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Shipping Container as Temporary and Permanent Structure Option

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Abstract - This research paper explores the feasibility of constructing with ISO shipping containers as structural elements. Widely available ISO shipping containers can be a low-cost building resource, as proven by a number of pioneering individuals. It's unclear why these units don't get used more frequently. The purpose of this document is to give an overview of this medium's visibility and to identify any issues that have occurred or might happen when using it.

Key Words: Shipping, Containers, Building.

1.INTRODUCTION

The shipping containers market in the last five years has witnessed continuous growth. Shipping container homes are built from strong aluminum and metal that makes them indestructible and hence sustainable. They can withstand harsh climatic conditions and they are designed to bear heavy loads. Due to their structural stability, they are extremely safe for all type of areas. These containers can last at least for 25 years but they can last even much longer if they are properly maintained. However, rusting is the only issue that can reduce the lifespan of these homes. The concept of container homes in India was only confined to low-cost accommodation and for mobile office around the construction sites. However, it is now becoming a popular trend among the High-Net-worth Individuals (HNIs) who want to experiment with different housing layouts. India's first container home is claimed to be built in Bengaluru five years back. Shipping containers are remarkably flexible and versatile. They are made out of steel, which provides superior durability that keeps secured and cost effective as compare with conventional method.

2. HISTORY AND TIMELINE

Before shipping containers, all goods were manually loaded into sacks, barrels and wooden creates loaded directly onto cargo vessels – known as break-bulk shipping. It could take up to 3 weeks to unload and load each ship. Today's massive container ships can be unloaded and loaded within 24 hours, thanks to the advent of the shipping container. Containerization has proven by far to be the most efficient and cost-effective option to conduct trade and facilitate consumerism across distant geographies. Around 55 percent of India's total trade currently moves in containers, and this ratio is growing. Maersk Line, a global container shipping company, transports around 20 percent of India's total container cargo. The intermodal shipping container was born back in 1956 by an American entrepreneur Malcom McLean and has since revolutionized shipping and global trade. He started working with engineer Keith Tantlinger to engineer the world's first shipping container. It was an incredible invention that eliminated wasted space and cut unloading time by up to 3 weeks. The most significant change is that the shipping container allowed cargo to be seamlessly transported between road, rail and sea. Today's modern shipping vessels can carry over 20,000 TEU shipping containers (Twenty-Foot Equivalent Units). There are currently 20 million shipping containers 'on the water' travelling between countries all over the world.

2.1 CURRENT SCENARIO

Research says that about twenty million containers are neglected around the globe at all times, with over one million having no purpose other than taking valuable space. It will explore the possibilities of low-cost housing and venture into how they will contribute to society in terms of finance According to research, students require more housing options due to high demand. Reusing and recycling of materials is considered as an important value in architectural filed.

2.2 SIZES AND STANDARD DIMENSION

Geometrically, container is a cuboid that comes in different modules as given in table no. 1

Table No.1

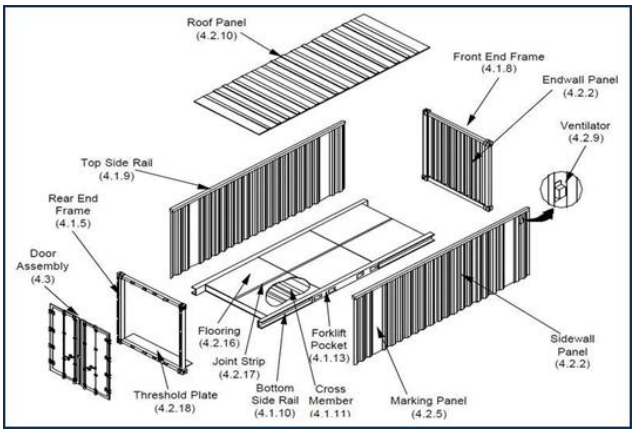

Fig.2.1: Components of shipping Container

2.3 RECYCLE AND UPCYCLE

About 250,000 containers of metal scrap are lying at major ports such as Mundra, Nhava Sheva and Chennai port with 200-250 medium and small-scale importers abstaining from taking delivery amid the nationwide lockdown to contain the Covid-19 pandemic. Process of turning a humble shipping container into new structures and thereby adding to its value. Structural construction is completed by simply securing them in place using the corner castings or fabricating additional connection points. Due to the containers' modular design additional construction is as easy as stacking more containers. Recycled Containers can be stacked up to 12 high when empty. A 40ft shipping container weights over 3,500KG so each time one is up-cycled we are saving thousands of kilograms of steel. In addition, when building with containers, we are also reducing the amount of traditional building materials needed (i.e. bricks and cement). Also, hotels, whole shopping centres, museums, colleges, even mobile football stadiums can be built through shipping containers.

