

2020
PERMANENT
MODULAR
CONSTRUCTION

REPORT



About the Modular Building Institute – The Voice of Commercial Modular Construction

The Modular Building Institute (MBI) is the international nonprofit trade association serving the commercial modular construction industry for over 35 years.

As the Voice of Commercial Modular Construction™ MBI promotes the advantages of modular construction while advocating for the removal of barriers that limit growth opportunities.

Through its long-standing relationships with member companies, policy makers, developers, architects, and contractors, MBI has become the trusted source of information for the commercial modular construction industry.

Acknowledgements and Special Thanks to:

Members of the Modular Building Institute for providing corporate and project data for this report.

Hallahan & Associates, Baltimore, Maryland – Hallahan Associates provides expert business planning and marketing consulting services to the modular housing industry. www.hallahanassociates.com.

Modular Administrative Programs – The industry's regulatory partners tasked with ensuring public safety and building compliance.

This annual report features images of award-winning buildings from the Modular Building Institute's 2020 Awards of Distinction. Learn more about the Awards and our winners at modular.org.



Cover:

Ocean Cay MSC Marine Reserve – Staff and Management Housing. Built by Vesta Modular & Southeast Modular Manufacturing. Winner: Best in Show - Permanent.

Thank you to our 2020 MBI Corporate Sponsors

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The definitive source for information about permanent modular construction in North America



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Vermont, New Hampshire,
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Rhode Island, New York*

*Region 2 – Virginia, West
Virginia, Pennsylvania,
Maryland, District of Columbia,
Delaware, New Jersey*

*Region 3 – Florida, Georgia,
Alabama, Mississippi,
North Carolina, South Carolina,
Tennessee*

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Arkansas, New Mexico,
Oklahoma*

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Indiana, Michigan, Illinois,
Wisconsin, Minnesota,
Iowa, Missouri*

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OVERVIEW

SECTION 1

of the Modular Construction Industry

The modular construction industry is primarily regulated at the state and local levels by building code administrators and authorities having jurisdictions. As with site-built structures, a building constructed using the modular process must meet the local codes where the building will be placed. Unlike federal manufactured housing products, built in accordance with the Housing

California State University
San Marcos – Veterans Center.
Built by Silver Creek Industries.
*First Place: Permanent Office
Under 10,000 Sq. Ft.*





Chilliwack Transitional Housing.
Built by Metric Modular.
Honorable Mention: Green Building.

and Urban Development (HUD) standard, there is no specific “modular building code” or exceptions for a building constructed utilizing the modular construction process. It is simply a more efficient process to construct building components at an offsite facility, and then transport and assemble components of a building at the final building site.

Modular construction can be utilized for residential, commercial, or industrial applications. MBI represents the commercial sector of the industry.

Commercial Modular Buildings are nonresidential factory-built building components and structures designed to meet all applicable building codes. Commonly, these buildings are constructed in accordance with the International Building Code (IBC) in the United States, the National Building Code (NBC) in Canada, or a local version modeled after these codes. In this context, prefabricated mechanical, electrical, or plumbing (MEP) systems are not included for industry revenue and production figures.

The commercial modular building industry is comprised of two distinct divisions, both represented by MBI.

- **Relocatable Buildings (RB)** – Relocatable buildings, as defined in the International Building Code, are partially or completely assembled buildings constructed and designed to be reused multiple times and transported to different building sites. This segment of the industry maintains fleets of relocatable buildings

offered for sale or lease to customers.

- **Permanent Modular Construction (PMC)** – PMC buildings are subject to the same building codes and requirements as site-built structures, depreciate in much the same manner, and are classified as real property. This segment of the industry provides construction-related services for the successful design, manufacturing, delivery, installation and finish-out of commercial and multi-family buildings.
- PMC is an innovative, sustainable construction delivery method utilizing off-site, lean manufacturing techniques to prefabricate single or multi-story whole building solutions in deliverable volumetric module sections. PMC buildings are manufactured in a safe, controlled setting and can

Cook Inlet Alaska Offshore Oil/Gas Platform Camp Replacement.
Built by Builders Choice Modular LLC.
Honorable Mention: Permanent Modular Workforce Housing.



be constructed of wood, steel, or concrete. PMC modules can be integrated into site-built projects or stand alone as a turnkey solution, and can be delivered with MEP, fixtures, and interior finishes in less time, with less waste, and higher quality control compared to projects utilizing only traditional site construction.

This report focuses on permanent modular construction division (PMC).

Unlike other “prefabrication” reports which rely heavily on publicly available data, and often include a mix of multiple types of construction processes under the offsite construction umbrella, MBI obtains industry information for this report from multiple sources including:

- **MBI member surveys** – Each year, MBI asks all members for data regarding their annual

revenues, sources of revenue, markets served, production, capacity, and total employees.

- MBI’s project database – Through the annual Awards of Distinction contest, MBI gathers specific project data to calculate average square footage of buildings by market type, average days to complete by market type, modular project cost, and total project costs.
- **Hallahan & Associates** – MBI contracts with Hallahan & Associates for additional production data by market and region. This data was obtained by direct conversations with state administrative agencies regarding labeling programs and production as well as analyzing data from the U.S. Census Bureau on new construction starts.

- **Industry alliances** – MBI participated in the development of various other construction industry resources and research and, as a result, was able to gather information from those efforts. In particular, MBI sponsored and supported Dodge Data & Analytics’ most recent SmartMarket Report: Prefabrication and Modular Construction 2020.
- **Construct Connect Insight (formerly Reed Construction Data)** – MBI uses this database to determine the baseline for new construction starts in key markets and to measure overall industry market share.

- **Publicly available data** such as news stories, public filings (U.S and Canada), and corporate websites.

Every effort has been made to ensure the accuracy and reliability of this data. In some cases, MBI’s best estimates and member experience are used. Given that no one single source for this information exists regarding production, revenue, and market share for the entire commercial modular industry in North America, MBI is confident that this report represents the most comprehensive and accurate information available on the commercial modular construction industry in North America.

About Permanent Modular Construction

Many industries regularly use permanent modular construction, including schools, banks, restaurants, hospitals, hotels, medical clinics, and housing developers. The industries that utilize our services are numerous (as measured by the North American Industry Classification System, or NAICS), but the most common categories include:

236116 New Multi-family Housing Construction

236220 Commercial and Institutional Building Construction

Modular construction helps owners and contractors address:

- **Quicker occupancy** – Streamlined construction process, in many cases 30-50 percent faster than with conventional construction

- **Labor Shortages** – More efficient use of skilled labor with a safer work environment
- **Predictability** – Due to the shortened construction schedule, up-front materials purchases, and reliable labor, modular projects provide a hedge against construction market uncertainty.

The term “modular” describes a construction method or process where individual modules stand alone or are assembled to make up larger structures. Unlike relocatable buildings, these structures are intended to remain in one location for the duration of their useful life; thus, they are permanent. Permanent modular buildings may be wood-frame, steel, or concrete and can have as many stories as building codes allow.

