

The use of natural materials in Planned Temporary Camps (PTCs) for refugees: a literature review

O uso de materiais naturais em Acampamentos Temporários Planejados (ATPs) para refugiados: uma revisão da literatura



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ABSTRACT

This article aims to establish the state of the art of materials used in the construction of Planned Temporary Camps (PTCs) for socio-environmental refugees. Through a Systematic Literature Review (SLR) and bibliometric analysis, 20 relevant articles aligned with the research theme, published up to August 2023, were selected without any time restrictions. The research considered two defined research axes based on search strings. The results indicated publications, authors, and journals with the highest number of citations on the subject, as well as the main trends in applications, such as materials used, 3D printing, comfort of buildings, among others. The research concluded that the use of natural materials such as earth and bamboo is a strategy used for socio-environmental refugees. However, there is an evident need for more studies on the social, cultural, and economic aspects involved in this process.

KEYWORDS

Planned Temporary Camps; Socioenvironmental Refugees; Sustainable Materials

RESUMO

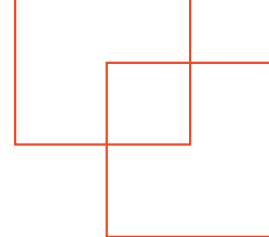
Este artigo tem como objetivo estabelecer o estado da arte dos materiais utilizados na construção de Acampamentos Temporários Planejados (ATPs) para refugiados socioambientais. Através de uma Revisão Sistemática da Literatura (RSL) e análise bibliométrica, foram selecionados 20 artigos relevantes alinhados com o tema da pesquisa, publicados até agosto de 2023, sem restrições de tempo. A pesquisa considerou dois eixos de pesquisa definidos com base em termos de busca. Os resultados indicaram publicações, autores e periódicos com o maior número de citações sobre o tema, bem como as principais tendências nas aplicações, como materiais utilizados, impressão 3D, conforto dos edifícios, entre outros. A pesquisa concluiu que o uso de materiais naturais, como terra e bambu, é uma estratégia utilizada para refugiados socioambientais. No entanto, há uma necessidade evidente de mais estudos sobre os aspectos sociais, culturais e



econômicos envolvidos nesse processo.

PALAVRAS-CHAVE

Acampamentos Temporários Planejados; Refugiados Socioambientais; Materiais Sustentáveis



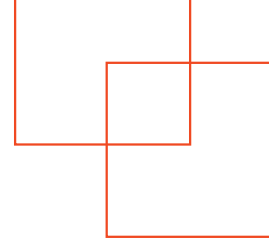
1. INTRODUCTION

According to the analyses proposed by Senne (2017), the concept of humanitarian architecture emerged approximately a century ago as a response to various crises and emergencies, acquiring crucial importance in contemporary times. Humanitarian crises can stem from both human actions, such as armed conflicts, economic instabilities, and political crises, and from natural events like droughts, floods, earthquakes, and even technological incidents like structural collapses, urban fires, and the release of radioactive substances.

Based on the analysis conducted by the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) in 2019, given the growing demands of crisis-affected populations, approximately 168 million individuals worldwide were projected to require humanitarian assistance in 2020. This scenario predominantly arises from contexts where populations struggle to access fundamental elements such as food provisions, water access, medical care, social support, security, accommodation, and temporary shelter.

Over the past decades, data presented by the United Nations High Commissioner for Refugees (UNHCR) in 2020 highlight that forced displacements resulting from disasters have reached alarming proportions, compelling over 67 million individuals globally to leave their homes, jobs, and loved ones in search of safety and freedom. Within this group, approximately 22 million are classified as refugees, while around 40 million remain internally displaced. In a context where armed conflicts, climate transformations, and economic challenges shape the landscape, achieving sustainable development requires urgent attention to the rights and needs of those affected by humanitarian crises. This underscores the necessity to provide targeted support and assistance to this vulnerable segment of society (UNHCR, 2020).

Therefore, in a world where armed conflicts, climate changes, and economic hardships sculpt the landscape, attaining sustainable development necessitates an approach that highlights the rights and needs of individuals impacted by humanitarian crises. This approach emphasizes the importance of providing shelter and temporary housing, a complex task due to the diversity of disasters that occur

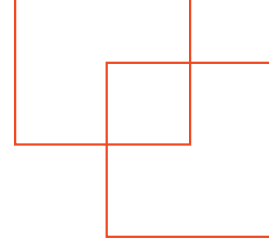


both globally and within the Brazilian context, exacerbated by the urgency to provide refuge. This also encompasses the relevance of providing a wide range of services, infrastructure, and support facilities to ensure operational effectiveness.

Observations by UNHCR (2020) indicate that the provision of shelter and temporary accommodation is of paramount importance during crises, contributing to the restoration of personal security, autonomy, and dignity. The right to adequate housing is implicitly embedded in the Universal Declaration of Human Rights and various declarations formulated by multilateral organizations, including the UN. In the first conference on this topic in 1996, it was established that access to basic and contextually appropriate shelter is a fundamental human need, even though the characteristics of such housing may vary according to cultural context, situation, climate, and other factors (UNIVERSITY OF WISCONSIN, 1996). However, Anders (2007) identifies the complexity in defining performance criteria for shelters and temporary housing, as well as creating indicators for their design, given the wide range of factors influencing their suitability.