3.METHODOLOGY

Data for this research report has been collected in both qualitative and quantitative natures in order to develop and examine the "whole scope" of the topic. Many pictures have been taken of the site through several different stages of the construction process as well in order to provide a sense of scope and timeline. Interviews were conducted with the owner, the general contractor, and the lead engineer in order to have a well-rounded and comprehensive explanation for what has gone well and where improvements could be made in order to make this form of construction more feasible for a temporary and permanent usages.

4. LITERATURE REVIEW

4.1 Case Study

1.Pavilion for Eastern Heights Real Estate in Taiyuan, China:

The Beijing-based architecture studio stacked up containers into two rows with opposing angles to create a building that boasts zigzagging edges, projecting roof terraces and cantilevered overhangs. Called Container Stack Pavilion, the structure is painted bright red on the lower level, while its upper tier is finished in a vibrant shade of yellow, helping it to stand out from its setting. People's Architecture Office designed the building for Taiyuan, a town that was recently connected to Beijing by high-speed rail, and that is set to get a new metro in 2020.

It provides an office and showroom for local property developer Eastern Heights Real Estate. The building can be moved to different locations as required. Its unusual form was created to offer an assortment of different spaces for the company's activities.

"The pavilion itself seems to extend out toward bordering streets, showcasing its interior activities." Each container has either glazed doors or windows built into both ends, allowing plenty of daylight to enter the building.

There is also large floor opening inside the building, creating a double-height atrium at the center of the plan. The architects describe this space as having been carved out. Seating areas are located on both levels, positioned within the various niches. Other features include an indoor ball pond and an outdoor sandpit, which both provide play areas for children.

Staircases are located both inside and outside of the building, linking the two floors with the expansive roof terraces.

