

“A Review Paper on A New Sustainable Approach in Building Construction: Shipping Container Homes Addressing Challenges, Opportunities & Evaluating Economic Viability.”

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Abstract - The research begins by conducting a comprehensive review of the current status and relevant literature about sustainable development in the construction industry and the escalating demand for affordable housing. The study then shifts its focus to shipping container house construction methods, aiming to identify both the opportunities and challenges associated with this unconventional approach. Through a detailed examination of case studies and emerging trends, the research provides valuable insights into the feasibility and viability of shipping container homes as a sustainable solution for affordable housing in India.

To substantiate the practicality of container house construction, an economic feasibility analysis is conducted. This analysis delves into the costs, benefits, and potential economic implications of adopting shipping container homes on a larger scale. The findings contribute to a comprehensive understanding of the financial aspects associated with this innovative housing solution.

In the final phase, the thesis discusses potential policy recommendations that can facilitate the widespread adoption of shipping container homes in India. These recommendations aim to address regulatory barriers and incentivize sustainable construction practices, fostering an environment conducive to the integration of shipping container houses into mainstream housing solutions. Through this multi-faceted approach, the research seeks to provide a holistic understanding of the prospects and challenges surrounding sustainable construction, particularly in the context of affordable housing in India.

Key Words: Sustainable Construction, Shipping Container House, Affordable Housing, Innovative Housing Solution.

1. INTRODUCTION:

Shipping container homes is a new and innovative approach to sustainable design in the field of construction. They involve repurposing used shipping containers,

typically made of steel, into functional and livable housing units. These containers, originally designed for transporting goods internationally, are now being utilized as building blocks for eco-friendly and affordable homes.

The concept behind shipping container homes lies in their numerous advantages. Firstly, they offer a cost-effective solution, as shipping containers are relatively inexpensive compared to traditional building materials. Additionally, the abundance of unused shipping containers makes them readily available for repurposing, reducing waste, and contributing to a more sustainable construction industry. Another key advantage of shipping container homes is their eco-friendliness. By repurposing existing containers, these homes minimize the need for new construction materials and help reduce the carbon footprint associated with traditional building methods. Furthermore, they often incorporate sustainable features such as energy-efficient insulation, solar panels, rainwater harvesting systems, and other green technologies, making them highly energy-efficient and environmentally friendly.

1.1 ISO Shipping Container

An ISO shipping container refers to a standardized steel container that meets the specifications set by the International Organization for Standardization (ISO). These containers are designed for the efficient and secure transport of goods by various modes of transportation, including ships, trains, and trucks. The standardization ensures that ISO containers can be easily handled, stacked, and transferred between different modes of transport without the need for unloading and reloading.

1.2 ISO shipping container dimensions

In shipping container house construction, several container sizes are commonly used, with the most popular being the 20-foot and 40-foot containers. These dimensions provide a good balance between space and structural integrity.

These containers are versatile and can be combined or modified to create various architectural designs for container homes. Their standardized sizes make it easier to plan and design structures, and they can be stacked or joined to create multi-story or larger living spaces.

Here are the typical measures of these two ISO shipping container sizes:

Measures Of ISO Shipping Containers			
Measure	20ft	40ft	40ft HC
Internal length(ft)	19.4	39.5	39.5
Internal width(ft)	7.8	7.9	7.9
Internal height(ft)	7.8	7.9	8.10
Tare weight(kg)	2,300	3,750	3,900
Payload capacity(kg)	25,000	27,600	28,600
Cubic capacity(cu ft)	1,172	2,389	2,694.5

Table - 1.1 Measures Of ISO Shipping Containers

1.3 Key Steps involved in Shipping Container House Construction

● **Draw A Floor Plan**

To initiate the construction process, start by creating a floor plan. For good results, Keep the design simple with an efficient layout. In this design 40 ft high cube-length containers are mostly used, these containers are with exterior dimensions of 40 feet in length (12.19 meters), 8 feet in width (2.44 meters), and a height of 8 feet 6 inches (2.99 meters). To enhance efficiency, design a floor plan that minimizes indoor circulation, favoring a linear arrangement of interior spaces. This involves situating all indoor functions along the rear wall, creating enough room for open plan living and unobstructed movement to the bathroom and bedrooms.

● **Purchasing A Container**

The shipping containers are categorized using three parameters: the size, the type, and the condition of the container.

