

CARGOTECTURE: THE MODULAR EVOLUTION OF ARCHITECTURE**Kyselova G. V.,**Senior Lecturer, Department of Urban Planning,
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Abstract. In connection with the global challenges that arise humanity in the 21st century, humanity continues to look for ways to reduce the costs of building housing and sub-housing. As an alternative option, more and more often standard sea containers are used, suitable for both permanent and temporary accommodation. The material of the article provides experience and general characteristics of housing from sea containers and its construction.

Over the past two decades, the trade imbalance between Asia and Europe on one side and North America on the other has been the main cause of the abundance and relative cheapness of shipping containers (SCs), as such containers carry manufactured goods to North America from Asia and, to a lesser extent, from Europe. Instead of ship empty containers back to Asia and Europe at considerable expense, manufacturing new containers is considered more economic.

Once these containers have served their purpose, they are thus stored at seaports in large numbers before they are recycled as scrap or reused as spatial modules in architecture.

The Reuse of SCs for architectural purposes is not limited to certain types of buildings but extends from small private homes to skyscrapers. SCs offer infinite possible assemblies based on their modularity and are used for all types of buildings, social, domestic, and commercial. The SC goes a step further compared to traditional masonry, with longer cantilevers originating from its structural composition. As a relatively untapped trend, SCs can be slotted into a structure, and this integration creates a new symbiosis.

In this article, based on an analysis of world experience, the prospects for building from sea containers are presented. The advantages and disadvantages, as well as the features of such buildings and structures are considered. The container specifies a specific module that imposes a restriction on the construction. But even so, the world resource of this material for creativity and construction is practically unlimited. One factor that has made it easier for the architecture and construction industry to accept the container as a building element is the fact that millions of containers are decommissioned every year. The balance of trade in many Western countries, which import more goods than they export, means that many containers remain in warehouses and are not used. Cost savings and space savings are also an advantage of the new approach.

Keywords: shipping container, cargotecture, design, building materials, box structure, architecture, system.

Introduction. Prefabricated houses from cargo containers are a new trend in modern architecture. Sometimes referred to as «cargotecture» shipping container architecture utilizes modified, repurposed shipping containers to create building elements. Container-based structures range from unique art sculptures to office buildings, sports stadiums, and even single unit storage containers – and the list goes on! There are many possibilities when it comes to modifying shipping containers into structures, so it's important to understand the advantages and disadvantages before embarking on a container modification journey. The sustainability of building with recycled elements, as well as reducing construction time and therefore the cost of buildings and their carbon footprint, are some of the benefits that are often claimed to be brought to architecture and construction. However, before the container becomes habitable, it is necessary to carry out serious measures for its isolation and conditioning.

Analysis of the latest sources of research and publications. The theoretical basis of the study is the analysis of research works on the theory of architecture related to the study of construction from cargotecture. Such scientists as Marc Levinson, Ross Gittins, A. H. McKinley, A. L. Brody, Jure Kotnik, Josep Maria Minguet and others were engaged in the problems of architectural theory and the development of construction schemes. Important for the analysis were the studies of such scientists as: I. P. Gnes, V. I. Babyak, A. Kalkin, B. Fainok.

Formulation of the task. The purpose of this work is to determine the container architecture, the advantages, disadvantages, and prospects of this direction. The study is based on the study of world experience in the use of sea containers in architecture, for the further development of scientific and practical methods for designing this type of building. Analyze and explain the areas in which this type of construction is positive, negative and areas that could benefit from further improvements.

The basic material and results. Cargotecture is the use of shipping containers for creating fully functional buildings whether they are for a business or for a home. There are a wide range of projects that can be built, from low-cost housing to vacation homes. The best part of these container conversions is that they are utilising containers that would otherwise not be used for much else.

The term cargotecture was coined in 2003 and it is used to describe a building that is either partially or fully constructed using recycled ISO shipping containers. This is a great way to utilise thousands of containers that would otherwise be sent for scrap. These containers can be relocated, are secure and versatile and can be extremely useful in situations where buildings are needed quickly because the basic structure is already in existence. The container can be placed in a location and then the interior can be modified, with the electrical wiring and plumbing being outfitted afterwards [1].

Cargotecture is also the art of taking one or more shipping containers and creating a design, complete with windows and doors cut out, that will accommodate the needs of the occupant. Many people love the fact that building with shipping containers allows them the opportunity to enter into an expensive housing market that they would never have otherwise been able to enter. This is an exciting opportunity to take a basic box, much like an empty canvas and develop it into something that can become a way for people to own their own home in a fraction of the time, and at a fraction of the cost.

