

# Research plan | Graduation Studio aE

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# Keywords

*The most relevant topics of the research, max 10 words.*

Vernacular architecture

Thermal comfort

Tropical climates

Biobased construction

Rural low-income communities

Energy efficiency

Bioclimatic design

# Problem Statement

Basic problem analysis covering the aspects: of context, program, and thematic focus. The definition of the problem has to be significant to a clearly defined area of research and design.

Vernacular architecture evolved from centuries of collective experience of people living in different climatic conditions. Thereby its designs involved the use of locally available resources and the cultural and historical background of people. Furthermore, it featured climatic and energy-conserving principles, that passively provided thermal comfort (Chadel et al., 2016). However, In the tropics, there is a gradual replacement of vernacular architecture by modern construction methods, both in urban and rural areas (Hashemi, 2017). Sustainable and local construction materials like adobe and thatched roofs are being replaced by environmentally damaging materials with low thermal resistance, like iron sheet roofs and concrete. Figure 1 is showing an example of construction materials changing in Uganda, which is representative of a global trend in tropical climate regions.

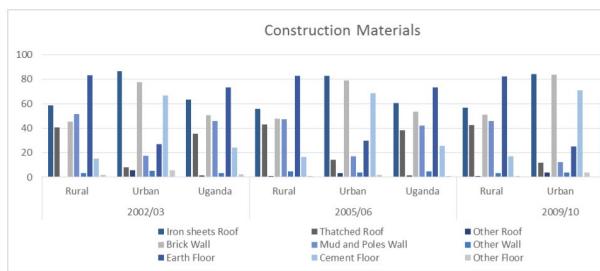


Figure 1 Development construction materials Uganda (Hashemi, 2017)

The abandonment of vernacular architecture in favor of modern conventional construction methods and materials is causing two major problems for an increasing amount of people. Firstly, by disregarding climatic and energy-conserving principles, inherent to vernacular architecture, people are experiencing an increasing amount of thermal discomfort in their dwellings. Modern construction methods

inadequately respond to the high solar radiation and relative humidity typical of a tropical climate.

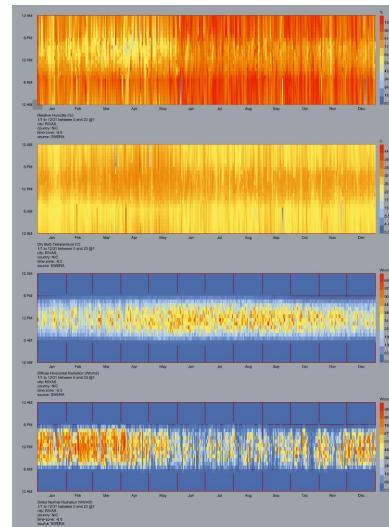


Figure 2 Characteristics of tropical climate (EPW data file)

This problem is only expected to increase in severity because of global warming. The average air temperature is expected to increase by 3–4 °C during the next 70 years, risking further deterioration of thermal conditions (Chadel et al., 2016). Secondly, the extinction of vernacular architecture is causing a greater dependency on Air Conditioning systems. This is contributing to the problem of thermal discomfort directly and indirectly. On a global scale, air conditioning systems are dramatically growing in popularity, especially in tropical climate regions their use is multiplying every year. It demands a growing amount of energy and increases CO2 emissions in the housing sector, which, in turn, contributes to the problem of rising global temperatures. But more directly, AC systems are paradoxically also creating thermal discomfort by over-cooling. The cause is attributed to the inappropriate use of thermal comfort standards, initially developed in and for the United States and Europe. The misjudgments of these standards led to constant thermal discomfort in tropical

buildings. The problem of thermal discomfort is negatively impacting residents' health and well-being. Thereby contributing to the sick building syndrome. Low-income people are most likely to suffer these effects because the majority live in low-quality homes and have little access to basic amenities (Chadel et al., 2016).

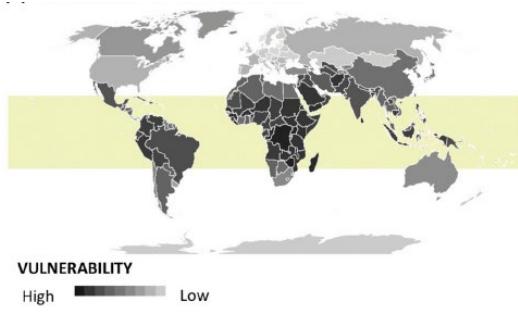


Figure 3 Vulnerability to climate change (Rodriguez & D'Alessandro, 2019)

There are multiple causes for the abandonment of architectural vernacular principles. The four major restrictions on the use of vernacular construction techniques according to a survey done by Chadel et al are economic status, trends

in construction, design problems, and the unavailability of masons. Further practical complaints like infestation by rodents, termites, plaster peeling, and frequent repair also play a part. However, excessive heat gain did not arise as one of the complaints. In the research of Chadel et al, the reasons were summarized: Vernacular techniques did not fit very well in present-day lifestyle and context (2016).