SIZE:

Shipping containers come in Standard lengths of 20 ft, 40 ft standard, 40ft High Cube, and 45 ft long either with a standard height of 8 ft, 6ft, or 9ft 6-inch high cube. The 20- and 40-foot containers are most commonly used to build container homes.

TYPE:

There are over 10 types of shipping containers however Standard Dry storage containers and high cube shipping containers are most commonly used to build container homes because they are commonly available.

CONDITION:

There are options to buy a container: A new container: Can be bought directly at the factory or from the dealer, One trip container: It is used to ship a single cargo of load and sold at its destination, A used container: It has varied goods more than once to various destinations around the globe. Building a shipping container house with a one-trip container is a better choice on both quality and price than buying a container locally to cut delivery costs.

● **Siting And Foundations**

A Proper foundation is most important to elevate the container off the ground away from moisture to avoid rust, corrosion, and dampness. In addition, the elevated position provides an ideal height to construct a deck to enlarge the limited indoor living space to the outdoors. There are five different types of foundations used in building shipping container homes. Pier foundation, Slab Raft foundation, Pile foundation, Strip trench foundation, or alternative foundations. Pier foundation is the simplest and cheapest type and most commonly used type. The size And type of pier to use depends upon load capacity. They placed each corner of the container and an additional pier in the middle.

● **Openings And Modifications**

Shipping containers, originally designed as watertight steel boxes for transporting cargo on ships. And now to transfer these into habitable spaces involves cutting openings in the container walls to establish connections for windows and doors. The purpose of these modifications is to ensure sufficient natural day lighting, cross ventilation, and proper access within the container-adapted living or working spaces. However, the modification of containers by cutting out openings weakens the structural integrity. So openings are reinforced by welding additional steel around them to maintain their strength and avoiding over-modification for economical construction is the best option.

● **Framing And Partitions**

Install a structural framework if additional support is required or for creating interior partitions. Build interior walls using suitable materials, taking into account the dimensions of the containers.

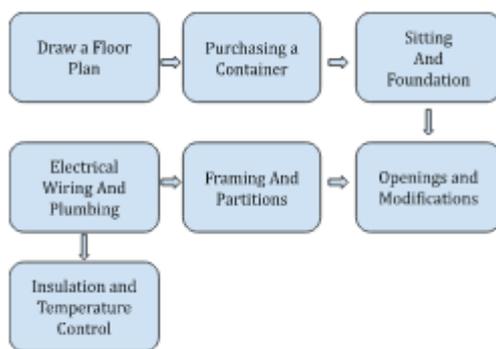
● **Electrical Wiring And Plumbing**

Plan the electrical layout, including placing outlets, switches, and lighting fixtures. Install electrical wiring, ensuring compliance with safety standards. Plan the plumbing system, including the location of bathrooms, kitchens, and other fixtures. Install plumbing pipes and connect them to the main water supply and sewage system.

● **Insulation And Temperature Control**

Apply insulation to the container walls, ceiling, and floor to regulate temperature. Choose insulation materials suitable for your climate. Install HVAC (Heating, Ventilation, and Air Conditioning) systems for temperature control.

Flow Chart:



Steps involved in Shipping Container House Construction

1.4 Benefits Shipping Container House Construction

● **Environmental Sustainability:**

Reduces the demand for new construction materials. This sustainable approach minimizes the environmental impact associated with traditional building methods by promoting recycling and reuse.

● **Reduced Carbon Footprint:**

Reduces the need for extensive manufacturing processes and transportation of traditional building materials. This results in a lower carbon footprint, contributing to the overall goal of reducing greenhouse gas emissions.

● **Cost Efficiency:**

The use of recycled materials and the modular nature of containers can lead to lower construction costs, making sustainable housing more affordable and accessible.

● **Rapid Construction:**

The ability to prefabricate components off-site and assemble them quickly on-site accelerates the construction process, meeting housing demands more efficiently.

● **Adaptability to Different Locations:**

Container homes are adaptable to different geographic locations and climates. Their robust structure makes them suitable for a range of environments, and modifications can be made to enhance energy efficiency and thermal performance, ensuring comfort in various settings.

● **Resource Efficiency:**

It minimizes the extraction of raw materials and reduces construction waste, contributing to a more sustainable and responsible use of resources in the building industry.