Within a multifaceted context, with inherent nuances in providing shelters and housing in disaster scenarios and other necessary structures, the primary objective of this research is to establish key concepts related to this topic, discern guiding parameters for planning, and gather indicators, guidelines, strategies, and examples of best practices related to shelters and temporary housing for application in Planned Temporary Camps (ATPs), including the exploration of the potential of natural materials to promote sustainable solutions.

In this context, conducting a Systematic Literature Review (SLR) stands out as an important step to gain a deep understanding of the current landscape of PTCs, given the increasing complexity of humanitarian crises, providing a comprehensive overview of practices, approaches, and innovations employed globally. By analyzing existing publications up to this point, it is possible to identify knowledge gaps, emerging trends, and new insights, enriching the understanding of the current state of humanitarian architecture and guiding research towards areas that require greater attention and improvement.



2. METHODOLOGICAL PROCEDURES

Phase 1 of the SSF method aims to define the research protocol, composed of five activities: (i) defining the search strategy; (ii) database search; (iii) organizing the bibliographic portfolio; (iv) standardizing article selection; and (v) composing the article portfolio, as follows:

Activity 1 defines the search strategy, which is a set of procedures that define how to search for and retrieve online information. The strategy involves the use of logical (AND, OR) and relational operators, quotation marks, special characters, and filters to refine the search and obtain more accurate results from the search query.

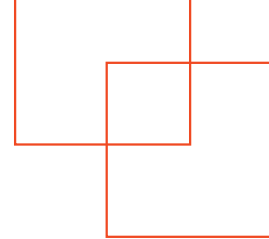
Activity 2 involves querying databases, which are online sources of information in various research areas. Researchers must choose the most appropriate databases for their topic and research area and parameterize the search (using the query) according to the strategy defined in Activity 1. Researchers should record the search date and set up an alert for new publications related to their query.

Activity 3 consists of organizing bibliographies using software that facilitates searching, filtering, counting, storing, citing, and referencing publications found in databases, such as EndNote®, Mendeley®, Zotero®, BookEnds®, among others.

Activity 4 aims to standardize article selection using selection filters. In this phase, researchers read the titles, abstracts, and keywords of each article and choose those related to the research topic. Additional filters, such as language and field of concentration, can be used as per the predefined strategy.

Activity 5 involves composing the article portfolio, which is the set of publications selected for systematic review. In this activity, researchers read all articles in full and conduct further filtering to exclude those not aligned with the research topic.

Phase 2 of the SSF method aims to consolidate data, wherein the researcher combines and analyzes articles, journals, most-cited authors, the year with the most publications on the topic, studied constructs, strengths and weaknesses of the study object, and more. The researcher uses software (spreadsheet) to combine, and group

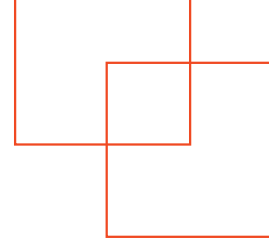


collected data and prepares an analysis and synthesis matrix to interpret data, identify existing knowledge gaps, and suggest topics for future research. With the acquisition of bibliometric data, which involves statistical analysis of publications found in databases, the researcher should critically analyze graphs, figures, and tables resulting from bibliometrics, demonstrating the value and relevance of the data for the research.

Phase 3 of the SSF method aims to synthesize data, constructing inferences about the topic and generating new knowledge based on the results of previous research. For this purpose, the researcher uses the Knowledge Matrix, a tool developed by Ferenhof and Fernandes (2014, 2016) that enables data extraction and organization from article analysis. While there is no standard model for constructing the Knowledge Matrix, there are some points to observe, such as keywords, publication year, author, journal, databases, article type, references, construct/definition, gap/lacuna, positive/negative points, and excerpts to be cited.

Phase 4 of the SSF method aims to consolidate results through scientific writing. In this phase, the researcher should revisit the literature review's objective, as well as the analysis and synthesis results. The writing of results should be grounded in the Knowledge Matrix and reports. Additionally, considerations for the document's intended audience, submission guidelines, language style, cover letter, and blind review by the chosen journal or event should be followed to ensure the resulting document conforms to the grammatical rules of the language in which it was written.

For the elaboration of the SLR, all phases of the SSF were carried out. The process started with Phase 1, defining the research strategy with two research axes involving temporary camps for socio-environmental refugees and the materials used in the construction/installation of these architectures. A search was conducted on August 9, 2023, using the following keywords in the search query: ("emerg* shelter*" OR "emerg* settle*" OR "emerg* camp*" OR "temporary shelter*" OR "temporary settle*" OR "temporary camp*" OR "transitional shelter*" OR "transitional settle*" OR "transitional camp*" OR "refugee shelter*" OR "refugee settle*" OR "refugee camp*" OR "planned shelter*" OR "planned settle*" OR "planned camp*") AND ("material*" OR "natural



material*" OR "sustainable material*").

In the specific case of this work, a direct search was conducted on the Capes Periodicals database to identify relevant databases related to the addressed topic for potential future research. This search yielded 754 articles. After the initial result, the first three filters were applied: (i) online resources; (ii) peer-reviewed journals; and (iii) open access. This process resulted in 392 articles, and the first results were analyzed to verify their alignment with the research topic. Following this, an additional three filters were applied using the search engine: (i) articles and journal articles; (ii) all subjects except those related to health and medicine; and (iii) languages - English, Portuguese, Italian. In this step, 335 documents remained selected for work in the spreadsheet manager.