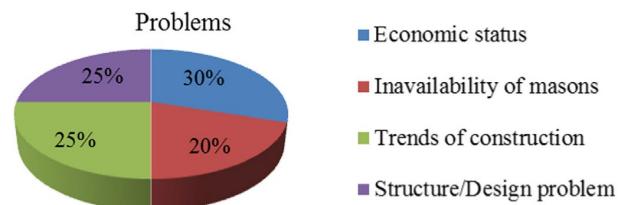


Figure 4 Problems of vernacular architecture (Chadel et al., 2016)

# Objective

*This section has to include what the intentions are of the graduation project and is therefore closely related to the problem statement.*

There is a general tendency to create an impermeable border between ourselves and the natural world. Architecture (and technology) has historically been a great tool to achieve this impermeability, but it has also given us insights into the consequences of this division. I see it as the role of the architect to create a more sensible border. To create a sustainable built environment that is better suited to its user's needs. In the context of this graduation project, it is my objective to

create a design for a fully biobased dwelling. The design will be informed by vernacular architectural principles from all tropical climates. Which will result in a more thermally comfortable dwelling that is meant to help rural low-income communities, because they are most vulnerable to the effects of climate change.

# Overall design question

Your overall design question should contain the following aspects: context, program, and thematic focal point. This should be formulated in such a way that the graduation project can answer this question.

To address this problem the following design question has been formulated:

How can **vernacular architectural principles** be re-integrated into the design of fully **biobased dwellings** for all **tropical climate** regions, to provide **thermal comfort** in **low-income rural communities**?

## 1. Vernacular architectural principles

The vernacular architecture will be analyzed according to the parameters that have the most effect on energy efficiency and thermal comfort: orientation concerning the sun, spatial planning, ventilation, sunspaces, construction material, and construction techniques. Resulting in the following sub-questions (Chadel et al., 2016).

1.1 How is *building orientation* been integrated into the design of vernacular dwellings in tropical climate regions?

1.2 How is *special planning* been integrated into the design of vernacular dwellings in tropical climate regions?

1.3 How is *ventilation* integrated into the design of vernacular dwellings in tropical climate regions?

1.4 How are *sunspaces* been integrated into the design of vernacular dwellings in tropical climate regions?

1.5 How are *construction techniques* been integrated into the design of vernacular dwellings in tropical climate regions?

1.6 How are *construction materials* been integrated into the design of vernacular dwellings in tropical climate regions?

Resulting in an elaborate amount of ways in which parameters have been used in the design of dwellings in the tropics.

## 2. Biobased construction methods/materials

Biobased construction methods and materials will be researched in three categories: wall infill, structural, and roof materials. This categorization is based on the fact that in a tropical climate solar radiation is disproportionately impacting the roof (Nguyen & Reiter, 2013). To inform the overall design question this division is made.

2.1 Which (new) biobased construction materials are used in the tropics?

2.2 Which biobased roofing materials are used in the tropics?

2.3 Which structural biobased materials are used in the tropics?

2.4 Which biobased infill materials are used in the tropics?

This will result in a list of methods/materials/references that can be used to inform the overall design question.

### **3. Tropical climate regions**

The Köppen-Geiger Climate Classification System will be used to characterize local outdoor climates. It is the most common climatic classification system and will form the basis for comparisons between different vernacular principles. It is based on vegetation and rainfall observations (Rodriguez & D'Alessandro, 2019).

3.1 What are the characteristics of a tropical climate?

3.2 What are the characteristics of a Tropical rainforest climate?

3.3 What are the characteristics of a Tropical monsoon climate?

3.4 What are the characteristics of a Tropical wet and dry or forest climate?

3.5 What are the differences between the different tropical climates?

### **4. Thermal comfort**

Thermal comfort will be assessed by using the adaptive approach. In this approach, the ability of people to adapt themselves to changing environmental conditions is accounted for. Resulting in thermal

standards and preferences that are better suited to a tropical climate and its vernacular building style (Ouedraogo et al., 2021).

4.1 How is the adaptive method used to measure thermal comfort in tropical climate regions?

4.1 What is the difference between thermal comfort in rural and urban areas?

### **5. Low-income rural communities**

The social economic status of people living in the rural tropics will be analyzed. The main goals of this research will be to provide insight into the commonalities and differences between people that live in a similar climate, but different geographical locations.

5.1 What is the occupation/level of income of people living in rural tropical regions?

5.2 What is the demographic of rural tropical regions?

5.3 What is the educational level of people living in rural tropical regions?

5.4 What are the different religions in rural tropical climate regions?

# Thematic Research Question

The thematic research question focuses on a specific aspect of your overall design question. Your thematic research question can be divided into several sub-questions that can all have their specific research methodology and can lead to different papers.