Industry Standards

The North American modular industry is currently made up

of over 250 regional manufacturers building everything from construction site offices to single-family homes and hotels. The industry is regulated primarily at the state level through administrative agencies that implement and enforce the rules for building in that state.

However, only 35 states (and one Canadian province) have such a program, meaning the remaining jurisdictions rely on local code officials to determine compliance and safety. Additionally, the programs lack a degree of uniformity in requirements and even terminology. For example, the program in Massachusetts is referred to as the “manufactured buildings program,” while in other states, the industry is referred to as “industrialized buildings,” or “factory-built housing.”

MBI is currently working with the International Code Council to help develop industry standards for various aspects of modular

and offsite construction including terminology. Once developed, these ANSI standards will address how modular buildings get approved, among other aspects of construction. Currently, these various state program requirements make it extremely challenging and costly for regional manufacturers shipping into multiple states. Helping to develop and implement more consistent administrative rules will improve efficiency and lower costs.

MBI is also working with the Canada Standards Agency for the development of a new standard for multi-story modular buildings including transportation, installation, and module-to-module connections. It is anticipated that the ICC and CSA standards will be completed in mid to late 2021 with industry advocacy efforts to align local regulations to occur after development.

Stages of Modular Construction

Primarily, four stages make up a modular construction project:

UNION FLATS IN SAN FRANCISCO CA | FROM DAVID BAKER ARCHITECTS | GUERDON MODULAR BUILDINGS | DCI ENGINEERS

01.



Design approval by the end-user and any regulating authorities

02.



Assembly of module components in a controlled environment

03.



Transportation of modules to a final destination

04.



Erection of modular units to form a finished building

Approval Process

Thirty-five states in the U.S. and one Canadian province (Alberta) have an administrative agency that oversees and regulates the modular construction industry. While the terminology sometimes differs (see next section on industry standards), the general procedures for building inspection and approval are similar. In the states where no agency exists, the local Authority Having Jurisdiction (or AHJ) is responsible for the inspection and approval process.

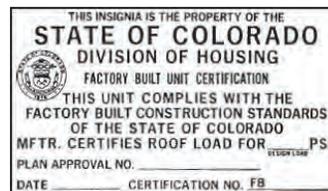
The administrative rules of each agency provide for safety standards and inspection procedures for industrialized building construction, design, and manufacture. Buildings and building components are either inspected and approved directly by the agency staff or by a third-party inspection agency (TPIA) or engineering firm acting on behalf of the agency.



LVL @ 4125. Built by Volumetric Building Companies & Johns Buckley.
Honorable Mention: Permanent Modular Multifamily.

Buildings constructed using the modular process must comply with all applicable building code requirements including wind, snow, and seismic conditions. Because most elements of the building – including electrical and plumbing – are completed and “closed” off-site at the modular manufacturing facility, the inspection protocols must be clear and concise. Local code officials must be

assured that the building has been inspected and will meet all requirements so that destructive inspections do not need to occur once the building is on site.



Example of state modular code label.

Once inspected and approved, modular/ industrialized building components are deemed to have met all the applicable code requirements and a modular program label or insignia will be affixed to the module (see image below of sample state insignia).

Once the modules are delivered to the final site, other requirements are subject to approval at the local level. These requirements may include land use and zoning, local fire zones, site development, building setback, side and rear yard requirements, property line requirements, subdivision regulations, subdivision control, review and regulation of architectural and aesthetic requirements, foundation design, utility, and module connections.

SECTION 2

DESIGN

Considerations

James A. Forrest Elementary School.
Built by Silver Creek Industries.
Honorable Mention: Permanent Modular Education Over 10,000 Sq. Ft.



Design for Modular Manufacturing

In 2019, MBI worked with the American Institute of Architects to help develop a new guideline called “Modular and Off-Site Construction Guide.” This Guide serves as a primer on the modular approach for architects and includes:

Value and opportunities of modular design

Pitfalls designers should be wary of

Case studies that exemplify successes and obstacles



The document can be downloaded for free at:
<https://www.aia.org/resources/6119840-modular-and-off-site-construction-guide>

Nihtat Corporation Office.
 Built by Horizon North Logistics, Inc.
 Honorable Mention: Permanent Office Under 10,000 Sq. Ft.



Architect's Role

In general, the architect's role in a construction project is critical to its overall success. The decision to utilize modular construction should be made prior to design and should factor in the following considerations:

- Three-dimensional modules have widths that are typically nominal

eight, 10, 12, 14, and 16 feet, with 12 and 14 feet being the most common. Framing dimensions are typically two inches less than nominal size.

- Module lengths are up to 70 feet, usually in two foot increments.
- Module heights vary from approximately 11 feet, six inches to 13 feet, not

including the height of the unit's transport trailer or frame.

- Wood-frame construction is the most common type of construction; however, manufacturers also build with steel and concrete and can meet the requirements for Type-I, -II, and -III construction.

- Multi-story modular buildings can be built up to the maximum stories allowed by code. While most modular buildings are one- to four-stories, a growing number of projects have exceeded 10-stories in recent years, including a 32-story project in New York.
- Restroom areas should be designed so that a module "marriage line" does not split the space.
- Multiple roof-framing styles are available. Some can be completed in the factory, and some may require the installation of trusses on-site.
- Modular buildings can be configured using modules of various lengths and widths.
- Design elements need to be decided earlier in the process (paint color, for example) as the off-site construction process begins and is completed more quickly.



Hostelling International Jasper.
Built by Horizon North Logistics, Inc.
First Place: Permanent Modular Hotel.

Best Practices for Modular Construction

MBI reached out to members of its Design Professionals Advisory Council to solicit best practices for those new to the modular construction process.

Innovative Structural Engineering (www.ISEengineers.com)

One major item we would like to share is the importance of early selection of your design consultant team, particularly structural.

When the structural engineer is engaged in the schematic design phase of a project, they have an opportunity to help the customer avoid costly design decisions that with just some minor adjustment, can allow for considerable reductions in the budget. A good structural engineer is going to inquire with the factory on what the desired outcome is both from an aesthetic and budgetary perspective, taking that into consideration when provid-

ing insight and direction on how to proceed with completing the build. One common area to which this applies is material selection. Your structural engineer should guide you on the proper material selection to achieve an efficient gravity and lateral resisting system that works within the restraints of the architectural design.

In addition to early selection of your structural engineer, we also have found that using the same structural engineer for the factory-built portion of a project as you do the site-built portion can greatly improve overall efficiency of the design and build processes, ensuring a more streamlined coordination process for both.

Some other important items to coordinate with your design team:

1. Mate line connections
2. Maximum shipping heights



Alloy at Tech Hill (wide).
Built by Champion Commercial Structures.
First Place: Permanent Modular Multifamily



Alloy at Tech Hill (close-up).
Built by Champion Commercial Structures.
First Place: Permanent Modular Multifamily

3. Pick points
4. Material preferences of the factory
5. Connection preferences of the factory
6. Modular connection to foundation
7. Multi-story threaded rod hold-downs (if applicable)

Lowney Architecture **(www.lowneyarch.com)**

Clearly documenting site and factory scope in the contract documents helps to streamline the regulatory review process, by avoiding jurisdictional confusion. It is also helpful in bidding of site scope and helps to avoid confusion and over bidding that can occur when

the documents are not clear.

