Tackling Housing Challenges in Vulnerable Communities: Sustainable Construction Using Recycled PET Plastic Bricks

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Abstract— **Inadequate housing affects over 1.8 billion people globally and poses significant risks to human dignity and public health. Despite being a fundamental human right, many individuals face eviction and homelessness. To combat this crisis, sustainable construction technologies, particularly those utilizing recycled plastics, offer a dual solution: mitigating the housing shortage while managing environmental waste. This study aims to evaluate the impact of using recycled materials in housing construction, focusing on its effectiveness in areas with severe housing deficits. This paper is organized into three main sections: contextualizing the housing crisis, analyzing its causes and consequences, and presenting and assessing the proposed solution. By examining reliable data and evaluating the feasibility of this innovative approach, the study seeks to provide engineers and stakeholders with actionable insights into sustainable and efficient housing solutions. Ultimately, this research is expected to contribute to both addressing urgent social needs and advancing sustainable development goals.**

Keywords: **Decent housing, plastic waste, recycled PET plastic bricks, sustainable construction**

Resumen— **La falta de acceso a una vivienda digna afecta a más de 1.800 millones de personas en todo el mundo y plantea riesgos importantes para la dignidad humana y la salud pública. A pesar de ser un derecho humano fundamental, muchas personas se enfrentan al desalojo y a la falta de vivienda. Para combatir esta crisis, las tecnologías de construcción sostenible, en particular aquellas que utilizan plásticos reciclados, ofrecen una solución dual: mitigar la escasez de viviendas y al mismo tiempo gestionar los residuos ambientales. Este estudio tiene como objetivo evaluar el impacto del uso de materiales reciclados en la construcción de viviendas, centrándose en su efectividad en zonas con déficit habitacional severo. El trabajo se organiza en tres secciones principales: contextualizar la crisis inmobiliaria, analizar sus causas y consecuencias, y presentar y valorar la solución propuesta. Al examinar datos confiables y evaluar la viabilidad de este enfoque innovador, el estudio busca brindar a los ingenieros y partes interesadas conocimientos prácticos sobre soluciones de vivienda sostenibles y eficientes. En última instancia, se espera que esta investigación contribuya tanto a abordar necesidades sociales urgentes como a promover objetivos de desarrollo sostenible.**

***Palabras clave*: Vivienda digna, desechos plásticos, ladrillos de plástico PET reciclado, construcción sustentable**

I. Introduction

Addressing the lack of decent housing is essential to protect human dignity and public health. Providing a safe and adequate place to live not only improves the quality of life for those affected but also benefits society in general by promoting equality and community wellbeing. Although adequate housing is a human right enshrined in international human rights law, more than 1.8 billion people worldwide lack adequate housing. Every year, 2 million people are forcibly evicted, many more are threatened with eviction, and around 150 million people worldwide are homeless [1].

In this context, sustainable construction technology using recycled plastics emerges as an effective solution. As such, it does not only address the housing crisis but it also contributes to environmental management by reducing plastic waste.

For this reason, it is necessary to offer solutions to this lack of decent housing. Addressing the construction of resilient and sustainable houses to meet this need in vulnerable societies is addressed by the United Nations in its Sustainable Development Goals (SDGs) Report. Particularly, SDG 9 aims to "Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation" [2].

Achieving an improvement in the percentage of the population with access to housing mainly involves providing them with decent housing. It is essential that these homes meet the basic needs of those affected.

The objective of this work is to analyze the impact that creating housing using recycled materials would have in areas where communities lack access to housing with basic resources. To this end, a review of the different data studied will be carried outthrough reliable sources and the results of the analysis will bepresented, which will allow engineers and other interested parties in these areas to choose a sustainable and efficient solution.

To meet this objective, this paper is organized into three sections. First, the contextualization of the problem will be addressed to understand its origin and relevance. Then, the causes and consequences of the problem will be analyzed, providing a complete framework of its impact. Following this, the proposed solution will be presented, contextualizing it within the previously described problem. Next, the viability of this solution will be evaluated, considering key factors for its implementation. Finally, a conclusion will be reached that summarizes the findings and reflects on the effectiveness of the proposal.

II. Housing Crisis Analysis: Identifying Areas with Critical Housing Needs

This section addresses the problem of housing crisis. It also describes its causes and consequences.