Fig: 4.1 Pavilion for Eastern Heights Real Estate in Taiyuan, China

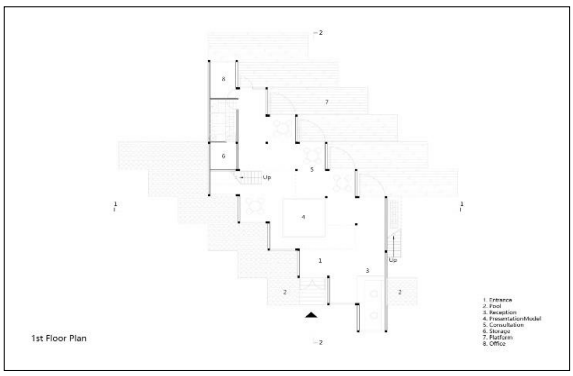

Fig 4.2: 1St Floor Plan

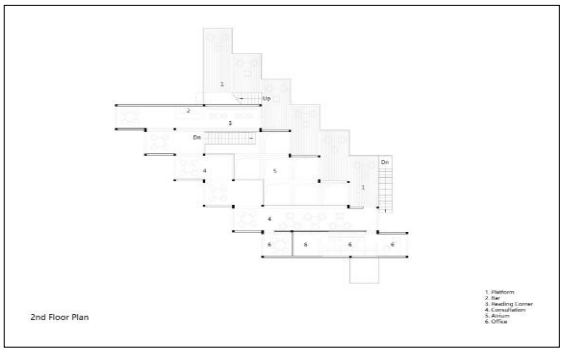

Fig 4.2: 2nd Floor Plan

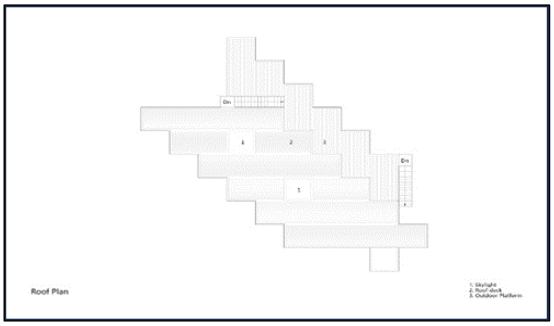

Fig 4.3: Roof Plan

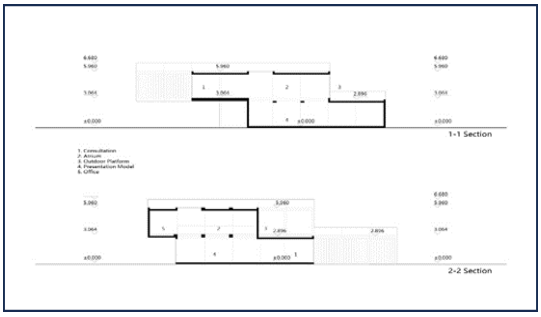

Fig 4.4: Section

2. Keetwonen Student Housing in Amsterdam, The Netherlands

Keetwonen is the name of the biggest container city in the world, living in a converted shipping container was a new concept in the Netherlands when launched by Tempo housing, but the city of Amsterdam took the step to contract Tempo housing to go and realize it. It turned out to be a big success among students in Amsterdam and it is now the second most popular student dormitory offered by the student housing corporation "De Key" (www.dekey.nl) in Amsterdam. The initial fears of some people that the container homes would be too small, too noisy, too cold or too hot, all turned out to be unfounded: they turned out to be spacious, quiet and well insulated and certainly offer value for money, compared to other student homes in the city. They also come complete with amenities often missing in other student dormitories: own bathroom and kitchen, balcony, separate sleeping and study room, large windows that provide daylight and a view and even an automatic ventilation system. The whole project was designed with an eye on how students like to live: a place for yourself, not having to share the shower and the toilet with strangers, but at the same time lots of possibilities to participate in the social life of the dormitory, including the many parties that come with being a student. The blocks have a closed off internal area for safe bicycle parking. Tempo housing's Keetwonen project was created in 2005. Residents may technically be studying in containers, but by no means are the individual rooms bare boned; each room has a bathroom, kitchen, balcony, and even high-speed Internet. The temporary project was originally meant to move on this year, but residents will be happy to know that relocation will not take place until 2016. And upon relocation, yes, the home can go with you.

Fig: 4.5.: Keetwonen Student Housing in Amsterdam, The Netherlands

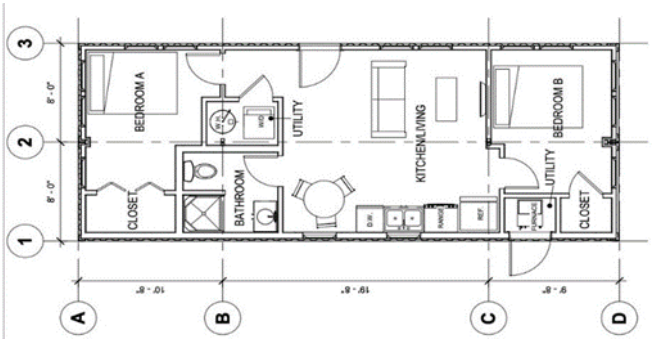

Fig 4.6: Typical Floor plan of a Single room Shipping Container

3. Zostel at Panchgani

Zostel at Panchgani, the hostel for backpackers is situated near a hill station Panchgani, the strawberry capital of India in the Western Ghats of Maharashtra. Design has evolved in response to the need of backpackers (18 to 40 years of age) for safe, comfortable and hygienic place to stay at a scenic location while traveling on a shoestring budget. Since it's opening, this place has been re-visited by many, in different Seasons for experiencing the sheer joy it offers through its design setting. With valley views to all and cascading outdoor spaces, it remains a sought-after destination among millennials with average 90 percent occupancy.

The design ideas for Zostel at Panchgani, have evolved from simple observations from the nature. The container boxes are poised as if they are keeping an inquisitive vigil over the valley and surrounding, not to miss any drama created by clouds with the sunlight or a flock of birds flying by or the breeze gushing through the grass. Structural properties of the shipping containers are fully exploited to obtain maximum habitable space with minimum ground contact by precariously balancing the ensemble of masses; much like the Sherpa carries loads while negotiating the narrow traversing routes on the Himalayan slopes. The hostel facility is provided with well-integrated mechanical, electrical and plumbing services with ease of operational maintenance.