Details with both factory and site interfaces should be reviewed and coordinated across the project team, factory, and site contractor. This helps to streamline the factory production and site construction and avoids scope gaps and possible on-site rework.

neUdesign Architecture, LLC **(www.neUdesignArch.com)**

The modular design process should be approached with a “reverse engineering” mindset. Understanding the intent and usage of design docs within a manufacturing facility will minimize redundancy and loss of design intent throughout the shop

drawing development phases.

Respect the “means and methods” of traditional assemblies within a factory environment. A thorough understanding of assembly sequencing and constructability reviews is essential to ensure compliance and continuity from Factory to Site-Built Construction Scopes.

Develop a Revit model with the intent that it will be built directly from your drawings. This “Modular Mindset” will ensure the assemblies and design documents are geared towards offsite construction procedures.

Just because it “can” be built modular, doesn’t necessarily mean that it “should.” A proper Modular Feasibility Study implements a critical analysis to weigh the pros & cons in order to maximize the value and efficiencies associated with offsite construction.

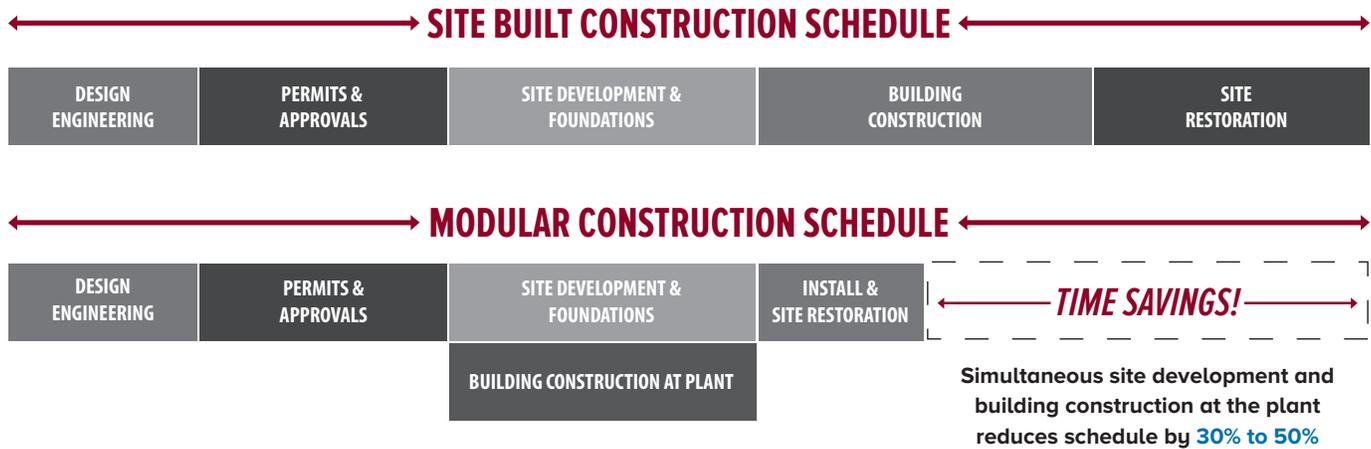


Key ADVANTAGES

Presidential Lakes Fire House & Community Center.
Built by Modular Genius, Inc. & Whitley Manufacturing Co., Inc.
First Place: Permanent Modular Assembly.



Shorter Schedules / Quicker Return-on-Investment



If you have ever tried to build a custom building in the dead of winter or during hurricane season, you understand that the weather has a huge effect on how long it takes your building to be constructed. Inclement weather can cause traditionally-constructed buildings to take months longer than anticipated.

The ability to construct building modules in a factory while simultaneously preparing the building site work leads to a shortened construction schedule, quicker occupancy, and therefore, quicker return on investment.

Time is money, especially where construction is

concerned. If you are creating a business, delays in construction equal delays in revenue. Hotel rooms cannot be rented, hospital equipment cannot be installed, and inventory cannot be stocked until your building is complete.

Modular buildings are significantly faster to build

than traditionally crafted buildings. In fact, numerous case studies demonstrate that modular buildings take 25-50 percent less time to build than traditional buildings.

Cost Savings

Generally speaking, MBI does not publish its own cost savings data on projects given all the variables that make up construction costs. Labor rates vary on project to project and from region to region. Contractor overhead varies based on several factors including waste minimization

and overall experience using modular construction.

However, Dodge Data & Analytics’ Prefabrication and Modular Construction 2020 SmartMarket Report did capture cost savings data from general contractors and construction managers. Ninety-one percent of all general contractors/construc-

tion managers responding (48 in total) reported a favorable impact on project budget performance, with many citing “cost certainty’ as a key benefit.

Over the years, MBI has found some contractors and companies that benefit from the advantages of modular construction may have in fact

experienced a cost increase on their first modular project, but gained efficiency and savings on future projects due to a greater understanding of the process.

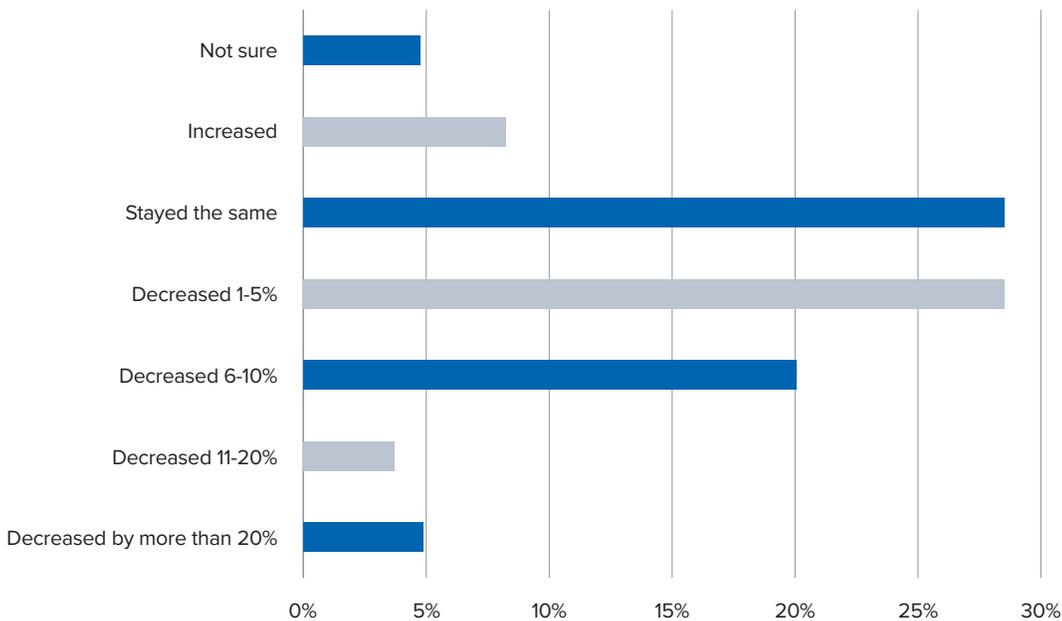
Environmental Impact

According to the Environmental Protection Agency, construction waste and debris is one of the largest contributors to landfills annually. While construction demolition of existing structures represents about 90 percent of this landfill waste, new construction activity accounts for nearly 57 million tons of landfill waste.

