University of Pécs

Faculty of engineering and information technology

Breuer Mercell doctoral school of Architecture

Sustainable Materials and Methods for Developing Refugee Affordable Core Shelters Performance

Ph.D. Thesis Booklet

Rojhat Ibrahim

Supervised by

Assistant Prof. Dr. Bálint Baranyai

Prof. Dr. Tamás János Katona

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1- Research Overview and Problem Statement:

The displacement issue of a large number of people is considered one of the continuous and major global challenges that individuals, societies, states, and even international and Non-Governmental Organizations (NGOs) nowadays are facing. Currently, most countries have suffered from migration issues due to having displaced people, hosting them from other countries, or spending too much on the subject within the international framework. The last report of the global trend in 2022 for the United Nations High Commissioner for Refugees (UNHCR) stated that the number of forcibly displaced people reached 103 million, an almost 60 million increase in one decade. The 2022 figure is equivalent to one forcibly displaced person for every 77 people living on earth. All this is due to violence, conflict, and persecution. Millions of people worldwide, such as Palestinians, Sahrawi, Rohingya, Kurdish, Afghan, and Somalian, have been displaced for decades and have lived in camps. More recently, the Russian-Ukrainian war in a relatively safe continent from wars and the recent earthquakes in Turkey and Syria indicate that the displacement issue and its causes are an unexpected challenge that could target any place.

Globally, the root causes of the continuous and increasing migration of masses of people are either natural disasters such as earthquakes, floods and droughts or man-made such as conflicts and persecution, ethnic and religious discrimination, economic and political instability, and demographic factors. Across the Middle East and North Africa (MENA), the main factor is more of a man-made rather than a naturally driven issue. Amongst the main causes of displacement in such regions is political instability driven by external intervention, internal armed conflicts, and ethnic persecution. These factors led a country like Iraq to be one of the world's major countries plagued with internal and external displacement. According to a 2022 report from the International Organisation for Migration (IOM), the Global Peace Index (GPI) rank for Iraq in 2021 is 159, and their passport index class is 109. Estimations show that there are more than 2 million Iraqi refugees worldwide, but fewer are registered. For instance, by 2022, the number of registered Iraqi migrants is around 1.125 Million in the United States of America, Germany, Turkey, Jordan and Syria, while there are more than 574000 asylum seekers by 2020. Also, UNHCR declared in September 2022 that there were more than one million Internally Displaced People (IDPs) besides 300 000 refugees.

Although many people have been displaced for more than 70 years and live in camps, conventional camps with temporary and inefficient transitional shelters have been the predominant approach in many countries. Consequently, such an approach greatly burdens refugees, host countries, international organizations, and the environment. Moreover, their short lifespan costs billions of US Dollars yearly.

There are several shortcomings, according to existing literature hence the bellow factors must be considered when aiming for sustainable shelters for displaced people, for instance:

- Upgrading strategies to prolong the lifespan.
- Affordability by host countries and displaced people.
- Sufficient thermal and air quality comfort performance.
- Minimum energy consumption.
- Socio-cultural aspects.
- Integration with local planning and design system.
- Minimum impact on the environment.

Although a considerable amount of research has been devoted to the displaced issue annually, there is a gap concerning integrating all the above factors in designing camps and shelters worldwide. In Iraq, like in many other countries, such integration is lagging behind. This study's main contribution and novelty are to fill that gap by combining the above elements in the six refugees' core shelters typologies designed based on the Middle Eastern cultural context using locally available sustainable construction materials and methods. In addition to proposing a unique approach that exploits a set of materials on every prototype walls for the reasons of affordability and adaptability and examines it is application performance.