In the spreadsheet manager filter, it was observed that all documents (335 items) were scientific articles, with only one article being duplicated, leaving 334 items. Continuing, a keyword-based exclusion filter was applied, excluding misaligned keywords, such as: (i) memory; (ii) malaria; (iii) thermal; (iv) diabetes; (v) insecticide; (vi) sanitation; (vii) HIV; (viii) health; (ix) education; (x) student; (xi) tuberculosis; (xii) COVID; (xiii) LiDAR; (xiv) satellite; (xv) food; (xvi) remote sensing; (xvii) animals; (xviii) archaeological; and (xix) translation. This resulted in 68 documents for title reading. From reading these titles, it was observed that 39 were aligned; this led to reading the abstracts, resulting in 26 articles considered aligned with the objective and selected for comprehensive reading. From this number, it was concluded that 20 articles would be aligned with the research theme and become part of the relevant article's portfolio.

3. ANALYSIS AND DISCUSSION OF RESULTS

The following 20 scientific articles are part of the collection of bibliographic sources researched in August 2023. From this survey, it was possible to identify the following aspects in the documents: (i) authors involved in the research; (ii) publication years; (iii) titles; (iv) citation counts; (v) publication venues; (vi) researchers' origins; (vii) disciplinary areas and/or subjects linked to the Capes Periodicals

Portal; and (viii) methods, techniques, and content of the publications. Table 1 displays the obtained articles along with their references. From the information presented in Table 1, it can be observed that the 20 identified publications occurred between the years 2014 and 2023. Notably, the years 2019, 2021, and 2023 witnessed the highest number of publications on Google Scholar, as indicated by Graph 1. Regarding the article citations, as illustrated by Graph 2, two articles stand out with the highest number of citations: (i) "Global or local construction materials for post-disaster reconstruction? Sustainability assessment of 20 post-disaster shelter designs" with 68 citations; and (ii) "The not-so-concrete Jungle: material precarity in the Calais refugee camp" with 46 citations.

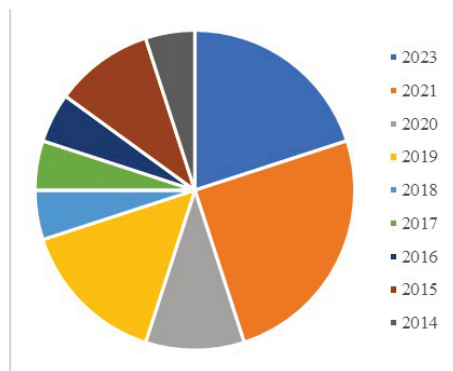
Table 1: Information authors, journals, countries, subjects and keywords.

AUTHORS (YEAR) ARTICLE NUMBER		JOURNAL	COUNTRY	SUBJECT	KEY WORDS
ALMOMANI et. al. (2023)	1	Buildings (Basel)	Jordan; Saudi Arabia; Greec	Technology; Science & Technology; Engineering	3D concrete printing; refugee shelter; decision-making; contour crafting; concrete printing; D-shape; AHP
ELTAWHEEL et. al. (2023)	2	Energy and buildings	United Kingdom	Civil Engineering	Shelters; Displaced people; Thermal comfort; Indoor temperature; Sustainable & affordable materials; Construction materials; Flexible architectural design; Parametric design; Building simulation; Environmental design; Optimisation Social values
IBRAHIM et. al. (2023)	3	Sustainability (Basel, Switzerland)	Hungary; Iraq	Energy Efficiency; Science & Technology	Upgrading strategies; Post-disaster shelters; Sustainable prototypes; Low-impact constructions; Energy efficiency; Thermal comfort
TIWARI, AZZAWI e AMIR (2023)	4	City, territory and architecture	India; United Arab Emirates; Algeria	Science & Technology	Emergency shelters; Resilient design; Master planning; Informal settlements; Temporary shelters; Refugees; Strategic camp planning; Climate change; Vulnerable community
KLANSEK et. al. (2021)	5	Journal of housing and the built environment	United Kingdom; Switzerland; United States	Geography; Landscape/Regional and Urban Planning	Temporary shelters; Refugee camps; Bangladesh; Transdisciplinary approach
MORAN et. al. (2021)	6	Energy for sustainable development	United Kingdom; Jordan	Civil Engineering	Refugee shelters; Thermal comfort; Thermal modelling; Overheating; Thermal mass; Desert
ALBADRA et. al. (2021)	7	Building research and information: the international journal of research, development and demonstration	United Kingdom	Architecture; Science & Technology	Participatory design; refugee camps; visualization tools; temporary shelters
GHOMI et. al. (2021)	8	Built environment project and asset management	United Kingdom	Civil Engineering	Housing; Performance; Post-disaster; Transform; Living technology
HAQUE e ISLAM (2021)	9	Cleaner Engineering and Technology	Bangladesh	Science & Technology	Plastic brick; Rohingya refugee; Cyclone; Plastic waste
ABURAMA, TRILLO e MAKORE (2020)	10	City, territory and architecture	United Kingdom	Refugees; Case Studies	Refugee camp; Informal cities; Jordan; Al Za'atari refugee; Temporary cities; Social impact
AWALUDIN, ADIYUANO e MURSYID (2019)	11	Materials Science and Engineering	Indonesia	Science & Technology	Not found
OLIVEIRA e CAMPOS (2019)	12	IOP conference series. Materials Science and Engineering	Portugal	Science & Technology; Social Sciences	Not found
ASALI, WAGEMAN e RAMAGE (2019)	13	Journal of housing and the built environment	United Kingdom; Chile	Geography; Landscape/Regional and Urban Planning	Internally displaces persons; Temporary housing; Mud villages; Post-disaster housing; Shelter; Syrian conflict