Shipping containers are one of the very many ingenious productions of the world of architecture. They are containers whose functions have been re-engineered to be suitable for all kinds of projects with ties to construction. These containers can be constructed into small cubical cabins, mini-homes on wheels, much bigger homes, and several other compartment peculiarities [2].

Shipping containers, used as building materials, offer a range of benefits. They are inherently strong, come ready-made, and can handle all types of harsh environments. They can be easily transported by train, truck, or sea (indeed, this is exactly what they are designed for), and can be easily stacked to create shipping container buildings of various sizes.

On top of that, building a shipping container house is quite simple. Conversion is not difficult, and they are relatively inexpensive and can be modified to suit a range of applications [3].

The shape of shipping containers makes them ideal for repurposing into buildings. Compared to building a similar structure with brick and mortar, on average, a cargotecture can be 30 percent cheaper. However, the savings will depend on the location and what type of home you are building.

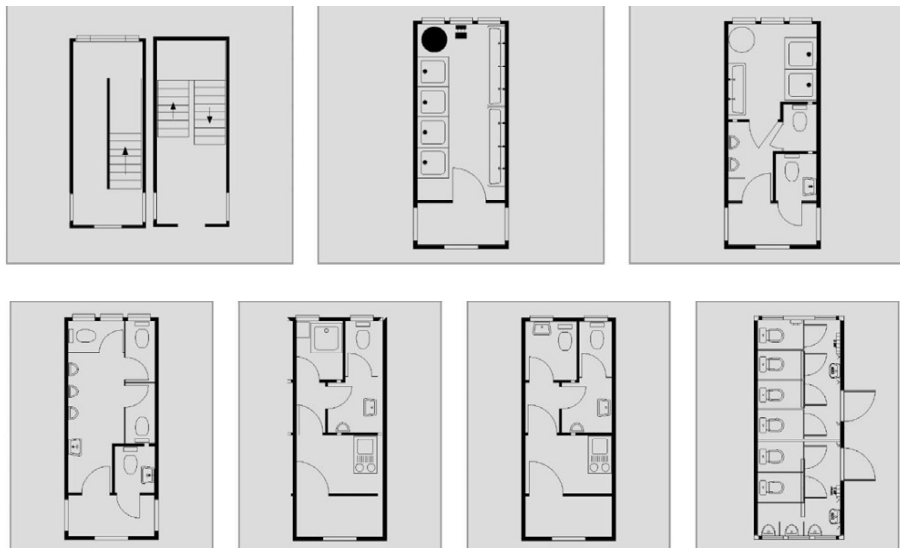
Another thing to keep in mind is that a cargotecture home won't be the same as what you are used to in a traditionally-built home – if cost is a top priority. The look and function will be different, and you will have to make compromises [4].

Once your shipping container home is designed and the containers are modified, it only takes a few days to take them to the desired location and put them all together. That means in only a few days, you can be making toast in the brand new kitchen of your brand new home.

The fact that increased global trade in the last two decades has made sea containers widely available at low prices has also contributed to the popularisation of this kind of construction [5].

The modulated containers housing establishes a complete production system. This system brings some challenges, such as internal temperature control. To solve this, it is important to study the orientation of the ground and the implementation of the project in order to take advantage of the local climate and to line the inner layers with thermo-acoustic insulation to guarantee the user's comfort. However, there are also advantages such as ease of assembly. In some cases, each container requires approximately half an hour to be raised. The box structure, doors, windows, roofing, floors, and walls can be completely prefabricated drastically reducing construction time.

Planning solutions for container modules are shown in (pic. 1) [6].



Pic. 1. Series of ADVANCE business class modules

Blossoming from the rugged terrain of the California desert, Whitaker Studio's Joshua Tree Residence is taking shipping container architecture to the next level. Set to begin construction in 2018, the home is laid out in a starburst of containers, each oriented to maximize views, provide abundant natural light or to create privacy dependent on their location and use. The shipping container «exoskeleton» will be raised on concrete pilotis, allowing water to continue to pass underneath.

Inside, the 2,150-square-foot (200-square-meter) home will contain a kitchen, living room, dining area and three bedrooms, each filled with natural light from the angled container light monitors and furnished with pieces from designer/architect Ron Arad, Whitaker's former employer. Off the back, two containers extend to meet the natural topography, creating a shielded outdoor area with a wooden deck and hot tub [7].

