Prefabricated Homes: Delivery At Your Doorsteps

Obed K. Otabil
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PREFABRICATED HOMES: DELIVERY AT YOUR DOORSTEPS

A Thesis Presented

by

OBED K. OTABIL

Submitted to the Graduate School of the University of Massachusetts Amherst in partial fulfillment of the requirements for the degree of

MASTER OF ARCHITECTURE

SEPTEMBER 2022

Department of Architecture
PREFABRICATED HOMES: DELIVERY AT YOUR DOORSTEPS

A Thesis Presented

by

Obed K. Otabil

Approved as to style and content by:

________________________________
Stephen Schreiber, Chair

_______________________________________
First: Ann Marshall

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Stephen Schreiber, Chair
Department of Architecture
DEDICATION

I dedicate this thesis to my newborn son Duke Otabil for being in my life, and giving me the opportunity to be a father. I also dedicate this to my late father Emmanuel K. Otabil for raising me as a responsible young man to pursue greatness, and impact our society.
ACKNOWLEDGMENTS

I want to thank God most of all, because without God I wouldn’t be able to get through my education. Not forgetting everyone who supported me during my study at the University of Massachusetts.

Thanks to my late father, Emmanule K. Otabil, and my mother, Elizabeth Anderson Otabil, for their prayers and support throughout my journey in life.

Thanks to my brothers and sister who supported my dreams in the Architecture program.

Thanks to my wife for her support and encouragement.

I will take this opportunity to thank my professors, Schreiber, Clouse, Marshall, Zikos, and others who guided me in my academic years.

I also want to thank my good friends Cyndi K. Harbeson, Alyssa K. Wright, and the late Arthur F. Kinney.
ABSTRACT

PREFABRICATED HOMES: DELIVERY AT YOUR DOORSTEPS

SEPTEMBER 2022

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Directed by: Professor Stephen Schreiber

This paper interrogates the potential for the building industry to apply online retail systems to the development of housing in the future. In so doing, the thesis highlights the history of prefabrication in the discipline of architecture, the relevant case studies for prefabrication, and then demonstrates the development of a system for prefabricated housing in the future, featuring online access. The thesis suggests lessons that could be learned from the past to apply to this model, and projects new futures for online prefabricated architecture. In doing so this online retail housing will create easy accessibility of homes that are available in the market in a short period of time, and also ready to be delivered to the purchaser door step.

These homes will come in a kit or in parts, and with little experience, the kit should be put together in as little as days to form a house. The prefab kit will come in a variety of shapes, and sizes with different styles that will create options for purchasers who will prefer a reliable and less costly prefabricated building compared to traditional stick built homes.
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CHAPTER 1:

ONLINE DEVELOPMENT AND PREFAB HOMES

Introduction

Today, when people sit in the comfort of their homes and place an order for food, buy an item on Amazon or even order a car, they are interacting with the retail industry in ways no one thought possible twenty years ago. Since so much is available to purchase at the click of a button today, is it possible to go so far as to place an order for a house? This question is an exciting challenge for the world of technology as well as for architects and engineers. Due to innovations in the construction industry that have led to new methods of fabrication, companies are already able to build small house models on request and transport them to the buyer’s destination. How can these same techniques be implemented on a larger scale in the future, for the mass production of full-sized family homes, or even neighborhoods?

Prefabricated buildings must meet the international building code and set high quality standards for production. These high standards are created in a factory, making it possible for a building to be assembled into a structure in less than a week depending on size and style. Creating a building offsite, typically in clean, secure fabrication spaces, has many advantages. These advantages include lower production costs, faster construction timelines, and high quality standards with repetitive factory assembly. But on the other
hand, disadvantages include challenges with transportation of the final product, and difficulty tailoring each building to a specific site, user and context.

Even though building fabrication systems are gradually becoming more popular, they are still a relatively recent innovation. Emerging technologies and techniques such as precision assembly have made prefabricated buildings more accessible than we thought. Lack of widespread use and lack of information has meant that they have not been very successful or compared with traditional building methods. Even so, prefabricated buildings have received growing recognition in recent decades since the early 2000s, fuelling the demand for architects and contractors to design and build more competitive, and affordable prefab buildings will help reduce the demand for homes on the market.