The unstable site slope was held together by a tree or two at places but largely had to be retained by narrow terraces, much like the paddy fields along hill slopes, to create usable spaces in stepped manner to place narrow and long footprints of the containers parallel to the slope, leaving the in-between spaces of this hamlet for traversing and for the community and inducing least impact on the local ecology. The new found modern idiom of architecture suits the culture of its own typology. Recognized as a social need, the design creates an environment amidst nature for young urban travelers seeking solitude, personal time with soul mates or to make new friends.

Fig 4.7: Zostel, Panchgani, Pune

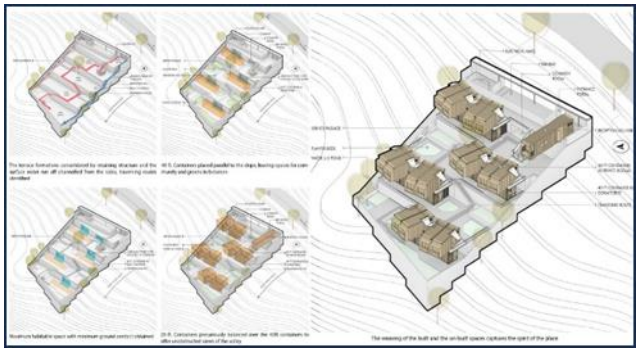

Fig 4.8: Typical Floor plan

4. PLATOON KUNSTHALLE BERLIN

Platoon Kunsthalle opened its doors on 19th July 2012. platoon kunsthalle is set up in berlin as a space for subculture in Europe and the global creative network of platoon. its programmatic orientation towards cultural movements beneath the radar creates a dynamic space where new ideas are born and presented. Platoon cultural development was established in 2000 in berlin. it runs diverse culture and communication projects in cooperation with an international community of 6,500 creatives from all different professions. the sister-venue platoon kunsthalle seoul / south korea opened in 2009 and functions as the asian headquarters of platoon. Platoon Kunsthalle is not about entertainment. the program provides a communication platform for anybody interested in subcultural creative fields like street art, graphic design, fashion, video art, programming, music, club culture, political activism etc.

Platoon Kunsthalle is built of 33 iso cargo containers. as icons of a flexible architecture in a globalized culture, the stacked containers form a unique construction that

can be rebuilt anywhere else any time. As platoon Kunsthalle is located in berlin/mitte as the confrontation of subculture with the close-by design houses, commercial galleries and brand stores creates a tension and interaction between the two worlds. Platoon Kunsthalle provides showcases of underground artists, studio residencies and a fine selection of cutting-edge stage performances to introduce the energetic potential of subculture.

Subculture at platoon Kunsthalle is presented in different formats like exhibitions, movie nights, concerts and multimedia performances, workshops, discussion panels and special events. the scholarship program gives young upcoming artists the opportunity to develop creative projects at the platoon Kunsthalle. the 3 showcases present every month striking works from the subculture and street art field including leading artists of the international urban art scene.