Shipping containers stacked and shifted in plan and layered in elevation maximize rooftop views and shaded public areas on the ground at the Container Stack Pavilion (pic. 2). A 7.5 meter cantilevered box is the point of entrance to the building's upper level roof, while the pavilion itself seems to extend out toward bordering streets, showcasing its interior activities. The ends of each container are capped with full height windows, allowing sightlines throughout the entire building. Inside, a double height central atrium is carved out where the two levels of shipping containers

overlap. The Container Stack Pavilion is a temporary structure that can be disassembled and moved to other locations [8].



Pic. 2. Container Stack Pavilion

Prospects for the use of cargotecture:

- 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. Using these unused containers is a great example of adaptive reuse.
- This form of construction relies heavily steel shipping container units to provide wall «framing structure», which ultimately limits the use of natural resources that are usually associated with traditional construction methods.

Risks of use of cargotecture:

- This type of construction can require extra permitting or cause delays due to permitting issues if you are building in areas that are unfamiliar with modular construction methods.
- Sometimes this form of construction can require more design consideration when dealing with running utilities such as water lines, electrical lines, stub outs, and HVAC piping inside the house due to limited, if any, wall and attic space.
- Areas such as the roof which are not as structurally sound as the sides of the container will almost always require additional reinforcement, especially when building in areas that accumulates snow.
- When cutting windows or entrances into the side of the containers, this weakens the structural integrity, therefore you must provide additional reinforcement in these areas to make up for the lost rigidity [9].

I think that this form of construction is very feasible for either quick emergency situations where time is of the essence, or when a project requires a more contemporary and artistic design. In fact, shipping container projects are widely used around world as modern residential construction, in the food and entertainment industry as well as commercial construction. And to narrow the conversation back down to providing temporary housing relief, this form of construction is also widely used as temporary housing structures for people displaced by disasters. There is also already in place a market of prefabricated container homes, in which people can customize the units to serve their needs and receive their modular home in as little as six weeks. This market of prefabricated modular home units is really the most feasible utilization of this method of construction.

Conclusions. After analyzing the particulars about case study as well as other supporting articles, the implementation of shipping container homes. In summation, the benefits that shipping container home construction are that it recycles existing materials, it is a faster way to build, and it is very often a cheaper way to build a home saving on traditional building materials and added labor.

Many places around the world are embracing the idea of building sustainable cities using revamped, upcycled cargo containers. This housing concept is revolutionizing the way we perceive modern architecture. It offers affordable housing options to underserved populations, creative options to those seeking to downsize and live more sustainably, and efficient solutions to business and industry.

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Анотація. У даній статті на основі аналізу світового досвіду представлені перспективи будівництва з морських контейнерів. Розглянуто переваги та недоліки, а також особливості таких будівель і споруд. Контейнер визначає конкретний модуль, який накладає обмеження на конструкцію. Але навіть незважаючи на це, світовий ресурс цього матеріалу для творчості і будівництва практично необмежений. Одним із факторів, який полегшив для архітектурної та будівельної індустрії сприйняття контейнера як елемента будівлі, є той факт, що мільйони контейнерів щороку виводяться з експлуатації. Торговий баланс багатьох західних країн, які імпортують більше товарів, ніж експортують, означає, що багато контейнерів залишаються на складах і не використовуються. Економія коштів і простору також є перевагою нового підходу.

«Карготектура» (злиття слів cargo (вантаж – англ.) та «архітектура») – будівництво будинків з морських контейнерів останніми роками перетворилися на одну з перспективних галузей будівництва. Протягом останніх двох десятиліть торговельний дисбаланс між Азією та Європою з одного боку та Північною Америкою з іншого був основною причиною великої кількості та відносної дешевизни транспортних контейнерів (МК), оскільки такі контейнери перевозять промислові товари до Північної Америки з Азії та, меншою мірою, з Європи. Замість транспортування порожніх контейнерів назад до Азії та Європи за значні витрати, виробництво нових контейнерів вважається більш економічним.

Після того, як ці контейнери виконали своє завдання, вони зберігаються в морських портах у великих кількостях, перш ніж вони будуть перероблені на металобрухт або повторно використані як просторові модулі в архітектурі.

Повторне використання МК в архітектурних цілях не обмежується певними типами будівель, але поширюється від невеликих приватних будинків до хмарочосів. МК пропонують нескінченну кількість можливих збірок на основі їх модульності та використовуються для всіх типів будівель, соціальних, побутових і комерційних. МК йде на крок далі в порівнянні з традиційною кладкою, з більш довгими консолями, що походять від її структурного складу. Будучи відносно невикористаною тенденцією, МК можуть бути об'єднані в структуру, і ця інтеграція створює новий симбіоз.

Ключові слова: контейнероконструкція, конструкція, будівельні матеріали, модульна конструкція, архітектура, система.