Today, software makes the case for on-demand architecture, digitally fabrication and construction on and off site making it easy to work with. This work requires a bridging of the prefabrication industry developed over the past century with the digital practices emerging in the past two decades. Coupled together, they create a space for design innovation as well. Efforts to create more efficient designs that also require less labor during the construction of prefabricated homes. Digital software creates 3D models and these help to analyze precision use of material and fast assembly during site visits. For example small size models are created for test samples, these samples are put together to simulate real life situations and create any adjustment needed to make it perfect for construction.
The renewed prominence for prefabricated homes has flourished among architects as they manage projects through computer software and other technologies. The creation of an interconnected network of materials, construction, assemblies, and finishing will become another step to make these buildings more attractive to interested clients and also potential buyers. Throughout the 20th century, architectural engineering and the design disciplines have helped to evolve building systems, while modern technology inherent in these systems promises increased efficiency and higher performance equal or superior to common methods of building.

**Method of production**

There are several ways of producing prefab homes making it a flexible process of production. One great example is producing the building part from different factory lines and putting the house together at the site. If the production line can’t manufacture all the parts, these parts are sent out to special manufacturers to produce in accordance with the specifications of the architect, contractor, or engineer. Basically, there are several steps of putting up a building from the foundation, raising up the structure and then putting on the roof and then the utility to run the building. Focusing on the three basic steps of building a house, where the foundation is the first to be laid out and this depends on if there is the need for a basement or a flat foundation.

After the foundation, the construction of the building begins and in this section what choice of material is used in the process. Is it a metal frame construction, wood or concrete? The process will determine how the manufacturer proceeds with the prefab
construction. These steps will also determine how quickly production comes off the manufacturer and delivered on time. Casting a concrete and waiting for it to cure before delivering to the site may take some days compared with using wood or metal framing systems.

The roof comes after the foundation has been laid and the building (body) is laying on top and this is the last step of completing a building. There are also several types of roof choices for buildings, especially for residential buildings. The most common roof is the classic gable roof. This roof style is not difficult to construct and will be a better choice for easy construction, saving time and money. Creating affordable homes with the method of prefab buildings does not mean the function of the building will be limited and also the roofing part of the prefab home should not be limited to just a simple flat or gable roofing, but to more interesting shapes and attractive types of roofs.

Producing prefab homes in these basic steps will accelerate manufacturers’ ability to assemble the structure in those three steps in any situation or condition depending on where the construction site is located. This method increases the ability to put together prefab buildings in less than a week.

**Marketing**

The rising cost of traditional homes in today’s realtors market is creating a rise in Americans looking up to living in a prefab home around the country. Multiple surveys prove the rising home prices have led to Americans looking into buying homes that are made from the factory and assembled on site at their choice of location. “According to the U.S. Census Bureau, there are currently 6.8 million manufactured homes across the
country.”¹ Today more than 17.5 million Americans live in manufactured homes, which makes up over 6 percent of the nation’s total housing stock.”²

As the popularity of houses that are manufactured and put together on site increases among home buyers, it has proven that consumers are open to trying these types of houses in order to cut down on costs and the expense of traditional buildings.

So, how can we increase the production of prefab homes that will equal out the popularity of traditional site built homes,

Jones, Jonathan. “U.S. States Where Manufactured Housing Is on the Rise.”³

With this information there is a great market for home buyers looking to purchase prefab homes. Even though prefab homes are not new to American’s and have been around, their existence is still not well known to the average American home buyer. In recent years, many realtors have been introducing these homes to clients looking to buy homes.