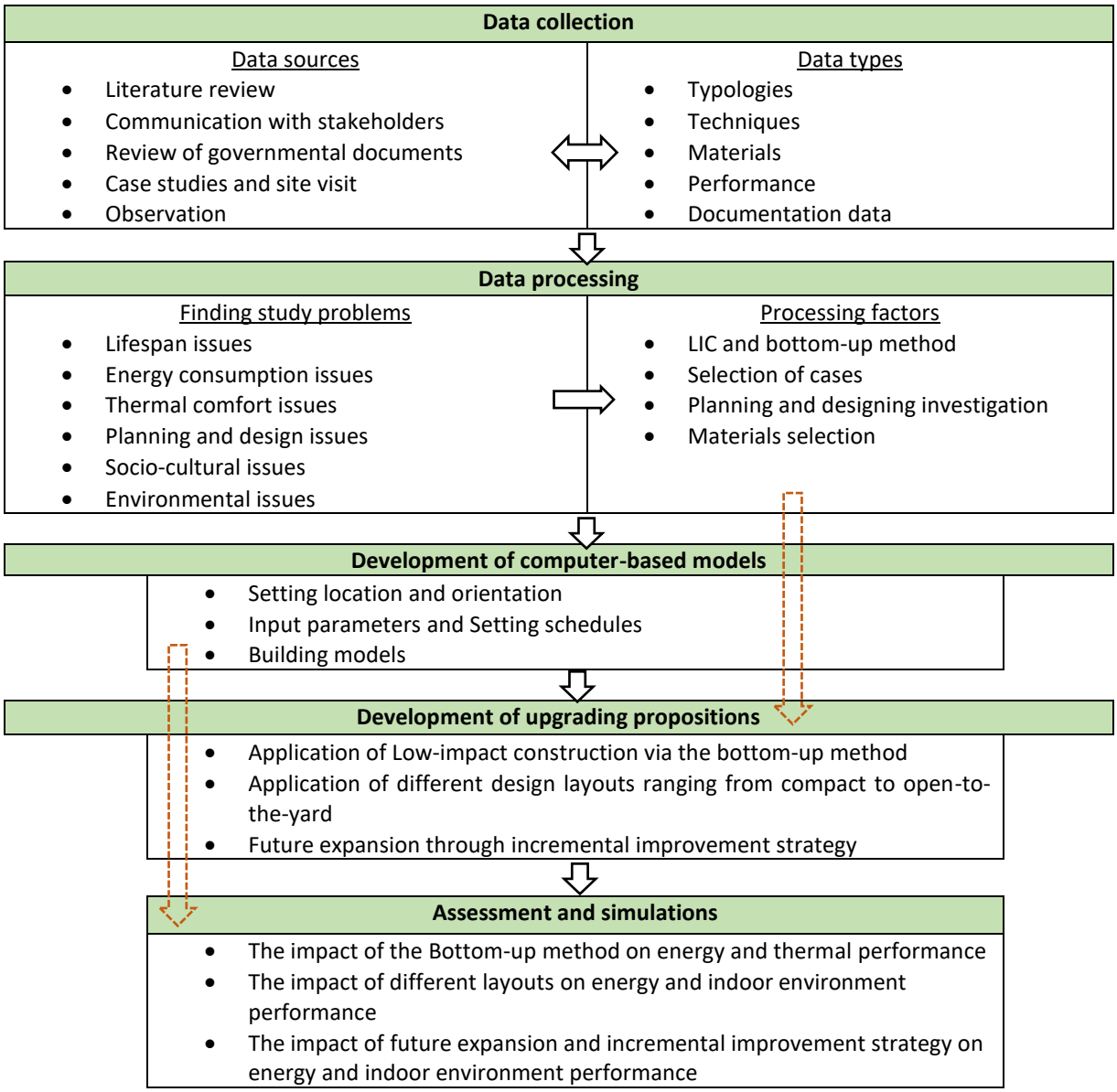
2- Research Aim and Objectives:

This study aimed to design affordable and applicable core shelter prototype typologies by adapting sustainable longer lifespan materials and methods, being culturally responsive, and achieving sufficient indoor environmental comfort with minimum energy consumption. To fulfill the above aim following objectives have been set:

1. Review the relevant current literature to understand the background context of the displacement, the current issues, and the common approaches in building affordable low-impact refugee shelters.
2. To understand the issue within the Iraqi context regarding factors shaping refugee camps, this includes but is not limited to the building characteristics of the existing shelters through sit visiting, reviewing governmental documents, and conducting and direct communication with key stakeholders.
3. To develop computer base models based on the data collected from earlier objectives.

4. To develop upgrading proposals based on locally available low-impact construction materials and techniques, propose a new affordable and applicable method and assess their impact on energy and thermal performance.
5. Design prototypes based on refugee and society needs using the most efficient upgrading proposal methods.
6. Propose three upgrading incremental phases for the designed cases and assess their energy and indoor environment performances.