ISMAIL e SZALAY (2019)	14	Earth and environmental science	Hungary	Science & Technology; Technology; Social Sciences	Not found
MOULD (2018)	15	Cultural geographies	United Kingdom	Science & Technology	Autogestion; camp geographies; domicile; precarity; sense of place
PUSCEDDU et. al. (2017)	16	International journal of disaster resilience in the built environment	Italy; United Kingdom	Architectural engineering; Engineering; Building construction	Disaster management; Climate change; Post-disaster reconstruction; Disaster resilience; Temporary shelter; Thermal reflective multi-layer system
TUMBEVA et. al. (2016)	17	Automation in construction	United States	Civil Engineering	Shelter; Structural morphology; Manufacturing; Sandwich panel; Lightweight structure; Temporary structure
KUITTINEN e WINTER (2015)	18	International journal of disaster risk science	Finland; Germany	Geosciences, Multidisciplinary	Carbon footprint; Humanitarian Construction; Lifecycle assessment; Primary energy
ZEHA e HABERT (2015)	19	Data in brief	Switzerland	Science & Technology	Sustainability; LCA; Transitional shelter; Construction
SURACI et. al. (2014)	20	Advanced Engineering Forum	Italy	Rural Areas; Construction	Italy; Rosarno; Self-Construction; Sustainable Architecture

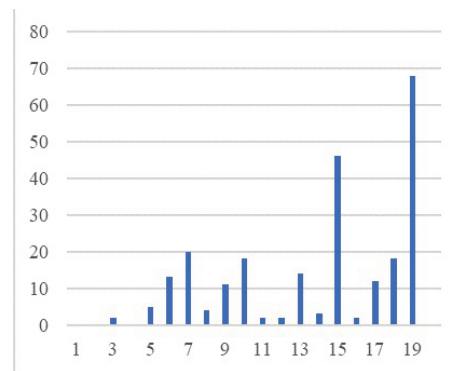
Source: Research Data (2023).

Graph 1: Publication Years



Source: Research Data (2023).

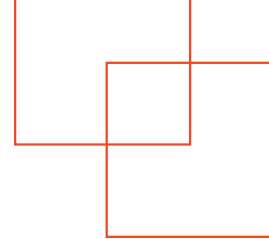
Graph 2: Number of Citations per Article



Source: Research Data (2023).

It can be observed from Table 1 that the publication journals for the articles are highly diverse. Regarding the geographical locations of the research, the majority of them were conducted in the United Kingdom, followed by the United States, Switzerland, Hungary, Jordan, and Italy. The disciplines and subjects covered in these works are focused on Engineering, Science and Technology, Architecture, Urbanism, and Geography.

While the keywords vary significantly, the main terms align with some of the terms in this systematic literature review (RSL). Concerning the content of the research, in general, it highlights the significance of the topic and emphasizes criteria for shelter design, cultural considerations, and the integration of new technologies and materials that can better reflect and contribute to local development.

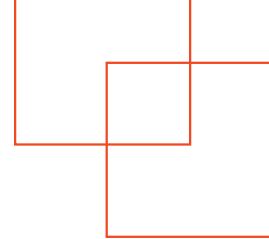


The study by Almomani et al. (2023) emphasizes the importance of improving the design of shelters for Syrian refugees due to the short lifespan of current shelters and uncertainties about refugees' return after the civil war. 3D printing with concrete is seen as a promising solution to create durable shelters that offer protection against extreme weather, privacy, and cultural respect. The study utilizes the Analytic Hierarchy Process (AHP) to select the best 3D printing technology, considering technical, structural, economic, and environmental factors. Among the options evaluated - contour crafting, D-shape, and concrete printing - contour crafting stood out as the most suitable choice, with tests and analysis confirming its effectiveness and rationale.

In the research of Eltaweel et al. (2023), the authors propose an incremental design method to meet the social needs of displaced people, while also conducting extensive thermal modeling and analysis using vernacular materials with high thermal mass to accommodate extreme weather fluctuations. The authors highlight that emergency shelters are evolving from tents to more robust solutions. The use of steel structures (Inverted Box Rib) is common, although the lack of thermal mass can cause issues in locations with extreme temperature variations.

Ibrahim et al. (2023) address the challenges of building sustainable shelters for refugees in the context of natural and human-induced disasters. The study proposes an integrated design for six shelters based in the Middle East, considering longevity, thermal comfort, energy efficiency, and cultural integration. Empirical assessments demonstrate energy savings, thermal comfort, and low levels of CO2 emissions.

Tiwari et al. (2023) tackle the challenges faced by emergency shelters, which often become informal settlements due to their temporary nature. These settlements experience conflicts, environmental pressures, and service inadequacies, resulting in climate vulnerability and low quality of life for refugees. The study proposes a resilient master plan for a refugee camp in Lebanon, aiming to address internal and external risks. The recommendations are strategic and aimed at strengthening the local community, promoting greater self-sufficiency during crises. The proposed model can be



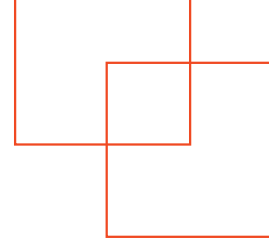
adapted for other emergency settlements, addressing multiple challenges and risks.