2. LITERATURE REVIEW:

Nandugwa Harriet (2021) This paper explores the environmental impact of building construction on climate change, emphasizing the association between increased construction and heightened greenhouse gas emissions. Focusing on sustainable alternatives, the study compares two structures of identical size (29m x 20m, three storeys) constructed with different materials—shipping containers and masonry. Carbon dioxide and embodied energy emissions were computed for each structure, revealing that the container-based construction exhibited a substantial reduction of 20% in embodied energy and an impressive 49.3% decrease in CO2 emissions compared to traditional masonry construction. The findings underscore the potential of using shipping containers as a sustainable approach to building, contributing to reduced environmental impact in the construction industry.

Dr. Mai Madkour (2018) Finds that Affordable housing remains a critical issue in many countries, including Egypt. Despite various government programs, the demand for housing for the poor exceeds the available resources. This research highlights the significant role of building materials, constituting 55% to 65% of construction costs. However, the study proposes an innovative solution—shipping containers as modular building materials. These containers can potentially reduce construction costs by 50%, offering a sustainable approach to mass housing development.

Vaishali Anagal (2020) Large infrastructure projects often require temporary housing for employees and their families during the project setup, which can span several years. However, this housing becomes unnecessary once the project is operational. Shipping containers offer a solution as prefabricated modular units for such temporary housing needs.

3. SCOPE OF WORK:

This study covers the opportunities and challenges associated with using shipping containers as a construction method for affordable housing. Explore factors such as cost-effectiveness and environmental

impact. Evaluate construction costs, potential savings, and long-term financial implications. Consider factors such as material expenses, labor costs, and maintenance requirements to determine the economic viability of this approach. Also, Examine the existing policy related to housing construction in India. Propose potential policy recommendations to facilitate the widespread adoption of shipping container homes. Consider regulatory adjustments, financial incentives, and public awareness campaigns to encourage sustainable and affordable housing solutions. Conclude with insights into the potential policy interventions required to successfully integrate shipping container homes in the Indian housing sector.

4. OBJECTIVES OF THE STUDY:

- To study the present status and make literature reviews of sustainable development in construction and increasing demand for affordable housing.
- To identify opportunities and challenges in shipping container house construction methods.
- To conduct an economic feasibility analysis on shipping container house construction.
- To discuss potential policy recommendations to facilitate the widespread adoption of shipping container homes in India.

5. METHODOLOGY:

The following methodology will be adopted:

- **Step 1:**
Collection of preliminary information through literature Review on sustainable development in construction and the rising demand for affordable housing.
- **Step 2:**
Conduct interviews (Questionnaire survey) with experts, owners, and individuals on shipping container house construction to gather qualitative insights on opportunities and challenges.
- **Step 3:**
Select representative shipping container home projects for in-depth case studies, focusing on their construction processes, energy efficiency, and economic performance.
- **Step 4:**
Develop a comprehensive cost analysis for shipping container homes and compare it with traditional construction methods

- **Step 5:**

Recommendation of potential policies based on the findings from the analysis to encourage the widespread adoption of shipping container homes in India.

6. STUDY PROCESS:

This study involves mainly the following process

- Determination of objective and scope of study work.
- Review of the literature.
- Site visit and collection of data using questionnaire survey.
- Cost analysis for shipping container homes and compare it with traditional construction methods.
- Suggestions for improving the performance of Shipping Container House Construction.
- Recommendation of potential policies.
- Discussion of result and conclusion.

6. PRACTICAL IMPLICATION:

The study seeks to have positive implication on

- **Public Awareness and Education:** Implement targeted public awareness campaigns to educate communities about the environmental benefits of shipping container homes, emphasizing reduced carbon footprint and minimized construction material waste. Promote understanding and acceptance of sustainable construction practices to garner support for this innovative approach.
- **Addressing Insulation Challenges:** Develop and implement effective insulation solutions to regulate indoor temperatures, ensuring energy efficiency and creating comfortable living environments. This practical step will contribute to overcoming a key hurdle in the widespread adoption of container homes.
- **Policy Recommendations:** Formulate the policies that support the widespread adoption of shipping container homes. Propose regulatory frameworks that encourage sustainable construction practices, incentivize the use of recycled materials, and streamline the approval process for container home projects.

7. CONCLUSION OF STUDY:

- There is a need for both affordable and sustainable housing solutions in India. The demand for housing that is both economically viable and environmentally responsible.

- The findings reveal a mix of opportunities and challenges in this innovative housing approach.
- The study underscores the need for increased education and awareness to foster understanding and acceptance of this alternative housing solution among the surveyed individuals.

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