A. Contextualization and definition of the problem

Homelessness is a global phenomenon that affects a significant portion of the population in various regions of the world. It manifests itself in different ways, including the total

lack of a place to live, living in precarious conditions, and the lack of access to decent housing. According to [4], this problem is visible in both developed and developing countries, although its magnitude and characteristics vary widely by region. Statistics show that millions of people around the world lack a safe roof over their heads. It is estimated that approximately 1.8 billion people live in inadequate housing, and about 100 million are homeless [3]. In large cities, homelessness is quite evident, with people sleeping in the streets, parks, and other public spaces.

B. Causes of Homelessness Worldwide

In this section, the various causes of homelessness will be explored. The main reasons for the crisis will be revealed, taking into account the importance of understanding this problem at its root to later discuss the consequences it generates. As indicated in [3] and [5], the main causes of homelessness are the following.

Firstly, economic disparities are evident. They prevent access to decent housing, especially for low-income families. In urban environments, the high cost of housing forces many people to live in precarious conditions, such as informal settlements.

In the second place, natural disasters and climate change also affect homes. These destroy homes and displace entire communities, further increasing the housing shortage. The increasing frequency and intensity of natural disasters related to climate change increase the vulnerability of already marginalized populations, exacerbating housing shortages and generating an urgent need for sustainable and resilient solutions.

In the third place, rapid urbanization and population growth are also important factors to consider. Population growth puts pressure on available resources and increases demand for housing, further intensifying the crisis in many parts of the world.

C. Consequences of Homelessness in The World

This section explores the various consequences of homelessness, focusing on its direct impact on individuals and communities. These consequences, drawn from reliable data in [3] and [5], demonstrate the significant social and economic costs associated with homelessness.

Firstly, the lack of access to basic services is one of the most immediate consequences faced by homeless individuals. Without a stable home, many people are deprived of essential services such as healthcare, education, and sanitation. This lack of access exacerbates the vulnerability of these populations, making it difficult for them to escape the cycle of poverty and marginalization [3].

Secondly**,** displacement due to natural disasters is another critical issue. As highlighted by [5], natural disasters not only destroy homes but also displace entire communities, forcing them into temporary shelters or inadequate living conditions. The frequency and intensity of these disasters, amplified by climate change, further worsen the housing crisis by leaving a growing number of people without permanent shelter.

Thirdly, the creation of informal settlements is a widespread consequence of housing shortages in rapidly urbanizing areas. As urban populations grow, many people are forced to live in makeshift homes without access to clean water, sanitation, or electricity. These settlements, often located in hazardous areas, not only increase the risks for their residents but also strain local infrastructure and contribute to environmental degradation [3].

The causes and consequences discussed above show the severity of the problem, but it is crucial to focus on possible solutions. From here on, this paper will explore the strategies that can reverse this situation. These actions will not only mitigate the negative effects but also create a positive impact in the future.

III. SUSTAINABLE HOUSING SOLUTIONS: USING RECYCLED PLASTICS FOR RECYCLABLE BRICKS

This section addresses the proposed solution to the real estate crisis. It also describes the advantages and disadvantages of its implementation.

A. *Presentation of the solution*

In the face of the global housing crisis, recycling plastic waste to manufacture bricks for housing could positively impact both this crisis and environmental sustainability. Instead of letting plastic pollute our environment, transforming it into durable building materials offers an economic and sustainable solution to homelessness while helping to reduce pollution. In this way, an environmental problem is turned into an opportunity to improve the lives of many people.

As seen in [6], houses built from recycled Polyethylene Terephthalate (PET) bricks can meet all the basic needs of a functional home (Fig. 1). For a typical family, houses that have bathrooms, bedrooms, and all the basic services of a home can be built using these bricks. These bricks can also be adapted, if necessary, to different climates or topographical adversities depending on the geography where they are located. Therefore, this type of housing can be functional both in Argentina and in different countries with climatic and geographical challenges.

Fig. 1. House built with PET brick [6]

These functional houses are not only sustainable for the environment, but also, being made with a percentage of waste plastics, they are easily accessible. In an example taken from [6], a house intended for a low-income family is shown. If work is done on the collection of plastic waste, these houses could be manufactured in a faster and more efficient way, providing thousands of families with houses that meet their basic needs.