Fig 4.9: platoon kunsthalle berlin

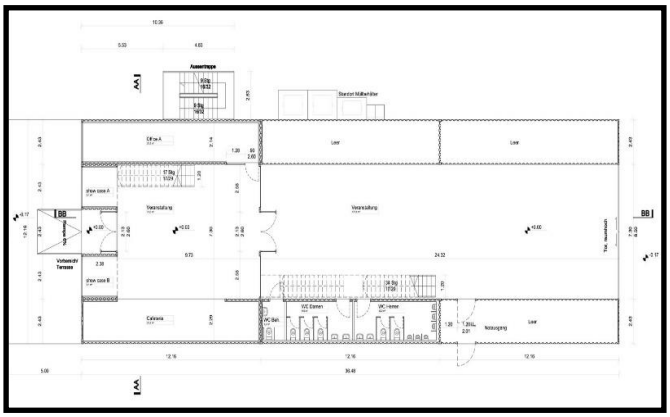

Fig 4.10 : Ground Floor Plan

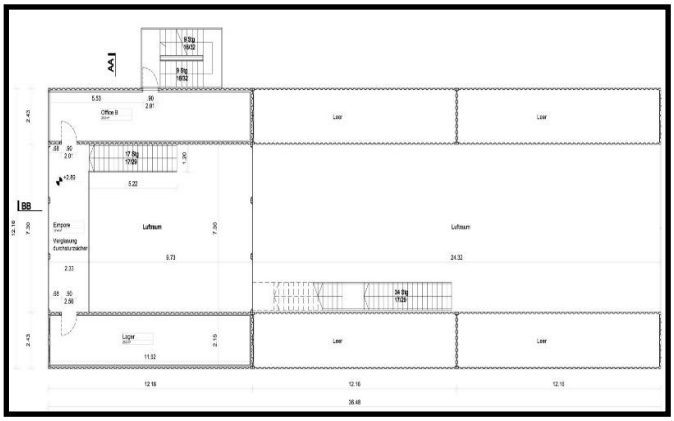

Fig 4.11: 1St Floor Plan

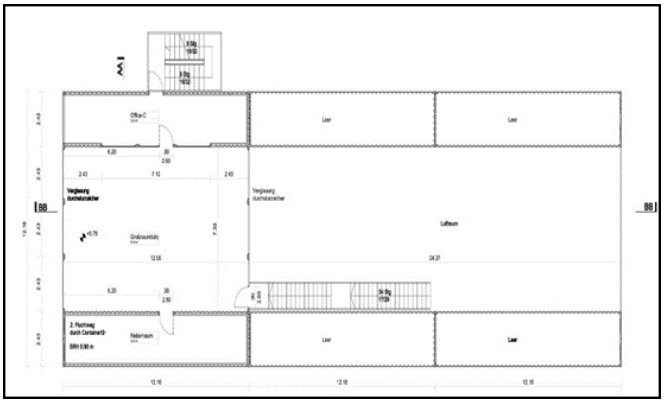

Fig 4.12: 2nd Floor Plan

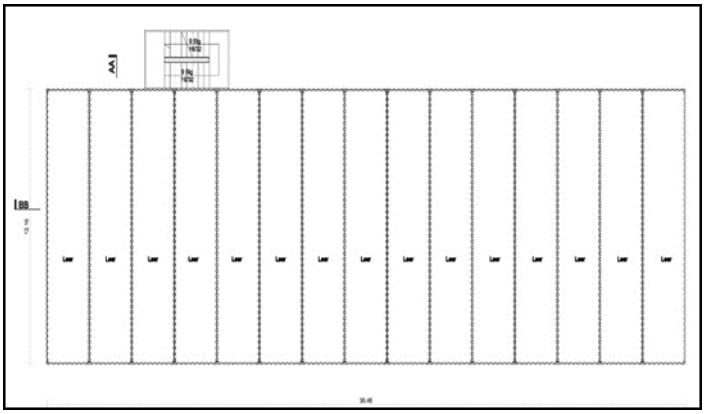

Fig 4.13: 3rd Floor Plan

5. Outcomes From Literature Review and Research

The use of shipping containers in construction allows construction to take place in a more expeditious manner. This type of construction can be built modularly, which allows them to be taken apart and moved around, making them a great option for temporary housing; and in this way, shipping container construction is one of the most

versatile forms of construction for emergency situations.

This form of construction is often much more cost effective than traditional ground up construction.

The inherent strength and ability to withstand large external forces put on these steel shipping containers provides for a very strong starting block for constructing a structurally sound building. It is an eco-friendly way of constructing since it recycles shipping containers that were already in circulation; one 40' shipping container recycles roughly 8,000 pounds of steel. Using these unused containers is a great example of adaptive reuse.

5.1 Social Impacts

Using shipping container as temporary and permanent structures has various social impacts both positive and negative.

5.1.1 POSITIVE IMPACTS:

Affordable Housing Solutions: Shipping container structures can provide affordable housing options, particularly in areas facing housing shortages or where traditional construction costs are high. This can contribute to addressing homelessness and improving living conditions for low-income populations.

Rapid Deployment in Emergencies: Shipping containers can be quickly repurposed into emergency shelters in the aftermath of natural disasters or humanitarian crises, providing immediate relief to affected communities.

Environmental Benefits: Reusing shipping containers reduces waste and the need for new construction materials. Additionally, incorporating sustainable practices such as solar panels and green roofs can further enhance environmental benefits.

Flexibility and Adaptability: Shipping container structures are versatile and can be easily modified or relocated according to changing needs. This flexibility makes them suitable for various purposes, including pop-up shops, community centers, and schools.

Promotion of Innovation: The use of shipping containers in construction encourages innovation in design and architecture. It challenges traditional notions of building materials and fosters creativity in adapting these industrial objects for human habitation.