Of the 203 architect, engineer, and contractor respondents to the Dodge Smart Market Report, only one percent indicated that modular construction had no impact on reducing waste, while five percent were unsure. Sixty-five percent said that it had a high or very high impact on reducing waste generated by construction

Cost Impact of Modular Construction on Total Budget

(59 respondents)



activities. Among the 59 contractor respondents, 97 percent report that modular construction does have a positive impact on reducing construction waste, while three percent were unsure.

On two occasions, MBI commissioned university-based research to determine the environmental impact of modular construction compared to traditional

site-built construction.

The University of Virginia conducted a study (Quale, et.al.) using life cycle assessment to quantify the environmental impacts of constructing a typical residential home using two methods, based on data from several modular construction companies and conventional homebuilders. The study, peer-reviewed and published

in the *Journal of Industrial Ecology*, included impacts from material production and transport, off-site and on-site energy use, worker transport, and waste management.

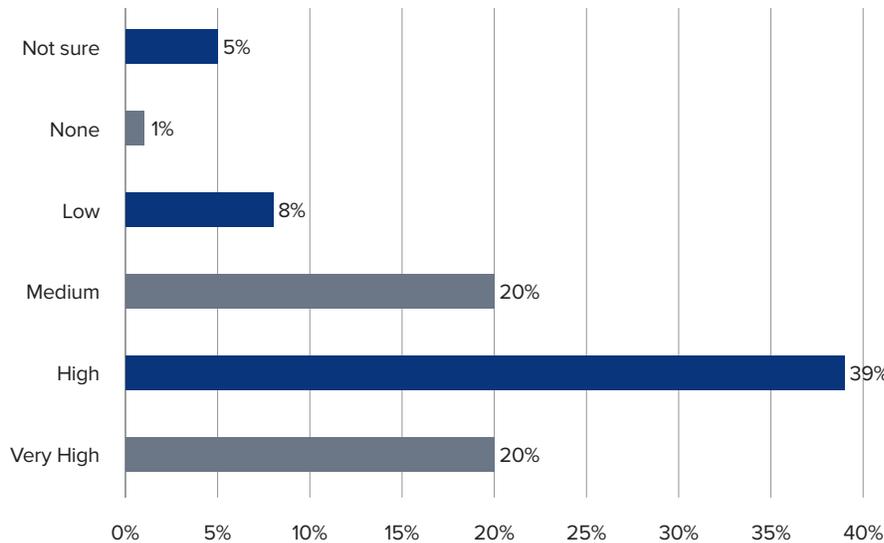
In terms of materials usage and waste, homes constructed using a modular process were found to use about 17 percent less material overall. This included greater material use for modular mate

lines and transportation but significantly less material waste for modular. In fact, the modular homes sent about 75 percent less wood and drywall waste to the land fill per project (1,380 lbs. for modular vs 5,500 lbs. for conventional). Worker transport to the jobsite daily had a negative impact for conventional construction while energy use in the factory added to the environmental impact for modular construction projects.

The analysis revealed that environmental impacts from modular construction are, on average, lower than those from on-site construction with total greenhouse gas emissions about 30 percent less by using modular construction.

A study conducted by the University of Alberta (North Ridge CO2 Analysis Report – Al-Hussein, et.al.) comparing modular and on-site construction noted

Positive Impact of Modular Construction on Reducing Construction Waste
(203 respondents)



even greater advantages for modular construction. The research found that by using modular construction, the overall schedule was shortened by four months on an 11-month project and CO2 emissions were reduced by 43 percent.

Worker Safety

Modular construction has demonstrated the ability to provide a safer environment for the construction workforce. By shifting as much as 80 percent of the building construction to an offsite, factory-controlled setting, workers have a much more predictable and consistent work atmosphere. Additionally, the ability to construct multi-story buildings in modules while remaining on the ground floor of a factory virtually eliminates hazards associated with falls, one of the most common accidents in the construction industry.

The 2020 Dodge SmartMarket Report addressed the issue of workplace safety and their research findings support MBI’s position. Of the 203 responses received regarding safety, only five percent of architects, engineers, and contractors indicated that the use of modular construction had no demonstrated

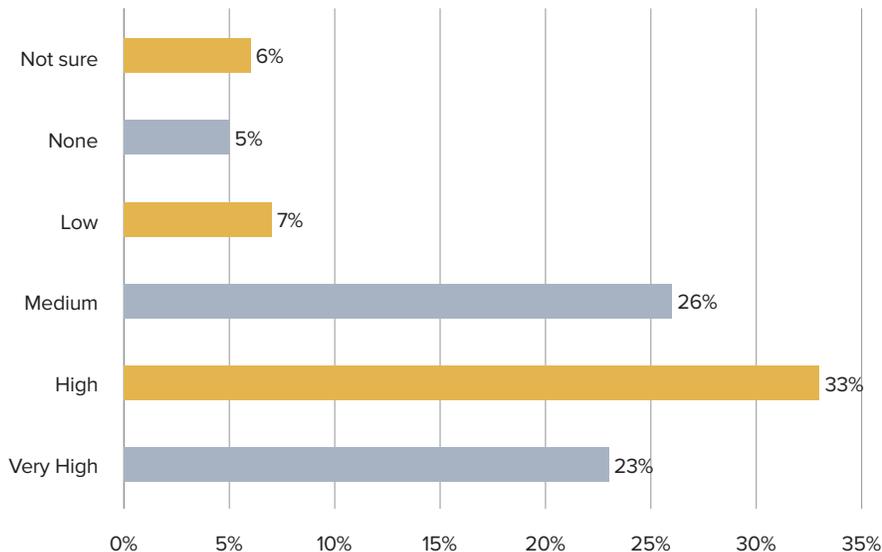
safety benefits, while 89 percent indicated it did (six percent unsure).

Of the 48 general contractors responding, only eight percent said that modular construction had no impact on improving safety, while 69 percent said it had a high or very high impact. The results are even more dramatic among large contractors

with revenues over \$100 million annually. Among the 18 contractors in that subset, half said that modular construction had a “very high” impact on safety. A full 100 percent of these respondents said that modular construction had a medium (11 percent) high (39 percent), or very high (50 percent) impact on worker safety.

Modular Impact on Overall Safety

(203 respondents)



SECTION 4

Key North American MARKETS



Totem Inn (exterior).
Built by Builders Choice Modular LLC.
Honorable Mention: Permanent Modular Hotel.

Permanent modular buildings are considered real property, built to the same building codes and requirements as site-built structures, and can be financed, sold, and depreciated in a similar manner. As such, the markets for permanent modular construction are similar to the markets for site-built contractors, with few exceptions. MBI has identified the following key markets for PMC in North America:

Multi-Family Housing

Federal, state, and local governments around the world are struggling with policies to help address the growing housing crisis. Modular construction offers the ability to provide condominiums, apartments, and student dorms in about half the time as traditional, site-built construction methods.