3- Conceptual framework:



4- Theses:

Thesis 1

The conventional construction materials and methods used in building refugee shelters in Iraq lead to high rates of indoor thermal discomfort and energy consumption, with heating demand being two to three times that of cooling demand. At the free-running stage, the mean indoor operative temperatures remain between 32 to 35 ˚C and 10 to 12 ˚C during summer and winter periods respectively. Shelters built with corrugated metal roofing, which are the predominant shelters, would require 220 kWh/m^2 and 77 kWh/m^2 for heating and cooling respectively, whilst those built with insulated roof sandwich panel (i.e. an 8 cm layer of insulating panel, skinned on both sides with sheet metal) would require 96 kWh/m2 and 44 kWh/m^2 for heating and cooling respectively. Such figures can be remarkably reduced by applying low-impact and thermally efficient materials such as earth-based materials and straw which are locally available and widely used by rural communities.

Thesis 2

By application of the novel mixed technique (triple techniques in one single shelter wall) for the reasons of affordability and adaptability and roof, from low-impact and thermally efficient materials, such as earth-based materials and straw which are locally available and widely used by rural communities can be remarkably reduced the energy consumption and enhance indoor thermal comfort. Conversely to conventional materials, such a technique has a great impact on reducing heating much more than cooling. For instance, it would require 17 kWh/m^2 and 34 kWh/m^2 for heating and cooling respectively. Additionally, the total cooling and heating energy that could be saved compared to the first base case (corrugated metal roofing) is 85%, and compared with the second base case (insulated sandwich panel) is 67.5%. Moreover, the thermal comfort accepted hours ratio for the adopted technique is about 90%. Regarding energy and cost implications and compared with the base case scenarios with conventional materials, this method has the superiority to save energy by more than 10000 kWh in simply one case equivalent to more than 2500 US dollars annually. (55 000 mWh and 13 750 000 US dollars in Domiz-one camp).

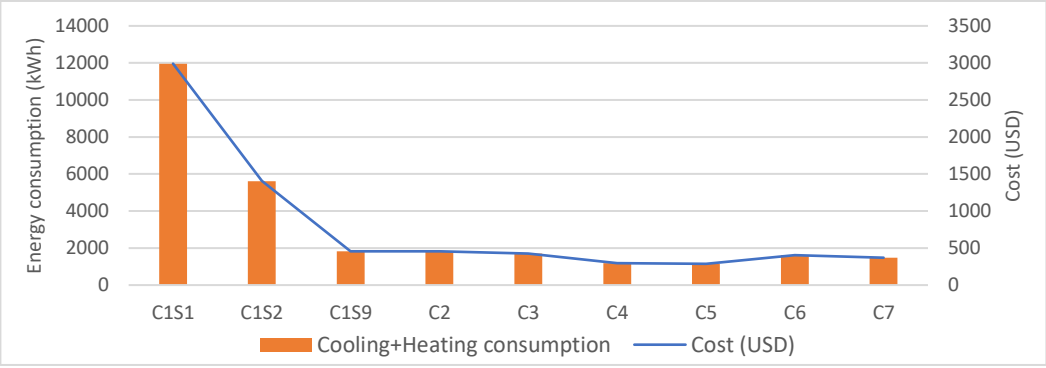


Figure 1. Cost assessment for energy (Base cases C2S1 and C1S2 with Proposed Cases)

Thesis 3

Different layouts have a different impact on the performance of shelters, with compact layouts having more superiority in terms of energy saving and provision of better indoor thermal conditions. Given its nature which provides much less opportunity for heat exchange between indoor and outdoor and thereby less opportunity for heat loss, with the compact layout, there is a possibility to keep the heating consumption below 2.5 kWh/m^2, a figure that is equivalent to almost 85% saving in heating fuel. This is besides keeping cooling consumption below 23 kWh/m^2. Given its nature and the more openings that it has to the yard which promote natural ventilation across the shelter, meanwhile, open to yard layout shows more superiority in terms of air quality, with more occupied hours below 1000 ppm (a level recommended by European EN 13777 for a safe and healthy environment).

Thesis 4

To minimize the environmental footprint, there is a high possibility to prolong the life span of shelters which later can be reused by low-income local communities when refugees return to their homelands. To accommodate their needs, however, the upgraded base shelters could be expanded through an incremental improvement strategy while keeping affordability and the energy and thermal efficiency of the shelters a top priority. Doubling the overall area by adopting materials and techniques mentioned earlier would require somewhere between 16 to 40 kWh/m^2 to provide acceptable indoor temperatures throughout the year. The variation, again, depends mainly on the layout used, with compact layouts showing the lowest heating and cooling consumption.