The thematic research question focuses on two specific aspects of the design question: vernacular architectural parameters and thermal comfort. The effect of the different parameters on thermal comfort is assessed through a literature review, case study analysis, and quantitative data comparisons. Which will result in a quantitative understanding of the extent to which the different parameters are improving thermal comfort.

The research question:

To what extent do **vernacular architectural** parameters improve **the thermal comfort** of dwellings in tropical climate regions?

The sub-questions:

1. To what extent does *building orientation* improve the thermal comfort of vernacular dwellings in tropical climate regions?
2. To what extent does *special planning* improve the thermal comfort of vernacular dwellings in tropical climate regions?
3. To what extent does *ventilation* improve the thermal comfort of vernacular dwellings in tropical climate regions?
4. To what extent do *sunspaces* improve the thermal comfort of vernacular dwellings in tropical climate regions?
5. To what extent do *construction techniques* improve the thermal comfort of vernacular dwellings in tropical climate regions?
6. To what extent do *construction materials* improve the thermal comfort of vernacular dwellings in tropical climate regions?

# Methodology

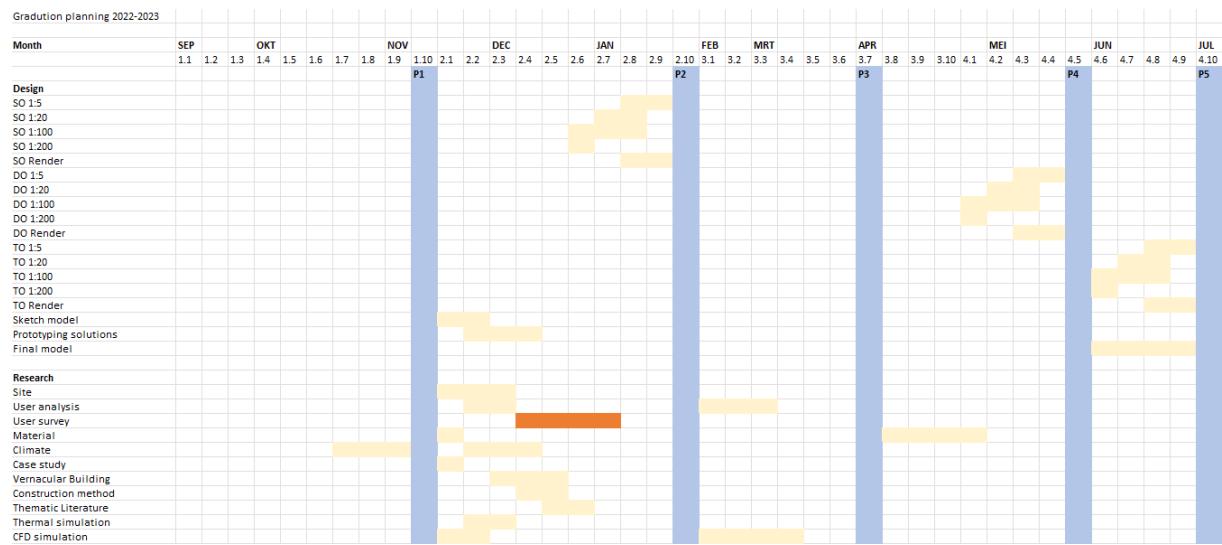
A description of the methods and techniques of research, which are going to be utilized. For example Literature study, reference analysis, research by design, etc.

To research the thematic research question, different methods are going to be applied.

Sub research question	Research Methodology
1. To what extent does <i>building orientation</i> improve the thermal comfort of vernacular dwellings in tropical climate regions?	Literature review, case study, quantitative comparison
2. To what extent does <i>special planning</i> improve the thermal comfort of vernacular dwellings in tropical climate regions?	Literature review, case study, quantitative comparison
3. To what extent does <i>ventilation</i> improve the thermal comfort of vernacular dwellings in tropical climate regions?	Literature review, case study, quantitative comparison
4. To what extent do <i>sunspaces</i> improve the thermal comfort of vernacular dwellings in tropical climate regions?	Literature review, case study, quantitative comparison
5. To what extent do <i>construction techniques</i> improve the thermal comfort of vernacular dwellings in tropical climate regions?	Literature review, case study, quantitative comparison
6. To what extent do <i>construction materials</i> improve the thermal comfort of vernacular dwellings in tropical climate regions?	Literature review, case study, quantitative comparison

# Planning

A scheme of the division of the workload of the graduation project in the 42-week timeframe. Compulsory in this scheme are the examinations at the middle and end of the semester, if required, the possible exams that have to be retaken. The submitted graduation contract might be rejected if the planning is unrealistic.



# Literature

The literature (theories or research data) and general practical experience/precedent you intend to consult.

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