MBI analyzed project data from 21 multi-family projects constructed last year including three student dorms and four workforce housing complexes. On average, the projects were 67,175 sq. ft., significantly larger than the average size reported in the prior report. On average, the projects consisted of approximately 85 modules each, again higher than in the past. These projects ranged in size from a 5,000 sq. ft. facility constructed with just seven modules, to a nearly 500,000 sq. ft. building with 408 building modules.

MBI also obtained certain cost data on 12 of these projects. The average total cost for a modular multifamily project in 2019 was \$11.3 million, with the modular portion of the cost making up about 48 percent of that total cost. The projects ranged in size from \$1.6 million to \$30 million, with the modular cost ranging from as low as 28 percent to as high as 92 percent of total costs. Accelerated project timelines are driving greater interest in multi-family. On average these projects were completed in 380 days from approval to occupancy.

The modular industry manufactured and labelled 2,041 multifamily units in 2019 or about 7.2 percent of total industry output. This figure is down slightly from 2018 indicating a shift of production into other markets such as hospitality. Five states account for the majority of multifamily modular projects: California,



Totem Inn (interior).
 Built by Builders Choice Modular LLC.
 Honorable Mention: Permanent Modular Hotel.

Massachusetts, New York, New Jersey, and Pennsylvania, with modular projects reported in nine other states.

While the cost and value of the projects was comparable to traditional construction methods, the earlier occupancy had a significant impact on cash flow. For example, consider the following project at an initial construction cost of \$10,000,000 and assuming the modular project is completed and ready to

rent in eight months while the traditional project is ready in fourteen months. A complex with 35 units rented at \$2,000/month with an occupancy rate of 90 percent would generate \$63,000 in monthly rental income. All other expenses—including taxes, insurance, and maintenance—remaining equal, the modular project would generate an additional \$378,000 in revenue for the owner due to earlier occupancy.

This earlier cash flow influx on the front end of a project often makes the difference for developers considering modular construction. Given the increasing number of successful modular multi-family projects, modular construction now has a proven track record of success. The added benefits of cost certainty, quality, and worker safety make this an obvious growth market for the modular industry.

Hospitality/Hotels

A shorter construction schedule means quicker occupancy for owners, and that means guests checking in months earlier than with conventional construction methods. It should come as no surprise that companies like Marriott Corporation have made modular construction part of their strategic plan. This sector was previously categorized under “multi-family housing” for MBI’s reporting purposes. However,



given the explosive interest and tremendous growth opportunities for the hotel and hospitality sector, this market has been identified as a key market for the industry.

MBI analyzed 25 hospitality projects completed from 2015-2018 to determine an average size of 45,568 square feet. On average, these projects took 249 days to complete, from approval to occupancy. MBI reviewed four additional hospitality projects completed in 2019 with an average size of 40,905 sq. ft. which were completed in 262

days, both consistent with prior averages.

The hospitality sector demonstrated the greatest growth in terms of number of units manufactured, from 1,487 units in 2018 to 1,955 in 2019. California was the strongest state for this market, followed by Kentucky, New Mexico, New York, and Texas.

Education

From single classrooms to complete campuses, modular construction offers public, private, and

charter schools what other construction methods cannot: accelerated project timelines, more economical pricing, and less site disruption. Permanent modular schools are indistinguishable from other schools and can be constructed to any architectural and customer specifications. MBI members design and build schools of all types and sizes using traditional building materials such as wood, steel, and concrete.

Virtually any size permanent school can be built, installed, and ready for occupancy in as little as 90 days. Perhaps most importantly, using off-site technology, open construction sites are eliminated while school is in session. Students are safer, and teachers do not have to compete with noises and construction-related disruptions.

Based on production figures, the education



Frankston Heights Primary School (interior). Built by Fleetwood Building Solutions. First Place: Permanent Modular Education Over 10,000 Sq. Ft.

market is the second largest for the industry in 2019 at nearly 25 percent of all production. This represents a 14 percent increase from 2018 production of 6,127 modules. California, Georgia, New York, North Carolina, Texas, and South Carolina were the top states in terms of utilizing modular construction in 2019, accounting for 45 percent of total production of educational units.

MBI analyzed data on 46 educational projects from 2015-2018. The total average size of these projects was

23,274 square feet, with the modular portion of the project making up about 13,404 square feet or 57 percent of the total project. Each project consisted of an average of 22 modules. The average completion for these projects was 155 days from approval to occupancy.

MBI also reviewed data on nine additional educational facilities completed in 2019. On average, these educational facilities were just over 10,000 sq. ft. and took 171 days from approval to occupancy. Of these nine projects,

cost data was obtained on seven, showing an average total cost of \$4,483,918 and an average modular cost of \$1,761,136 per project or about 39 percent of the total cost.

Healthcare

Many hospitals and healthcare facility contractors are turning to modular, primarily for building components such as bathroom pods and headwalls. However, entire hospitals have been constructed utilizing modular construction techniques. Modular construction offers

quiet, safe, and clean applications for medical, surgical, clinical, and dental use.

The insight MBI contractors have from designing and building medical facilities has resulted in satisfied healthcare professionals worldwide. If an organization or community needs a new rehabilitation clinic, emergency room, operating room, hospital extension, laboratory, diagnostic center, or other medical facility, modular construction can be used for custom-built facilities with the tightest budgets while maintaining strict medical and aesthetic specifications. Modular construction also results in much less on-site disturbance during the construction phase.

MBI analyzed data on 24 healthcare projects over the past five years with an average size of just over 18,000 sq. ft. The modular portion of these buildings was approximately 17,500 sq. ft. indicating that most of the

building footprint was made up of modular components. Most of these projects were labs, clinics, and health and wellness centers as evidenced by the relatively small building size.

MBI obtained cost data for ten of these projects showing an average total cost of approximately \$5 million. The modular portion makes up 96 percent of total square footage of the footprint but only 47 percent of the value of the project.

Historically, the healthcare market makes up between five to eight percent of total industry output. MBI expects this figure to change substantially in 2020 based on the healthcare facility shortages exposed by the COVID-19 crisis.

Office and Administrative

Permanent modular buildings serve as corporate headquarters, satellite



Suncor Convenience Store.
 Built by NRB, Inc.
First Place: Permanent Modular Retail.

offices, institutional and administrative buildings, and offices for all business types. Modern single- and multi-story buildings can be configured in several ways to include independent offices, conference rooms, elegant lobbies, kitchens, restrooms, and large open spaces for cubicles or other partition systems.

MBI members have architectural and engineering designs for workspace planning, storm water management, landscaping, parking, and zoned heating and air conditioning. If it is time to capitalize on company growth, modular construction offers a fast, economical approach.

The business and office market represents the largest building sector for the industry. Just under half of all modular production in 2019 is attributed to this market. This market experienced a 4.8 percent growth in units produced to 13,463 in 2019. Forty-six percent of these units were placed in California, Florida, Georgia,

New York, South Carolina, Texas, and Virginia.