**Delivery of Product**

As America depends highly on transportation and delivery systems in today’s economy, they are increasingly getting better and faster every time. How advanced it has become to sit in the comfort of your own home and place an order over the internet and receive your purchase within one to seven working business days. Amazon and Ebay set great examples of how to place and order online and have it delivered at a place of your choice. These procedures have revolutionized the economy through the American marketing system and there are more steps being taken to improve how fast and efficient the

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delivery method will work. The food industry is one of the most complex and diverse in the country. This industry ranges from the fast food establishment, grocery, restaurant, gas station, and the local street corner shops that are run from corporations to individuals. This industry has secured its part in home delivery across the country. This delivery system increasingly got popular when COVID-19 halted the everyday lifestyle of walking to and from nearby stores. The methodology of delivering goods and items to a person or a destination from where it was produced and distributed has enforced the idea of how it is possible to deliver almost everything except oversized items. Multiple delivery companies are taking the opportunity to also make delivering goods to their destination autonomous and that means, transportation of goods will be cheaper and faster from days to a day, and hours to minutes. Applying this delivery methodology to housing and affordability, it can change the housing crisis and possibly how homes are built in the future. If there are multiple companies working to perfect prefab home delivery and putting them together in a matter of days or a day, this will revolutionize accessibility to prefab homes and housing in general. The long wait of traditional buildings in months will possibly be an exception.

**Online Retail for Housing**

How easy could it be to order a house and have it delivered to your place of convenience? If you can order a pizza from a restaurant, give out your specification of toppings and how you want it cooked, and the pizza gets delivered to your destination in twenty-five minutes, couldn’t a similar situation be true for a house? In the 21st century, the rapid development of technology has enabled great advances in work, communication, and education. In recent years there have been home delivery services offered by stores
around the country. In addition, the 2019-20 pandemic (COVID-19) further solidified networks of home delivery service around the country, and user comfort with these systems. Auto dealerships like Carvana provide online retailers and provide home delivery when a car is purchased on their website. So why not order a house online with specifications and have it delivered wherever you specify? This is a question being asked and the housing industry is working hard to make it a possibility. There are several industries that have taken steps to create the process of manufacturing small homes by placing an order online to have part of the house delivered. Even though the process is not yet perfected, it is slowly being worked on by the building and construction industry. Several companies that used to create prefabricated homes have laid down the footprint of how others can follow and perfect this process of ordering a family house online. As early as the 19th century, Sears used to sell prefabricated homes ordered from catalogs, and today Amazon is following in those footsteps. Amazon is investing in small prefab companies to produce smart homes, “Amazon has made its first foray in prefab construction, investing in a company known for sustainable construction and smart home technology.” The online marketplace has picked up with prefabrication from past precedents, and is poised to launch house development into a new era.

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A number of important examples of prefabricated buildings can be identified in Africa, and the U.S throughout history. Of particular importance are those that integrate advances in technology, architecture, or design. Early examples of prefabrication came about in the early 19th century, as mass-production and new materials and factory conditions emerged in the US. Later, notable architects such as R. Buckminster Fuller and Frank Lloyd Wright, took on the challenge of designing specifically for prefabrication. Not all of these examples were successful, but they point to new advances and possibilities in the architecture of prefabrication.

“Henry Manning, a London carpenter, built components for a house and shipped them to Australia in 1837. He advertised them in the newspaper as the "Manning Cottage.".....Sears brought prefab to the mainstream when they began offering homebuyers their kit homes back in the early 1900s “5

Sears Roebuck Catalog Houses

The mass production of prefabricated housing in the US is perhaps best characterized by the mail-order Modern Homes program run by Sears, Roebuck and Co. These ubiquitous catalogs were shipped across the US from the early 1900’s until WWII, and included 447

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different models. According to the archives, “Sears and Roebuck began selling prefabricated homes in 1908 and discontinued the line 1940.” (Sears Archives, 2012)

These housing options ranged from elaborate to simple dwellings, with additions that could be purchased and added as needed. “Somewhere between 70,000 and 75,000 houses were sold during that period (Sears Archives, 2012), and these houses remain a lasting presence in American cities and towns. Catalog houses of this era reinforced mainstream housing styles and development patterns, departing from traditional architectural practices primarily in terms of access and delivery, rather than style or construction methods.”

Sears catalog homes began to struggle when construction styles changed and there were more options and how home buyers wanted something different. People wanted customized homes and different home styles on the market; Sears home sizes were smaller compared to the current family homes size on the market today, an 800 square foot size home was smaller to the new generation and growing family across the country. People also wanted to create their own home so they hired an architect who can design what they are paying for to live in.