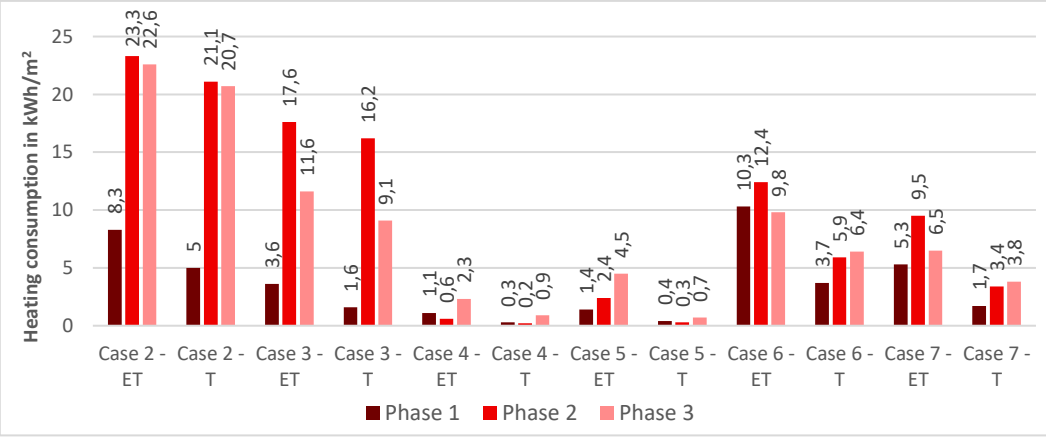


Figure 2. Heating energy assessment for Cases scenarios

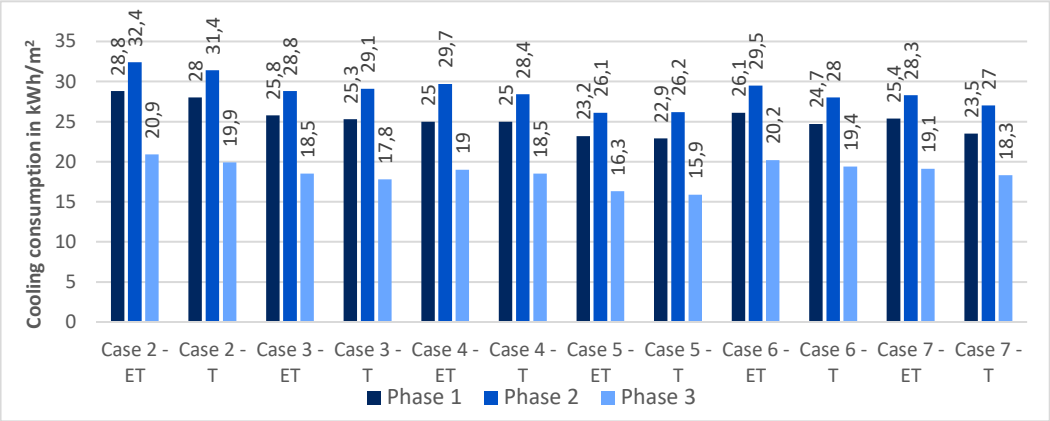


Figure 3. Cooling energy assessment for Cases scenarios

5- List of Publications and Symposiums:

Publications
1- Upgrading a Typical House to Meet the Passivhaus Standard in Iraq. The Potential Benefits Journal of Building Engineering, under reviewing process
2- Energy and Indoor Environment Performance in Sustainably Designed Refugee Shelters. Three Incremental Phases Journal of Sustainability, under reviewing process
3- Impact Assessment of Morphology and Layout of Zones on Refugees' Affordable Core Shelter Performance Published in Sustainability Journal
4- Developing Migrants Prototypes Performance Through Bottom-up Construction Method Published in Pollack Periodica Journal
5- **Methods & Strategies for Sustainable Architecture in The Kurdistan Region, Iraq** Published in Procedia Environmental Sciences
6- **Potential of Energy Conservation in Residential Building Regulations – Kurdistan, Iraq** Published in Procedia Environmental Sciences
Symposiums
1- An Overview of Developing Energy Prototype in Bottom-Up Construction Shelters
2- Assessment of Morphological Impact on Energy Performance for Migrants Shelters
3- Impact Assessment of Location and Orientation on Migrants Shelters Energy Performance

https://m2.mtmt.hu/frontend/#view/Publication/SmartQuery/1127/