MBI analyzed 28 office and administrative buildings constructed from 2015-2018. The average size of the buildings was 17,348 square feet, with the modular portion making up 15,313 sq. ft. or 88 percent of the overall footprint. The average total cost for the six of the buildings MBI obtained data on was \$2,804,099. The modular portion of the building made up 47 percent of the total cost.

MBI obtained data and analyzed information on an additional nine projects completed in 2019. The average size of these projects was smaller than the prior averages, at 11,698 sq. ft. each. The average cost of these most recent modular office projects was just under \$1 million each with the modular portion of the cost making up \$383,000 or about 38 percent of the total project cost.

Commercial & Retail

Simply put, quicker occupancy equals quicker return on investment. Modular construction is accelerated construction. Why is this important to banks, restaurants, convenience stores, childcare centers, and other retail establishments? Because earlier occupancy means a customer generates revenue faster. In fact, it is not uncommon for many modular buildings to be up and running within a week—an important consideration for retailers of all types.

Typical retail applications include restaurants and diners, banks, golf pro shops, convenience stores, gas stations, car washes, and concession stands, to name a few. MBI contractors provide a full array of services including site, mechanical, and electrical work. Customers can accommodate their emerging business with modular buildings customized to their financial needs, space

requirements, and deadlines.

Modular projects in this market made up just about one percent of all production again in 2019, with between 150-250 modules produced annually.

MBI was able to obtain and analyze data on 18 retail projects constructed over the past five years. Not surprisingly, the average size of these buildings was smaller than in other markets at around 4,000 sq. ft. The modular components made up 90+ percent of the footprint of the typical retail facility.

MBI obtained cost data for seven retail projects, with an average total value of \$556,143. The modular portion of these projects averaged 60 percent of the total value.

Institutional & Assembly

This market includes police and fire stations, prisons, and facilities used for assembly

such as churches. While not a large market overall, some modular companies specialize in these types of facilities.

As expected, the number of PMC institutional buildings declined after larger projects in 2018 were finalized. For 2019, the industry manufactured 742 units, compared to 818 the prior year, with new jail cells accounting for a majority of that figure.

MBI obtained data on 22 projects in the market built in the last four years. The average size of these buildings was about 60,000 sq. ft., with the modular portion constituting about 40,000 sq. ft. or 66 percent of the footprint.

MBI also obtained cost data for five projects in this market over the past several years, showing an average total cost of \$1,196,800 with the modular portion making up about 60 percent of that total cost.

REGIONAL Analysis

CANADIAN MARKET OVERVIEW

MBI represents 60 companies based in Canada, including 26 manufacturers of modular structures. In all, MBI estimates that there are about 45 total modular manufacturers in Canada fabricating for a variety of markets including residential, multi-family, commercial, educational, and industrial sectors. MBI directly obtained revenue data from 11 Canadian manufacturers.

UPS Office.
Built by Kent Homes,
a division of J.D. Irving, Ltd.
Honorable Mention:
Permanent Modular Retail.



SEDAR (www.sedar.com) is the official site that provides access to most public securities documents and information filed by issuers with the 13 provincial and territorial securities regulatory authorities (“Canadian Securities Administrators” or “CSA”) in the SEDAR filing system. MBI also obtained relevant information from annual filings on the following companies:

ATCO Ltd. was incorporated under the laws of the province of Alberta and is listed on the Toronto Stock Exchange.

Horizon North Logistics Inc. is a corporation registered and domiciled in Canada and is a publicly-traded corporation, listed on the Toronto Stock Exchange under the symbol HNL.

On average, manufacturers in Canada generated approximately \$13,004,545 CAD in revenue in 2019, up from \$11,012,676 in 2018. The



**Custom 2-Storey Office Complex.
Built by Black Diamond Group.
Honorable Mention: Permanent
Office Over 10,000 Sq. Ft.**

industry accounted for \$1.064 billion CAD in construction activity, up from \$901 million in 2018.

Overall non-residential construction put in place for key modular markets increased to \$27 billion CAD in 2019, up from approximately \$25 billion in 2018. This excludes single-family residential and engineering (bridges, highways, infrastructure).

Across Canada, overall increases in key markets were driven by increases in new education starts (up 11.5 percent), office construction

nearly doubling, and new multifamily starts (up 13.6 percent). New multi-family projects made up over half of all new construction opportunities in these key markets.

Historically, one of the key markets for the modular industry in Canada has been the industrial workforce housing sector. The modular industry provided temporary workforce housing solutions in remote regions where the energy sector was active. With the decline in oil prices in recent years, the industry has diversified into some of

the above-mentioned markets more aggressively.

Construction industry activity in key modular markets is forecast to hover between \$25-\$27 billion for the next few years according to Construct Connect Insights.

Western Canada (British Columbia, Alberta, Saskatchewan)

Overall construction starts in this region rebounded to nearly \$10 billion CAD in construction activity after falling off in 2018. Gains were driven by increasing in multifamily projects (up 34

percent from 2018), education (up 23 percent), and office/administrative spaces (up 57 percent).

Like other regions, the multi-family market is the biggest opportunity for the industry, with nearly \$5.5 billion CAD in projects in 2019, representing over half of the construction opportunities in key modular markets. British Columbia saw an increase of nearly 22 percent in the multi-family market to \$4.1 billion CAD in 2019, while Alberta all but doubled from \$662

million CAD to \$1.3 billion.

The education sector exceeded expectations and surpassed \$1.6 billion CAD in this region. The growth in the education market came mainly from British Columbia, nearly doubling from \$465 million CAD to \$851 million in 2019.

Government-funded projects largely drove the market in Saskatchewan with a majority of construction projects falling into education, government office, or fire and police stations.

Eastern Canada

(Atlantic Provinces, Ontario, Quebec, Manitoba)

Overall construction activity in the eastern provinces jumped 21.5 percent in 2019, to \$26.4 billion CAD in key modular markets. The biggest gains by market included government offices (up 164 percent from 2018), general office/administrative space (up 103 percent), and retail (up 215 percent). It is somewhat surprising that the growth did not come from many of the traditionally strong modular markets such as

education and multi-family.

Nonetheless, the multi-family sector held its own and grew slightly to \$11.9 billion CAD in the region. Multi-family projects accounted for 51.4 percent of all new projects in key modular markets in 2018 but dropped to 44 percent in 2019. Ontario is still the biggest driver for multi-family projects in the region, accounting for \$8.5 billion CAD in 2019.

Education was still a strong market in the region, particularly in Quebec, with over \$1.6 billion in activity in 2019. Ontario dropped off in this market in 2019, after investing \$1.2 billion in 2018.

The retail market boom in Quebec was the single largest gain of any market in any Province, going from \$327 million CAD in 2018, to \$1.7 billion in 2019. Overall, Ontario accounted for \$15.4 billion CAD of all construction activity in the region, or 58.2 percent of the total. Quebec accounted for \$8.6 billion CAD or 32.6 percent.



Beausejour Family Crisis Resource Centre.
Built by Kent Homes, a division of J.D. Irving, Ltd.
Honorable Mention: Permanent Modular Dormitory.

U.S. MARKET OVERVIEW



Army Depot Park.
Built by Blazer Industries.
Honorable Mention: Permanent Modular Assembly.