Frank Lloyd Wright

Frank Lloyd Wright designed a number of prefabricated homes during his architecture career, beginning in 1911 (Sisson, 2016). He designed a line of prefabricated houses through a company called American System-Built homes, working with developer Arthur

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Richards to promote and sell the structures. Building kits were prefabricated at a factory and delivered to the construction site to be assembled. For a major name like Frank Lloyd Wright, the development of prefabricated houses offered the promise of bringing high design to the masses (Sisson, 2016). While these units never gained widespread acceptance, there are notable examples throughout the US today, and these houses offer a precedent of the appeal that a major architectural personality can offer to the prefabrication movement. In this case, the potential for American System-Built houses to gain prominence was perhaps curtailed by the war, and other external factors. “Wright created hundreds of drafts for a little-known, early 20th century scheme to provide affordable prefab housing, the American System-Built homes, a concept that quickly fell victim to WWI material shortages and became a footnote in the architect’s career”  

**Buckminster Fuller**

R. Buckminster Fuller designed a new type of prefabricated housing, through a prototype called the Dymaxion house, in 1930. This prototype was revisited in 1945, but both versions highlight major advances in assembly and ease of shipment. The design of the Dymaxion house was futuristic for the time, and departed from typical associations of single-family house design and construction. Unlike more normative models, this house was considered a “machine for living” (Keats, 2016, p.57), and reinterpreted residential activities and experiences in new ways. Clad in lightweight aluminum panels, and meant to be delivered by air, the model employed strategies for enabling mass production in the

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factory and then possibilities for various modes of shipment to a building site. It was Fuller’s goal to promote affordability, accessibility and better human health outcomes through this design, but these lofty goals failed to take off in popular development practices. Instead, the Dymaxion House stands out as a model for prefabricated housing that departed significantly from past models, and was perhaps too unusual for widespread adoption.
CHAPTER 3:

PREFABRICATED HOMES

Prefabricated Homes as Alternative to Traditional Home

It is important that today’s built environment creates the dynamic ability to produce quality buildings for every purpose whether it be residential, commercial, or for any other function. The gradual increase of prefab homes in today’s economy is due to their low price compared to the traditional homes that take a long time to build at a high price in the housing market.

The recent rise in house prices is part of a larger trend. 2021 and 2022 are not excluded and median house price has risen year-on-year. During the Covid pandemic, there has been a high rise of house prices both to rent or buy. The increase in house value grew where there was a rise in price but limited increase in supply for building materials and manpower for the housing market. The current population shows interest in purchasing as a result of low interest rates in the country.

It is important to focus on prefab technology and mass production of prefab housing by pointing out how they can help meet the high demand for housing with their efficiency of production and low expense compared to traditional homes. The greatest advantages for prefab homes are how quickly they can get off the production line and how quickly they can be constructed at the point of delivery. Today, the manufacturing technology helps in mass production of what the consumer needs, and it is not different from a customer having a second thought at not competing with other buyers in the market, which will save the consumer money and time in the long run. The focus on saving money and time
in the building industry is important to create a profit margin, not compromising the built quality and materials used for construction in order to make profit gain are crucial parts of the building industry.
CHAPTER 4:

TRADITIONAL HOMES

Comparing Prefab with Traditional Homes

To the average home buyer, when asked? The question likely to be asked is what is a prefab home and what is the difference between prefab and a traditional home?

Further explanation will explain there are several types of prefab houses, and the concept types include a modular home, a manufactured home, a panel-built home, a mobile home, and then other varieties of off site homes. In conclusion the term “prefab home” is not associated with a specific building type or style, but instead it is affiliated with every type or style of house constructed or built off-site, transported in parts, and then installed for or assembled at the final location on site.

Let’s specify those homes and how they are different but fall under the same category of buildings that are made off site and assembled at their place of destination.

Modular Home

What is a “modular home” mean when a consumer asks? In explanatory terms, a “modular home is simply a home built offsite, in an indoor factory setting, to a local state code.” ⁹

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These homes start out as modules of parts of the rooms or house that have been built in a factory, put together with the help of large construction machinery like cranes and forklifts at the construction site. “These modular homes are usually single story with two or three completed sections, requiring minimal site assembly.”