Klansek et al. (2021) emphasize that most refugees live in self-built shelters using simple materials. The study highlights the importance of a transdisciplinary approach for holistic data collection in such shelters. Research was conducted in refugee camps in Bangladesh, using various methods such as interviews and physical measurements. The multidisciplinary approach revealed underlying issues and allowed for the development of shelter improvement plans and interventions, impacting over 70,000 shelters.

Moran et al. (2021) seek to understand how internal temperatures in refugee shelters affect health. In displacement contexts, solutions are constrained by time, cost, material availability, and local requirements. The study investigates whether optimizing thermal comfort through prototyping or thermal modeling is more appropriate. A field experiment was conducted, adapting shelters in a refugee camp in the desert. Thermal modeling was compared to real results. It was concluded that prototyping offers advantages such as visual experience, comparison of construction difficulties, and precise identification of financial and temporal costs, resulting in significant improvements of up to 6°C.

In the study by Albadra et al. (2021), the focus is on how shelters for displaced individuals can face sociocultural incompatibility and occupant dissatisfaction. Participatory design (PD) is an alternative to reduce these issues. The study investigates the effectiveness of different PD methods to involve and capture user needs for shelter design in refugee camps. Two PD methods were employed: (i) personal design (where refugees proposed their ideal shelters) and (ii) design adaptation (where refugees evaluated and modified pre-existing designs). Shelters from method (ii) were presented using three visualization tools: computer models, physical prototypes, and virtual reality. The design adaptation method stimulated more dialogue and was more informative, with physical prototypes facilitating shelter modifications and virtual reality being better for communicating scale and size.

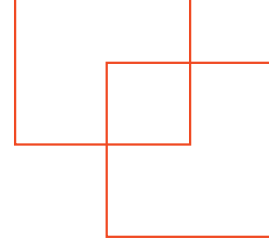
Ghomi et al. (2021) investigate the performance of post-disaster housing reconstruction projects and propose the conceptual approach



of "Living-transforming disaster relief shelter" (LTFDR-shelter), where temporary shelters are gradually transformed into permanent homes using life technologies, aiming to provide sustainable housing after disasters induced by natural phenomena. A questionnaire survey was conducted with 120 beneficiaries of post-disaster housing projects in Sri Lanka to assess project performance in relation to occupant expectations. The applicability of the proposed LTFDR-shelter approach was investigated to address identified issues. The study identifies physical, technical, and socioeconomic performance issues in post-disaster housing and discusses the applicability of the LTFDR-shelter approach as an effective tool to enhance identified factors, covering relief, rehabilitation, and reconstruction phases with life technology. The study offers a conceptual basis for a new theoretical approach in post-disaster housing, encouraging interdisciplinary collaborations and empirical investigations that potentially enhance post-disaster housing performance and facilitate the application of life technology in the built environment.

Haque and Islam (2021) applied their research in Bangladesh, home to around 1.3 million Rohingya refugees. Current shelters, mainly made of bamboo and plastic sheets, are not resilient to environmental disasters such as monsoon rains, cyclones, and landslides, and are prone to vector-borne diseases. The study developed plastic bricks using discarded polyethylene terephthalate bottles filled with dry sand as filler material. A cardboard mold was used to shape the brick, which was filled with mortar manually. The prepared bricks underwent compression tests, resulting in average strengths of 2.88 and 3.29 N/mm² for compression ages of 14 and 28 days, respectively. This demonstrates high potential for using the bricks in constructions. Considering the risks of environmental disasters in displacement camps and the need for plastic waste management, the use of plastic bricks can be a cost-effective, useful, and sustainable way to create secure and sturdy housing structures.

The study by Aburamadan, Trillo, and Makore (2020) highlights the conversion of shelters into long-term housing due to economic motivations. The article explores whether the spatial configuration of these camps should be permanent or reflect the transient nature of the community. The Al Za'atari camp was investigated, revealing that its

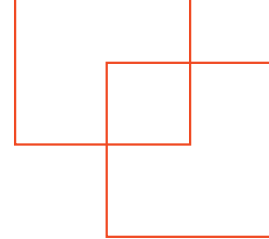


configuration reflects social organization, suggesting more personalized design approaches that better meet residents' needs.

In the study by Awaludin, Adiyuano, and Mursyid (2020), after the 2018 Lombok earthquake, a large number of houses needed to be rebuilt or partially repaired. About 75,138 out of more than 216,519 damaged houses had to be demolished and rebuilt in the same location. This construction process was necessary due to the lack of privacy in the temporary shelters where most affected individuals were living. A house model called RISBARI was proposed, made from cold-formed steel structure. The RISBARI was developed to meet two essential criteria: fast assembly process and budget constraints. A real-scale test was conducted to assess its lateral strength. The article outlines the earthquake-resistant RISBARI house, as well as the planning for its mass production through the 5Ms principles.

Emergency architecture creates temporary shelters to protect disaster victims. Oliveira and Campos (2019) assert that not only quick construction solutions need to be considered, but also human needs. The research by these authors proposes a flexible and temporary emergency shelter with an adaptable modular structure, providing minimum living conditions for a short period. The model can be allocated in different ways, adapting to people's needs, with a basic structure for stability and lightweight, thermally efficient construction.