5.1.2 NEGATIVE IMPACTS:

Limited Space and Comfort: Shipping containers have compact dimensions, which may result in cramped living conditions, especially for larger families. Adequate insulation, ventilation, and amenities must be carefully considered to ensure occupants' comfort and well-being.

Health and Safety Concerns: If not properly refurbished, shipping containers may contain hazardous materials such as lead-based paint or toxins from previous cargo. Additionally, inadequate ventilation can lead to indoor air quality issues and respiratory problems.

Regulatory Challenges: Local building codes and zoning regulations may present obstacles to the widespread adoption of shipping container structures, requiring extensive permitting and approvals that can delay projects and increase costs.

Solar Heat Gain: The metal surface of shipping containers absorbs solar radiation, leading to increased interior temperatures, particularly in sunny climates or during the summer months.

6. SCOPE FOR PREFABRICATED SHIPPING CONTAINERS FOR TEMPORARY AND PERMANENT USABILITY

There are broader initiatives and policies related to affordable housing, sustainable development, and innovation in construction that could indirectly support the use of shipping containers for building purposes.
Here are some government programs and initiatives in India that could potentially be leveraged or adapted for container-based construction:

1. Pradhan Mantri Awas Yojana (PMAY): PMAY is a flagship affordable housing program launched by the Government of India. It aims to provide affordable housing to urban and rural households by 2022. While the program primarily focuses on traditional construction methods, there may be opportunities to integrate container-based housing solutions, especially in urban areas facing land scarcity.

2. Smart Cities Mission: The Smart Cities Mission aims to drive sustainable urban development and improve the quality of life in Indian cities through technological interventions and innovative infrastructure projects. Container-based construction could be explored as part of smart city initiatives to address housing challenges and promote sustainable urbanization.

3. Startup India: The Startup India initiative promotes entrepreneurship and innovation across various sectors, including construction and housing. Startups and entrepreneurs in the construction industry could receive support, funding, and mentorship through this program to develop and scale innovative solutions using shipping containers as building components.

4. Make in India: Make in India is an initiative aimed at boosting domestic manufacturing and attracting foreign investment in key sectors, including construction and infrastructure. Encouraging the local manufacturing of prefabricated container modules and components could align with the goals of this program, promoting job creation and economic growth.

5. National Mission for Sustainable Habitat (NMSH): NMSH focuses on promoting sustainable urban development practices, including energy-efficient and environmentally friendly construction techniques. Container-based construction, with its potential for recycling and reduced environmental impact, could align with the objectives of this mission.

6. Technology Innovation Hubs: The Indian government has established technology innovation hubs and research institutions to promote research and development in emerging technologies and sectors. These hubs could support research, testing, and validation of container-based construction methods and materials, driving innovation in the field.'

7. Skill Development Programs: Skill development initiatives aimed at the construction sector could include training programs for architects, engineers, and construction workers on container-based construction techniques. Enhancing skills.

7. CONCLUSIONS

The information collected from this research and experience constructing with this method is particularly practical in circumstances where time is of the importance or when a project calls for a more modern and creative design. Additionally, modern residential development, the food and entertainment industries, and commercial construction all use shipping container projects widely around the world. and to refocus the study on offering temporary housing. Prefabricated container homes are already on the market; users can customize the containers according to their requirements and have a modular home in shorter timer period. The greatest practical application of this construction technique is the prefabricated modular home market. Repurposed containers are a flexible, cost-effective, and available substitute for traditional building materials, suggesting that they may be the building material of the future. The building's energy consumption has not increased significantly, according to Simulation of energy. Shipping containers can be integrated as a structural element into mid-rise buildings, as demonstrated by residence design technique. There is a lot of potential for the futuristic usage of shipping containers as an affordable and environmentally friendly living option. In a world that is changing quickly, shipping containers provide a flexible way to meet the growing need for housing because of their built-in durability, flexibility, and modular design. They can be a popular choice for both temporary and permanent homes because of their affordability as well as their adaptability to different demands and settings. Also, their sustainability credentials—which come from reusing pre-existing materials and having a smaller environmental impact than traditional construction methods—align wonderfully with a growing focus on eco-friendly living that is being placed on worldwide. Shipping container housing is primed for growth as creative design strategies continue to surface and technological developments allow for even greater improvements in comfort and efficiency to have an important effect upon how affordable and sustainable living is developed in the future.

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