These homes can be constructed by local manufacturers with the same assembly line system. The modular home is delivered to the site and is about 80% to 90% completed in which it makes the duration of assembly on site or location just days compared to a traditional site built home.

Modular homes overall afford flexibility in design and customization options and there are mostly the possibility of creating two or three stories of modular homes. Comparing traditional homes with modular homes, and most importantly the cost savings and time cannot be comparable with traditional homes. “The average time to construct a custom modular home is 90 to 120 days, including building the garage, attached porch, installing the septic system, and doing any other site work.”

Traditional homes take longer depending on where they are in the country. A typical home in the Northeast takes about 10 months to complete, and putting into consideration the weather. In the south, it takes about 5 to 6 months to complete.

Another factor in their affordability is manufacturers of these homes buy materials in large quantities and can negotiate better prices than buying building materials for just a traditional home, saving 10-20% on cost.

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Manufactured homes are often confused with mobile homes. So what is a manufactured home? Manufactured homes are almost similar to mobile homes but some elements are different. Manufactured homes are “built off site and then assembled on site on a rectangular chassis rather than a permanent foundation.” Today manufactured homes are more customized and luxurious than what we think. They’re known to be more luxurious than mobile homes of the past, are much bigger, and look more like a small house.

These homes can be surprisingly spacious with multiple bedrooms and other spaces such as a kitchen, a full bathroom with a possible bathtub, living space, and sometimes these homes closely resemble site-built homes. There have been some manufactured homes with tall or good ceiling heights and different types of floor plans and to the extent it is sometimes difficult to spot a manufactured home from how it looks on the outside. Thanks to new modernization of these homes and their rectangular shape, these homes mostly have features expected in standard homes and they also offer different designs on the interior and exterior.

In general, manufactured housing’s benefits for potential home buyers over other traditional housing are cost and the duration of time construction takes to be completed.

“For example, in Connecticut, a double-wide home - an extended version of a

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manufactured home that has twice the width - costs an average of $138,800, according to the U.S. Census Bureau, and in Indiana that price drops to $71,700.”

It is important for consumers to know the difference between these prefab homes before shopping for a new home. Some customers use the term “manufactured home” and “modular home” interchangeably. However, “the differences between manufactured and modular homes, where manufactured homes are built to the HUD code (U.S. Department of Housing and Urban Development), and modular homes are built to the IRC code and modular homes are built to the IRC code by the same manufactured home manufacturer are similar.” Designs and construction quality are similar but modular pricing is slightly higher in price because of code differences.

**Panel Building**

Another great choice of prefab type of home is the panel built home. This type of construction will be best described to a customer as a hybrid between the traditional stick building method and modular building. (blog.bardenbp.com/the-pros-and-cons-of-panel-built-homes) As options grow better in choice of prefab homes in comparison to traditional homes (stick building), the future for demand in prefab homes is easily perceived as it is the way to build and save time and money. Looking into panel building, further explanation shows panelized construction creates lots of flexibility on both the site and factory made parts for the house. Another

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way to explain panel construction to a consumer is “Panelized construction is a method of building certain parts of a house in a factory rather than onsite. This construction method is the natural midpoint between a standard stick-built home and a completely modular pre-manufactured home.”\textsuperscript{15} This method eliminates time spent on construction and the amount of waste associated with on-site construction because of the precision of manufacturer methodology that produces efficient manufacture of materials.

The primary goal of building is to create shelter in the most cost-effective and efficient way possible. Premanufactured homes are livable in just a few days as compared to traditional homes, which take months to build and to move into.

Traditional homes still dominate today’s housing market due to a lack of homebuyer awareness about the advantages of prefab homes, namely that they are equally comfortable as traditional homes but at a much lower cost. Nevertheless, society is in need of cheaper and faster housing solutions, therefore it is important for the building industry to introduce better options for consumers looking to purchase a house. Between 2020-2021 the surge in evictions and increased demand for housing has created a crisis which has been very difficult for the American family. The current surge of COVID-19 has created an eviction crisis, which the CDC has attempted to address by ordering a temporary halt in evictions under specific circumstances. The organization has provided “a Declaration form that tenants, lessees, or residents of residential properties who are covered by the CDC’s order temporarily halting residential evictions to prevent the further spread of COVID-19. [...] Unless the CDC order is extended, changed, or ended,

the order prevents these persons from being evicted or removed from where they are living through December 31, 2020."16

