solutions for renewable energy, and by integrating rainwater harvesting methods.

The evaluation of public housing schemes in Kerala urges the need for efficient and effective implementation strategies, suitable for the socio-economic and cultural specifications of the state. It identifies the integration of the four aspects of sustainability as crucial for achieving sustainable-affordable housing. The involvement of all stakeholders in the building process including beneficiary households, the local community, non-governmental organizations, and the local government can strengthen the integration between these aspects.

Recommendations proposed are:
- an integrated approach in the overall process with support from a strong network of all the different stakeholders and institutions to achieve the objectives of sustainable-affordable housing.
- the formulation of a support mechanism ("Housing Support Organizations" similar to that of People's Housing Process of South Africa) for capacity building and to enable people to address their own housing needs.
- to improving the affordability for households, by ensuring a consistent income through empowerment or through facilitating income-generating activities.
- to ensure the technological sustainability in the building process
- to ensure basic infrastructure facilities and the conservation of resources