This proposed use of PET bricks offers a clear path to addressing the problem, but it is important to evaluate its implications in detail. The next section will analyze the advantages and disadvantages that this solution entails. This analysis will help to better understand its effectiveness

and possible challenges in its implementation.

B. *Advantages of building houses with PET bricks*

This section introduces the main advantages of this project, highlighting its most favorable and beneficial aspects. Firstly, thermal insulation is a crucial aspect when selecting construction materials, as it influences the energy efficiency and comfort of a home. Plastic, being a poor conductor of heat, acts as an excellent thermal insulator, surpassing traditional materials such as clay bricks. According to [7], insulation tests showed that recycled plastic bricks have a heat transfer coefficient (U) value that is ten times more efficient than that of clay bricks, making them especially suitable for extreme climates or regions with large temperature variations.

In the second place, sustainable construction industry has a large environmental impact, consuming up to 40% of global energy and generating 30% of greenhouse gas emissions, according to [7]. Recycled plastic bricks offer a sustainable solution by encouraging the recycling and reuse of plastics, reducing the need for virgin plastics and high-emitting materials such as steel and concrete. They also help reduce pollution from plastic waste in landfills and oceans.

In the third place, the strong and durable plastic bricks are a great option for those seeking strong and durable building materials. Thanks to the fibrous nature of the plastic and the intertwining of its fibers, these bricks can withstand extreme weather conditions and high pressures. The use of hydraulic compression machines in their production eliminates air pockets, increasing their strength. According to [7], these bricks are two to seven times more resistant than concrete bricks, and mixtures with a lower amount of sand offer greater compressive strength.

C. *Disadvantages of building houses with PET bricks*

Although the advantages of recycled plastic bricks, such as their excellent thermal insulation, sustainability, and durability, offer significant benefits, it is also important to analyze the potential disadvantages that could arise during the development of this project. For instance, their sensitivity to fire and high temperatures presents a challenge. Plastics are composed of thermoplastic polymers that degrade when exposed to high temperatures, according to [7]. At temperatures above 400°C (752°F) or in the presence of fire, recycled plastic bricks can melt and release toxic gases. Consequently, these bricks are more susceptible to fire compared to traditional materials such as concrete or stone.

In the second place, difficulty in repairing plastic bricks can be challenging, as removing, and replacing a damaged section without affecting the entire structure is problematic. Additionally, once installed, some plastic brick designs make it difficult to adjust or replace a part without impacting the rest of the construction. This difficulty can complicate maintenance and modifications to the structure.

In the third place, a notable limitation of recycled PET bricks is their lower absorption capacity compared to traditional materials. This characteristic can affect humidity control and thermal regulation inside buildings. In humid climates, the inability to manage moisture properly could lead to problems such as mold growth or condensation.

After evaluating the advantages and disadvantages, it is observed that this project presents a solid proposal, as the identified advantages outweigh the disadvantages. Although challenges exist, the benefits surpass the potential difficulties, reinforcing its likelihood of success. Based on these points, it is possible to move toward a conclusion that summarizes the key aspects and overall feasibility of the project

IV. CONCLUSION

This housing construction project using recycled plastic bricks addresses the critical issue of inadequate housing, a problem affecting over 1.8 billion people globally. The study contextualizes the severe housing deficit and the detrimental environmental impact of discarded plastics. By proposing the use of recycled PET plastic bricks, the project not only provides a sustainable solution for managing plastic waste but also offers an effective alternative for addressing the global housing shortages.

By examining the project details, including its advantages and disadvantages, it becomes evident that this is a viable initiative. It not only addresses the fundamental need for access to decent housing but also contributes positively to all the areas discussed throughout the project. Therefore, this project is not only technically feasible but also responds to urgent social needs, offering a promising solution for the future of sustainable construction.

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The present manuscript is part of the research activities in the Inglés II lesson at Universidad Tecnológica Nacional, Facultad Regional Paraná. Students are asked to research intoa topic so as to shed light on a topic of their interest within the National Academy of Engineering's Grand Challenges or the United Nations' Sustainable Development Goals frameworks. If sources have not been well paraphrased or credited, it might be due to students' developing intercultural communicative competence rather than a conscious intention to plagiarize a text. Should the reader have any questions regarding this work, please contact Graciela Yugdar Tófalo, Senior Lecturer, at gyugdar@frp.utn.edu.ar