Another crisis currently besetting the American economy is the high cost of houses, either by renting or buying. Prices of houses are rising, homes are selling quicker, and sellers are getting the price they are asking for. Some clients are overpaying for homes in order to outbid others and secure a house at this time of the housing crisis. At this moment, not a lot of houses are on the market and contractors are not building as much as they should because of Covid-19. “With homeowners unwilling to sell, a record low supply of homes for sale has forced buyers into intense bidding wars. At the end of April, there were only 1.16 million houses for sale in the U.S. down 20.5% from the year before.”17 Higher costs of land, depending on where the location is, labor, and building materials including lumber have also affected home builders all over the country.


CHAPTER 5:

PRECEDENCE

Modular Home.com

Modular Home.com provides great examples of how prefab homes are as good as traditional homes, and will serve as a good alternative for online home purchases which will be delivered and put together. Modular Home.com demonstrates how much a modular home costs, the size, style and other options. The modular home New Moon A-46653, built by Redman Homes Ephrata, comes with the details of:

3 Bedrooms
2 Bathrooms
Living area
Kitchen
Dining room
Foyer

New Moon A-46653 is 1,760 square feet (with length 66’ 0” and width 26’ 8”) and will be 20% cheaper than a traditionally built home. Using Zillow to find a similar house will make a significant difference to the cost. A traditional two bedroom family house in Springfield, MA, with 3 bedrooms, 2 bathrooms, and a square footage of 1,708 in Springfield, MA, costs $215,000, compared to the much lower price of New Moon A-46653, which is $180,000. A traditional stick-built, two bedroom family house on the market in Springfield, MA, with a square footage of 1,378, currently has an asking price of $249,000. It was built in 1955 as a single-family residence. Without factoring in
whether this house is new or old, it would cost 20% less than a modular or prefab house with two bedrooms, two bathrooms, with a square footage of 1,202.
Figure 1A: Modular Home. Front View

“Name: New Moon A-46653 is 1,760 square feet.”

Front elevation of modular home used for this research. A typical one story building with a foundation.
Figure 1 B: Modular Home. Back View

“Name: New Moon A-46653 is 1,760 square feet.

Back elevation of modular home used for this research. A typical one story building with a foundation.
Figure 1 C: Modular Home. Floor Plan

Typical ground floor plan of a modular home.

“Name: New Moon A-46653 is 1,760 square feet”\textsuperscript{18}

CHAPTER 6:

DESIGN METHODOLOGY

Designing a building with an open concept that will lead to an easy construction method for this prefab building is critical. The design layout should create less complex building structures and this method will carry through the usability of the building such as, easy walk-through, living space arrangement and functionality.

The building footprint is set up based on the bedroom, being the fundamental key of a home, and then other rooms are designed around it. The prefab design varies from studio room, one bedroom, and up to three bedroom space. This plan meets the International Building Code (I.B.C.), and this particular building is designed for tropical or sunny geographical areas and will comply with the regional or town building code. The design methodology will follow the process of a building kit that will be assembled together in pieces on site.
Figure 2: Conceptual layout of prefab building plan, shape and how the rooms are positioned alongside each other.
Figure 3: Foundation Platform with tongue and groove method. This design is created to hold each platform together, and also prevent water leaking through from the ground.
Figure 4: Each wall is designed with specifications and numbers for easy identification when assembling on site. The walls are all prefab, enter locks together and are structurally independent.
Figure 5: The prefab walls are in two classifications and combinations of alphabets and numericals. The grouping starts with Upper Walls and Lower walls. Upper Walls lay on the Lower Walls from the lintel level and upwards and this supports the roof. The Lower Walls support the Upper Walls, host the windows, walls and any other opening, even though some Upper Walls also host some openings for light penetration into the rooms.
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<tr>
<td>Upper Wall - A.1, 2 and 3</td>
<td>(Upper walls installed on left and right of prefab building)</td>
</tr>
<tr>
<td>Upper Wall - B.1, 2 and 3</td>
<td>(Upper walls installed at the back of prefab building)</td>
</tr>
<tr>
<td>Upper Wall - C.1 and 2</td>
<td>(Upper walls installed at the front of the prefab building. 1 without opening, 2-with opening)</td>
</tr>
<tr>
<td>Lower Wall - 1,2,3 and 5</td>
<td>(Lower walls installed in both front, back, left and right with no opening)</td>
</tr>
<tr>
<td>Lower Wall - W1,W2 and W3</td>
<td>(Lower walls installed in both front and back, with window opening)</td>
</tr>
<tr>
<td>Lower Wall - D.1</td>
<td>(Lower walls installed with door opening)</td>
</tr>
<tr>
<td>Lower Wall Overhead</td>
<td>(Lower walls with overhead opening)</td>
</tr>
</tbody>
</table>