The refugee scenario has alarmed the world, with particular emphasis in the media on Syrian refugees. Asali et al. (2019) point to the problematic nature of internal displacement in Syria, where more than half of the population (Internally Displaced Persons - IDPs) was forced to leave their homes, totaling more than six and a half million in 2017 (about a third of the total Syrian population). However, internal displacement adds a dimension to the complex notion of mass shelters: shelter policies, or the lack thereof, as well as shelter itself as a product of design and construction, express the power of those who govern more than the aspirations of those who inhabit. Affected groups find solutions themselves, via national or international organizations, or a combination of both. However, such solutions operate under the influence of authorities controlling the area where IDPs are received. Among the available alternatives for displaced communities, this article analyzes two cases of families housed in a



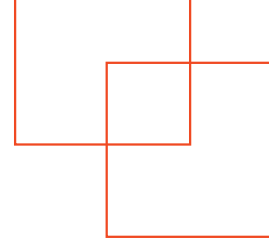
collective center in Damascus controlled by the government (schools) and a planned camp in the village of Afes, in a rebel-controlled area near Idlib.

In Sudan, for instance, the intense summers with temperatures reaching 42°C in the South and 48°C in the North are not considered in building technical solutions, including strategies for protection against solar radiation and natural ventilation. Ismail and Szalay (2019) argue that there is a lack of information about the physical characteristics, energy consumption, and building stock in Sudan. The objective of this article was to collect data from population and housing censuses, scientific research, and reports to prepare a typology table of buildings, establishing a relationship with the Sudanese climate and its different zones, geographic characteristics, and levels of urbanization. Building materials range from natural materials like straw, wood, and clay to modern materials like bricks and concrete. The building typology varies from structures for temporary shelters to permanent single-family or multi-family homes. The main result of the article is to identify a typology of buildings in Sudan with reference to specific buildings. This is the first article to introduce the Sudan typology table.

In the vicinity of Calais, Mould (2018) emphasizes the refugee camp known as 'the Jungle,' which was recently demolished in a violent act, marking the culmination of a long history of imposed precarity. In recent years, the camp had significantly increased in population, and through collective actions alongside volunteers, it incorporated what Doreen Massey would describe as a 'progressive sense of place,' culturally and socially rich, yet also conflict-ridden and violent. This cycle of making/unmaking/remaking home, through interventions by governing bodies, was most visibly represented by its materiality, which was highly precarious, and by a 'progressive' sentiment that mixes hope and despair, wealth and conflict, construction and deconstruction of home.

Salvalai et al. (2017) investigated the feasibility of a Thermal Reflective Multi-layer System (TRMS) to support Disaster Resilience. One result of this study is the proposal for the Air Shelter House (ASH), a new shelter concept based on TRMS with low-cost building materials and a 3D printer system.

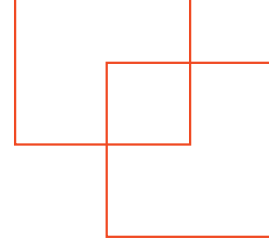
In the article by Tumbeva et al. (2016), lightweight and thermally



insulated temporary shelters are explored, crucial for military operations and disaster relief. To minimize costs and increase sustainability, reducing material waste during manufacturing was one of the considered aspects. The study investigates quilt patterns - interconnected geometric shape designs - as inspiration for structural topologies that can be manufactured from flat sheets with minimal material waste (where the shape interfaces serve as cutting and folding lines). Detailed finite element analysis and the design of three concepts are presented. To achieve a lightweight and thermally insulated design, structures are composed of sandwich panels (fiber-reinforced polymer faces and a foam core). The performance of each design is compared to an existing rigid wall shelter, demonstrating the effectiveness of the proposed forms. This is the first study to investigate the use of quilting as inspiration for structural systems.

Kuittinen and Stefan (2015) research the occurrence of extreme climatic events and political disputes leading masses to leave their homes. Their transitional settlements must be produced to minimize greenhouse gas emissions (GHG) to avoid any further acceleration of climate change and the humanitarian crises it causes. Thus, a study of the carbon footprint and primary energy demand of the building materials of eight different transitional shelters is carried out. The lowest carbon footprints were found in shelter models made of bamboo or wood. The highest emissions were caused by shelters with a short lifespan or those made of metal-intensive structures. The choice of cladding materials was surprisingly important. The results were compared to the overall impacts of each construction project, per capita GHG emissions by country, and construction costs. Some shelter projects had a notable total energy consumption, even when compared to the annual energy use of industrialized countries. The study concludes that building materials have a significant impact on shelter carbon footprints. However, comparisons should only be made between similar functional units.

Zea Escamilla and Habert (2015) evaluated whether using local or global materials in post-disaster reconstruction projects is more appropriate. Twenty transitional shelters in different locations were compared, considering environmental, economic, and technical performance. Results indicate that shelters with high technical



performance can be achieved at a low cost and environmental impact, regardless of the material. Local materials present lower environmental impact and costs, while global materials tend to have better technical performance. Local construction systems can be advantageous but demand more effort in structural design.

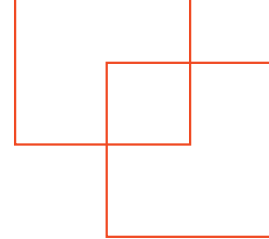
Lastly, in Suraci et al.'s study (2014), an architectural project is proposed to create a self-sufficient village in the agricultural town of Rosarno, located in Calabria, the southernmost region of Italy. The project aims to provide an alternative to a temporary camp created by the military after an uprising of African immigrants working in orange plantations under precarious conditions and little rights protection. The proposal, called RoSunLand, seeks to be an alternative solution that accepts diversity as wealth and emphasizes work as an important means to achieve dignity, contrasting with the refugee camp established by government authorities.