Based on data obtained from state modular administrative agencies, production of PMC modules grew to 28,251 in 2019, up from 26,269 units in 2018 (increase of 7.5 percent). This figure represents the number of labeled units only, as not all states have a labeling program.

Region 1 – Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York.

Production in this region decreased slightly to 2,662 units in 2019 compared to 2,834 in 2018. Educational and multifamily units were up slightly for the region, but

more than offset by declines in office and business facilities.

Top markets in this region included education, offices, and multi-family. The multifamily market continues to make gains in this region accounting for 29 percent of units compared to 18.5 percent the prior year.

Region 2 – Virginia, West Virginia, Pennsylvania, Maryland, District of Columbia, Delaware, New Jersey.

Total production in this region was flat at 2,974 units in 2019, compared to 2,999 in 2018. Strong markets in this region continued to be office, education, and multi-family housing.

Region 3 – Florida, Georgia, Alabama, Mississippi, North Carolina, South Carolina, Tennessee.

Total region was up slightly to 6,436 units in 2019 compared to 6,278 in 2018 despite a slight drop in multifamily units. Gains in educational and office units largely carried this region.

Region 4 – Louisiana, Texas, Arkansas, New Mexico, Oklahoma.

This region showed some of the strongest gains in terms

of modular units placed, up 19 percent from the prior year. Gains in office and educational units again carried the region. This came as no surprise as the education market in Texas is one of the strongest markets anywhere for the industry.

Region 5 – Ohio, Kentucky, Indiana, Michigan, Illinois, Wisconsin, Minnesota, Iowa, Missouri.

The total number of newly constructed modules was up nearly 20 percent in 2019

to 4,161 units. The overall growth was distributed across several markets including offices, education, and institutional, while multi-family units declined slightly.

Region 6 – California, Arizona, Nevada, Utah

One of the strongest regions, units labelled and placed in these states were up 25.5 percent compared to the prior year, with nearly 5,300 units labeled. The gains were driven largely by the hospitality sector which nearly doubled from 818 units to 1,539 in 2019. The growth was also largely driven by production in California, one of the top states for several markets including office, education, and multi-family.

Region 7 – Oregon, Washington, Idaho, Alaska, Hawaii

Total regional labelled units were down 37 percent, dropping below 1,000 units for the region in 2019. Administrative

offices and educational facilities were the strongest markets in this region.

Within this region, there still exists potential opportunities for growth in the hospitality and multi-family sectors.

Large urban areas such as Seattle and Portland are considering modular solutions to address urgent housing needs.

Region 8 – Colorado, Kansas, Nebraska, South Dakota, North Dakota, Wyoming, Montana

The total number of labelled units for this region was flat compared to 2018, at 1,591 units. Administrative office and education markets showed slight growth while declines in the multifamily sector negated those gains. The office and education markets in this region accounted for 82 percent of all modular production in the region in 2019.



Corcoran Police Station. Built by Silver Creek Industries & Accelerated Modular Concepts, Inc. First Place: Permanent Modular Correctional.

OUTSIDE NORTH AMERICA



Modular Extension of
Hotel BoniFaCio SPA
& Sport Resort. Built by
DMD Modular Sp. z o.o

MBI represents twenty-five European companies and obtained revenue data from ten. Based on this data, the average revenue in 2019 was US \$9,344,500. Three of the companies focused almost exclusively on the multi-family market, while

the other companies were more diversified in their market mix.

For further insight into the European modular market, MBI reached out to the co-chair of its European Advisory Council, Bostjan Jevsek of Piva Group.

Modular market overview Europe

Bostjan Jevsek, MBI European Council co-chair

Summary

The European modular market grew in strength in 2019, echoing the performance

of almost all sectors in the European economy. It is estimated that the modular market in Europe represented around 2.5 percent of the construction market (<https://www.interconnectionconsulting.com/industries-markets/container-raumsysteme>) and

has enjoyed continuous and steady growth of 3.5-5.5 percent annually.

The total value of existing modular buildings in Europe in 2019 is estimated at around nine billion Euros (<https://www.interconnectionconsulting.com/wp-content/uploads/2018/09/Total-Market.jpg>). The largest European modular markets remain the United Kingdom, Germany, Italy, France, Poland, Turkey, and the Benelux countries (Belgium, the Netherlands, and Luxembourg). Of course, the European modular market differs from the North American market quite a bit, with the main differentiator being the type of modular construction used. In Europe, steel is the prevailing construction material, with typical unit sizes mostly in the range of eight to ten feet wide and 20-30 feet long (depending on the population density of the site).

Put simply: modular construction is popular in Europe. In fact, the Austrian



Leipzig Modular Residential Estate.
Built by Kan-Bud



parliament and their support services have been meeting in the modular building set up in front of the parliament building while it undergoes a three-year-long renovation. The modular building can accommodate 450 people and, once renovations are complete, will be dismantled and repurposed as kindergartens and schools.

Types of modular construction and industries served in Europe

A general distinction between European and North American modular types is in the construction of the units. Whereas some Northern European (i.e. Scandinavian) countries use wood as primary building material, most of the modular manufacturing in Europe relies on steel. There are two general types of steel construction:

- 1) steel moment frame with panelized walls, where the steel frame is the load-bearing element

- 2) steel skeleton construction (similar to North American modular buildings), where the steel structure and wall studs are the load-bearing elements and with walls made in one piece.

Due to road restrictions in Europe, typical module sizes vary from eight to 10 feet in width and 20-40 feet in length. There are, of course, exemptions to this rule.

Just as in North America, the industry is divided into permanent modular construction and relocatable modular buildings. Permanent modular construction is strongest in Germany, the Benelux countries, and the United Kingdom, where a range of hospitals, schools, apartment buildings, student apartments, and hotels are being made from

prefabricated volumetric modules, transported to a site, and assembled. In most cases, fit and finish is made in the factories as well, so that on-site work is minimized.

Modular companies from Europe are exporting their solutions to the North American markets, as well. Many European companies provide fully code-compliant modular solutions to the U.S. and Canada, including the modules used in the tallest modular hotel in the world to be opened by Marriot on 6th Avenue in New York City.

The European modular market is very strong in commercial buildings with some of the modular buildings bridging the divide between permanent and relocatable. The most common examples are modular office buildings being used as extensions of existing buildings when companies need more space for their workers, or as temporary offices while traditional buildings are being renovated. Fit

and finish of these buildings, although meant as temporary solutions, often exceed expected designs for temporary buildings, giving the buildings a unique, modern look.

The rental fleet market is also a major industry, however there is a clear difference between European and North American rental fleet units. In Europe, a vast majority of the units are smaller (as mentioned previously) and are engineered to be stacked two, three, or even more stories high. This is necessary as space is at a premium in Europe.

The rental fleet market is one of the fastest growing segments in the industry, with typical annual growth rates of 5.0% and higher.

The bathroom pod segment also constitutes a large part of the modular industry in Europe, from simple vinyl-molded bathroom modules to steel and concrete construction units used in the top brand hotels.