**Table 1**
<table>
<thead>
<tr>
<th>Wall Classification</th>
<th>Wall Classification</th>
<th>Wall Classification</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Upper Wall - A.1</td>
<td>Lower Wall - 1</td>
<td>Lower Wall - D.1</td>
<td>Lower Wall - O.V - 1</td>
</tr>
<tr>
<td>Upper Wall - A.2</td>
<td>Lower Wall - 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Wall - B.1</td>
<td>Lower Wall - 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Wall - B.2</td>
<td>Lower Wall - W.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Wall - B.3</td>
<td>Lower Wall - W.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Wall - C.1</td>
<td>Lower Wall - W.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Wall - C.2</td>
<td></td>
<td></td>
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</tbody>
</table>

**Table 2**
**Figure 6:** This image exhibits how all of the prefab walls assembled together create a building shell.
Figure 7: This image shows both the prefab roof and walls coming together.
Figure 8: This image shows the prefab walls and foundation coming together.
Figure 9: This image depicts the prefab roof, wall and foundation assembled together.
Figure 10: This image is a rendering of the prefab building.
CHAPTER 7:

BUILDING PLANS

The building plan designated for this prefab building follows a typical studio or
traditional bedrooms plan. With all the plans including the studio, open floor plans are
better suited to how the building will be split in parts and put together when in
construction.

In a process where a building will have to be split vertically, the split must not obstruct
any important structural element that holds the building together. The structure may be
split into 6-foot sentences, depending on how many building kits will be used for a single
unit. Multiple options of 6 feet up to 12 feet maximum are allowed when splitting the
building. This structural process must cut across the foundation, walls and the roof.

As simple as this building plan looks, the basic principle of creating a habitable space
needs to be factored into the plan layout. Good window and fenestration size that allow
ventilation and exposure to sunlight are essential. Open spaces are an important element
in a living space, as they create a sense of freedom and less restriction in a home. It is
critical to create openings that facilitate multiple functions in a home, such as movement,
visibility, placement of furniture and aesthetics.

Enclosed spaces used in this building plan are to meet the requirement of privacy, with
bedrooms categorized as one of these spaces. Such space is very important because it
completes a living space that qualifies a building as a residence.
Figure 11: Ground floor plan of the 2 Bedroom open concept proposed for construction.
Figure 12: How the building plan was developed by using the size of the bedroom to create other spaces around it.
Figure 13: Multiple views of the rendered prefab building.
CHAPTER 8:

WALL DESIGN

Wall process

Creating this prefabricated wall depends on what materials are being used for the construction. The second consideration is in what geographical location is the construction taking place. In this instance, selection of materials for walls is important because this will determine the wall weight and density, relating to heat gain or heat loss and how durably the wall can withstand weather over time.

The location for this project is in a warmer climate, and materials used must be capable of withstanding heat. The type of insulation materials and external facade must also be carefully selected to be lightweight and convenient when shipping in parts and installing on site. Prefabrication is one of the most efficient methods of building regarding time and materials, and has also proven to be the preferred choice of some construction companies.