4. CONCLUSION

In this study, we conducted a Systematic Literature Review (SLR) to analyze the current landscape of characteristics, key materials, and design parameters related to shelters in planned camp settings within disaster and refugee contexts, with a special focus on natural and sustainable materials. Within the set of 20 articles encompassed by this bibliographic research, we noted that the oldest dates to 2014, indicating the recent emergence of this topic on a global scale.

The predominant methods and approaches observed in the analyzed studies were based on case studies. This approach underscores the emphasis on analyzing real situations and perspectives of the people directly involved, highlighting the importance of these approaches in the realm of research. Additionally, we identified a gap in the consolidation of specific guidelines aimed at the planning of temporary shelters in planned camp scenarios, pointing to an area that requires further in-depth exploration.

It is worth noting that, considering the last update of the SLR on August 9, 2023, the intrinsically interdisciplinary nature of the topic was outlined. Most contributions are rooted in the disciplines of Civil



Engineering and Science and Technology, underscoring their relevance in these spheres of knowledge.

The research findings offer significant contributions to the evolution of shelter design for displaced populations such as the research by Eltaweel et al. (2023) propose an incremental design using vernacular materials to meet social needs and extreme climate fluctuations, while Ibrahim et al. (2023) focus on sustainable shelters in the Middle East, presenting positive results in longevity, thermal comfort, and energy efficiency. Additionally, the research emphasizes the importance of a transdisciplinary approach in self-built shelters, impacting over 70,000 shelters in refugee camps in Bangladesh (Klansek et al., 2021), Moran et al. (2021) which revealed that prototyping significantly improves thermal comfort and Albadra et al. (2021) that explore participatory design methods.

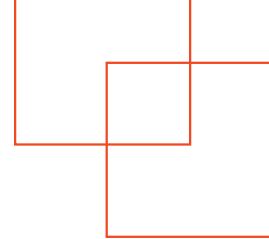
It becomes evident that there is an underlying conceptual basis for the terms frequently used in this field, such as shelters and temporary housing. However, we have not yet observed a universal adoption of these terms, and many specific contexts elude their definition, prompting the emergence of new terminologies. This evolution in terminology reflects the complexity and continuous evolution of this research field, constantly adapting to emerging demands and challenges.

REFERENCES

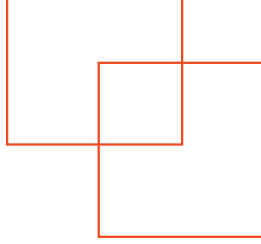
- ABURAMADAN, Rania; TRILLO, Claudia; MAKORE, Busisiwe Chikomborero Ncube. Designing refugees' camps: temporary emergency solutions, or contemporary paradigms of incomplete urban citizenship? Insights from Al Za'atari. *City, Territory and Architecture*, v. 7, p. 1-12, 2020.
- AL ASALI, M. Wesam; WAGEMANN, Elizabeth; RAMAGE, Michael H. Living on the move, dwelling between temporality and permanence in Syria. *Journal of Housing and the Built Environment*, v. 34, p. 829-843, 2019.
- ALBADRA, Dima; ELAMIN, Z.; ADEYEYE, K.; POLYCHRONAKI, E.; COLEY, D. A.; HOLLEY, J.; COPPING, A. Participatory design in refugee camps: comparison of different methods and

visualization tools. *Building Research & Information*, v. 49, n. 2, p. 248-264, 2021.

- ALI, S. Ismail Ahmed; SZALAY, Zs. Towards developing a building typology for Sudan. In: *IOP Conference Series: Earth and Environmental Science*. IOP Publishing, 2019. p. 012012.
- ALTO COMISSARIADO DAS NAÇÕES UNIDAS PARA REFUGIADOS – ACNUR. Agência da ONU para Refugiados. [s. l.], 2020 a. Available in: <http://www.acnur.org/portugues/>. Access at: August. 2023.
- ALMOMANI, M. A.; AL-ABABNEH, N.; ABDALLA, K.; SHBEEB, N. I.; PANTOUVAKIS, J. P.; LAGAROS, N. D. Selecting the Best 3D Concrete Printing Technology for Refugee Camp's Shelter Construction Using Analytical Hierarchy Process: The Case of Syrian Refugees in Jordan. *Buildings*, v. 13, n. 7, p. 1813, 2023.
- ANDERS, G. C. Abrigos temporários de caráter emergencial. 2007. Dissertação (Mestrado em Arquitetura e Urbanismo) - Faculdade de Arquitetura e Urbanismo, Universidade de São Paulo, São Paulo, 2007.
- AWALUDIN, A.; ADIYUANO, Y.; MURSYID, F. A. RISBARI: an alternative house model for the 2018 Lombok earthquake affected people. In: *IOP Conference Series: Materials Science and Engineering*. IOP Publishing, 2020. p. 012069.
- BIANCO, Alessia; CERADINI, V.; SURACI, A.; DI PAOLA, A. RoSunLand: A Sustainable Self-Construction Village for Emigrant African Workers in Italy. In: *Advanced Engineering Forum*. Trans Tech Publications Ltd, 2014. p. 79-86.
- ELTAWHEEL, A.; SAINT, R.; D'AMICO, B.; POMPONI, F. A parametric thermal analysis of refugees' shelters using incremental design and affordable construction material. *Energy and Buildings*, v. 290, p. 113110, 2023. Available in: <https://www.sciencedirect.com/science/article/pii/S0378778823003407>. Doi: <https://doi.org/10.1016/j.enbuild.2023.113110>
- ESCAMILLA, E. Zea; HABERT, Guillaume. Global or local construction materials for post-disaster reconstruction? Sustainability assessment of twenty post-disaster shelter designs. *Building and Environment*, v. 92, p. 692-702, 2015.
- GHANBARZADEH GHOMI, Sara; WEDAWATTA, G.; GINIGE, K.; INGIRIGE, B.. Living-transforming disaster relief shelter: A