The option to customize a prefab space, which will be easily assembled and transferred to the construction site without using oversize-load transportation, will be appealing to many developers and individuals. The walls should be light enough for two people to be able to install with minimal use of light equipment such as small size cranes, but must also be as durable as a traditional wall, and have the structural ability to sustain heavy weight.
Figure 14: This image exhibits a Wall Kit designed to be able to support itself during installation. Wall Kit has been customized with lightweight material from the wall framing to the insulation, and these materials combined deliver a wall that performs to the IBC standard.
Figure 15: This Wall Kit is designed to have the advanced framing technique that uses less materials but has traditional wood framing, including top plates, crippled, header, trimmer, seal for the windows, bottom crippled, and bottom plates.
Figure 16: In wall design, sheathing is as important as other materials that complete the wall, bearing in mind that the sheathing adds excess weight to the wall but it is needed to house the building skin. In this design, the wall has a lightweight sheathing that will perform equally to traditional sheathing.
Figure 17: This design includes well-structured walls that hold themselves together by interlocking. The picture above shows the prefab walls being locked in a 90° angle without a supporting column or wall fasteners.
**Figure 18**: The wall is designed to have locking mechanisms that secure together when lined up beside each other to form a complete wall.
Figure 19: This image depicts the step-by-step locking process of two Wall Kits.
Figure 20: This image shows complete prefab wall panels joined and secured together.
**Utility wall process**

*Figure 21:* This prefab wall is customized to meet the needs of each modular home made for the consumer. The walls are fitted with utility pipes that create access for piping and electrical connections through walls that are assembled together side by side during construction.
Figure 22: This image shows hot and cold water piping layout in the prefab walls.
Figure 23: This image shows how bathroom fixtures and furniture can be arranged.
CHAPTER 9:

AFFORDABILITY, PRODUCTION AND SOLUTION

Affordability and mass-produced

The challenge of delivering housing that is affordable, fast to produce, and well-made, is a perennial problem in the construction industry. In the US today, the rise of lumber prices has triggered a shortage of new houses, and home prices will continue to become more expensive. According to the National Association of Home Builders, “the shortage has resulted in a 250% increase of framing lumber costs. Typical prices for 1,000 board feet of lumber sit around $200 to $400. Now, prices are well above $1,000.”19 This extreme increase of lumber prices started during the 2020 pandemic, prices of lumber were stable but had a slow increase in price previous years.

House construction is trailing demand in the real estate market today, and in many parts of the country homebuyers are offering more than market value for real estate because of the shortage of homes to purchase. The high demand for housing increases the need for prefab housing as a way to balance the market and ease the demand for homes. The high cost of houses is driving many new homebuyers to hold off on purchases in hopes that prices will drop and allow them to better afford a home. This has led to struggles among some middle-class American families to find housing when they can’t afford the high purchase prices.

According to Peter Lane Taylor (2021), “As recently as just a few years ago, it used to be
that the hardest part about buying a house for most people was the financial colonoscopy
of getting approved for a mortgage. Now, that’s the least of buyers’ worries. In virtually
every American city right now, many single-family homes hitting the market are selling
in bidding wars and the buyer with the most cash who closes fastest wins.”

**Solution**

So the idea is, what if the prefab industry is popular to most new and old home buyers,
and having sufficient inventory to supply every online purchase during this difficult time.
Prefab buildings made from alternative materials that are cheaper and light in weight to
produce instead of following the traditional stick build home where lumber is used, and
prices of lumber and construction laborer will always go up. The chances of more
inventory with traditional building and chipper lumber is possible to nothing.
Prefabricated buildings are gradually becoming the better alternative to the problem of
high-cost single family homes that take seven months to be completed in addition to the
labor costs and the work of putting the houses on the market for sale. This method of
building family homes will cut the cost of labor, the duration of construction, and the
amount of material used is better. The prefabrication method maximizes production and
reduces waste of materials. Because of the several advantages of prefab construction over
the traditional way of building onsite, there will be more affordable homes on the market,
helping to solve the shortage of homes. Stacey Freed (2021) suggests that “One solution
that may help mitigate the housing shortage is to build homes — all or in part — in a
factory and transport them to a site instead of building a house on site. Known as

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prefabricated or prefab housing, this type of construction has been around for over a century.”

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APPENDIX

Figure 1 A - New Moon A-46653 showing in Front View

Figure 1 B - New Moon A-46653 showing in Back View On a trailer with wheels underneath it.

Figure 1 C - New Moon A-46653 showing Floor Plan
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