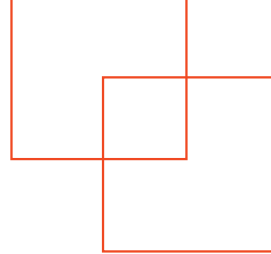
- conceptual approach for sustainable post-disaster housing. Built Environment Project and Asset Management, v. 11, n. 4, p. 687-704, 2021.
- FERENHOF, H. A.; FERNANDES, R. F. Passo-a-passo para construção da Revisão Sistemática e Bibliometria Utilizando a ferramenta Endnote. [s. l.], 2014. Available in: http://www.igci.com.br/artigos/passos_rsb.pdf. Access at: Agosto 2023.
- FERENHOF, H. A.; FERNANDES, R. F. Desmistificando a revisão de literatura como base para redação científica: método SFF. Revista ACB, Florianópolis, v. 21, n. 3, p. 550-563, 2016. Available in: <https://doi.org/10.13140/RG.2.1.1937.2401/1>
- HAQUE, Md Sazzadul; ISLAM, Shabab. Effectiveness of waste plastic bottles as construction material in Rohingya displacement camps. Cleaner Engineering and Technology, v. 3, p. 100110, 2021.
- IBRAHIM, Rojhat; BARANYAI, B.; ABDULKAREEM, H.; KATONA, T. J.. Energy Use and Indoor Environment Performance in Sustainably Designed Refugee Shelters: Three Incremental Phases. Sustainability, v. 15, n. 8, p. 6903, 2023.
- KLANSEK, Tonja; COLEY, D. A.; PASZKIEWICZ, N.; ALBADRA, D.; ROTA, F.; BALL, R. J.L. Analysing experiences and issues in self-built shelters in Bangladesh using transdisciplinary approach. Journal of Housing and the Built Environment, v. 36, p. 723-757, 2021.
- KUITTINEN, Matti; WINTER, Stefan. Carbon footprint of transitional shelters. International Journal of Disaster Risk Science, v. 6, p. 226-237, 2015.
- MORAN, F; FOSAS, D.; COLEY, D.; NATARAJAN, S.; ORR, J.; AHMAD, O. B.. Improving thermal comfort in refugee shelters in desert environments. Energy for Sustainable Development, v. 61, p. 28-45, 2021.
- MOULD, Oli. The not-so-concrete Jungle: Material precarity in the Calais refugee camp. cultural geographies, v. 25, n. 3, p. 393-409, 2018.
- OFFICE FOR THE COORDINATION OF HUMANITARIAN AFFAIRS - OCHA. OCHA's 2019 in review. [s. l.], 2019. Available in: <https://unocha.exposure.co/ochas-2019-in-review>. Access at: August. 2023.



- OLIVEIRA, Nadine MM; CAMPOS, Inês DD. Flexible refugee shelter. In: IOP Conference Series: Materials Science and Engineering. IOP Publishing, 2019. p. 032021.
- PUSCEDDU, Cristina; BLUMBERG, G.; SALVALAI, G.; IMPERADORI, M. The use of building technology to support disaster resilience: the case study of air shelter house. *International Journal of Disaster Resilience in the Built Environment*, v. 8, n. 02, p. 139-157, 2017.
- SENNE, L. L. B. Projeto APIS: uma experiência construtiva em arquitetura humanitária. In: GUNTHER, W. M. R.; CICCOTTI, L.; RODRIGUES, A. C. (org.). *Desastres: múltiplas abordagens e desafios*. 1. ed. Rio de Janeiro: Elsevier, 2017. p. 259-278.
- TIWARI, Pallavi; AL AZZAWI, Nibal; AMIR, Lübnä. Sustainable refugee camp design in the Dalhamyie settlement (Bekaa, Lebanon) for climate change context. *City, Territory and Architecture*, v. 10, n. 1, p. 1-14, 2023.
- TUMBEVA, M. D.; Wang, Y., Sowar, M. M., Dascanio, A. J., & Thrall, A. P. Quilt pattern inspired engineering: Efficient manufacturing of shelter topologies. *Automation in Construction*, v. 63, p. 57-65, 2016.
- UNITED NATIONS HIGH COMMISSIONER FOR REFUGEES - UNHCR. Shelter. [s. l.], 2020. Available in: <https://www.unhcr.org/shelter.html>. Access at: August. 2023.
- UNIVERSITY OF WISCONSIN. First International Emergency Settlement Conference. In: (D. Schramm, P. Thompson, Org.) 1996, Madison, U.S. *New Approaches to New Realities*. Madison, U.S.: University of Wisconsin, Disaster Management Center, 1996. p. 508.

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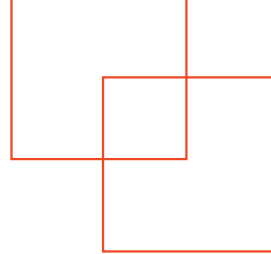
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