The United Kingdom, Poland, and some other European countries lead the way in the pod industry.

The growth of the modular industry in Europe over the past five decades has spawned a whole new industry of specialized suppliers to modular manufacturers. These suppliers have mostly developed unique solutions for panelized walls, windows, doors, and steel profiles, which enable modular manufacturers quick and easy manufacturing and assembly.

PivaGroup from Italy (www.pivagroupspa.com), for example, is the largest European modular supplier. Piva also sells its products worldwide and also manufactures windows, doors, and wall panels as ready-made segments. This type of manufacturing resembles the automobile industry with key suppliers acting as developing partners and suppliers of prefinished components.

Modular industry on the rise in Europe

The excellent economic environment over the last couple of years has positively influenced the modular industry. There are all sorts of modular companies in Europe, ranging from small, family-run businesses to large companies employing 1,000+ people and revenues of several hundred million dollars annually.

In most European countries, education systems—at least on the primary and secondary level—are state operated. In the past decade, there has been a big push to increase the capacity of kindergartens and schools. To meet the demand and timelines, the modular industry has contributed enormously since most of additions and temporary space expansions are modular systems.

As the result of turmoil in the Middle East and Africa, Europe has experienced a large influx of refugees and

migrants from 2014-2018 and the influx continued in 2019, albeit on the lesser scale. At one time, authorities often turned to the modular industry to manufacture and provide temporary space and shelter for the refugees. This trend is projected to continue as those temporary shelters are turned into permanent housing. The need for new schools will also likely benefit the modular construction industry.

Infrastructure projects, funded by public money, also meant a lot of demand for accompanying modular buildings on construction sites in 2019. Public tenders have been a major driver for the modular industry and projections are strong for the future.

Commercial clients also increased their orders from the modular industry in 2019, basing their orders on strong industry trends. Typical lead times for modular factories around Europe



Casa Estilo Pilar.
Built by Ruca Panel.

have extended to 10-14 (or more) weeks due to the additional demand.

Some modular factories experienced a shortage of skilled labor in 2019, but that was not uncommon across

the entire manufacturing industry in the wake of general expansion. The general growth rate in the industry in 2019 was between 3.5 and 5.0 percent, with certain industries and companies experiencing high

double-digit growth. Analysts project above-average growth rates in the future as well.

South America

Political uncertainty and turmoil have impacted many

regions in South America in 2019 including Bolivia, Chile, Ecuador, Venezuela, and Colombia. Despite the financial and political uncertainties in the region, the construction industry grew by 1 percent in



Cotabamba - Police Base of Special Operations. Built by Cataminon.

2019 and is expected to expand on average 2.6 percent annually between 2020-2023. (Source: Association of Equipment Manufacturers). The International Monetary Fund is slightly less optimistic, forecasting economic growth in Latin America to average 2 percent per year over the next five years, below the global average for emerging-market economies.

Historically, the oil, gas, and mining industries drive revenue for the modular construction industry in South America. For greater insight, MBI reached out to its members in South America on specific modular markets and activity in 2019.

Argentina:

In 2019, business activity increased slightly compared

to 2018 for many companies. However, due to the Argentinean peso devaluation (almost 100 percent and with an inflation of 55 percent) there was an overall decrease in annual revenues. The main market for modular construction in Argentina was workforce accommodations (mining and energy-related), with activity in other

markets such as offices and administrative buildings, retail, and healthcare facilities.

The biggest challenge or barrier for greater modular industry growth in South America is the economic environment, which has limited growth since 2018. There is still some bias against the prefab industry in the local market due to the lack of understanding and (likely) the scarcity of quality modular building companies.

“Informal” labor availability is a challenge as the traditional construction market typically utilizes a large percentage of this labor force. Logistics, mainly related to the availability and cost of Inland transportation, roads, and cranes also pose challenges to growth.

Opportunities exist in the markets of commercial and hospitality sectors due to a greater awareness that the modular delivery methods allow early revenues.

Additionally, as in most parts of the world, there will be a general need to rethink and review the design of the healthcare industry due to the COVID-19 crisis.

Brazil:

The construction market in Brazil is finally showing itself truly willing to evolve in its processes, its products, in management as a whole, and in innovations. The number of startups focused on civil construction is proliferating as never before and with the active participation of the main construction companies.

Undoubtedly, it is a great opportunity for modular construction to consolidate itself as a faster, viable, ecological alternative, with a lot of quality and fair price, fostering a market needing building systems with a much shorter lead time than conventional systems. Culturally, the old mindset of price over quality

(due to projects being dependent on financing from publicly-owned banks) still holds true. This, in turn, facilitates the approval of conventional construction over modular construction.

Currently, there are opportunities for growth in the modular construction sector, with the consolidation of many established companies and the entry of new ones. In Brazil, there has never been so much discussion surrounding the modular construction system. The biggest barrier for greater modular industry growth in Brazil is uneven taxation on industrialized construction (+20 percent over). Currently, industrialized systems pay higher rates than systems made onsite and quality control is more rigid and costly due to the lack of construction standards. Another challenge is the limited options for materials

easily available for dry construction, such as external coatings, to accommodate and be more attractive for the Brazilian preferences.

There are a few key markets for modular construction, primarily workforce housing, educational, and commercial spaces. Modular workforce accommodations in Brazil are delivered mainly for mining sites. In 2019, however, modular construction was used more for education, events, and commercial markets, especially fast food franchises.

FINANCIAL Data



Bogner Hall – 3rd Residence Hall.
Built by Axis Construction Group & Modlogiq Inc.
First Place: Permanent Modular Dormitory.

Revenue and Market Share

This report provides estimates of PMC market share from 2015 to 2019 for sub-segments that frequently utilize PMC techniques.

Process

In estimating the overall North American market share for commercial modular construction, it is necessary to make a series of calculations and adjustments to compare to a baseline figure more accurately.

MBI uses data from Construct Connect Insights as its baseline measurement for new construction starts in the key markets previously mentioned. As new construction starts can be volatile year-over-year, MBI uses a three-year average for new construction starts.

MBI obtains revenue and production data from its manufacturer base to



Wellspring Health & Surgery Center. Built by Innovative Modular Solutions, Inc. & Whitley Manufacturing. *First Place: Permanent Modular Healthcare.*

determine the average (mean) revenue per manufacturer. That number is then multiplied by the total number of North American manufacturers engaged (or partially engaged) in PMC projects.

The industry's revenue survey generated 60 total responses from manufacturers, with the overall modular building industry estimated to encompass 252 firms. For the average building project using PMC technologies, the modular construction team

supplies approximately 55 percent of the total value of the project put in place. This was determined by reviewing nearly 200 projects in our database over the past four years. Consequently, to obtain the value of projects using PMC, these revenues have been multiplied by the ratio 1/0.55.

For 2019, MBI collected data from 60 manufacturers engaged in PMC in North America, the highest number of responses ever received.

The overall average revenue of these manufacturers was \$19,941,888, up slightly from 2018.

When scaled by 1/0.55, the total value of modular building construction projects for 2019 can be estimated at \$9,137,010,425, up from \$8.9 billion in 2018 and \$7.2 billion in 2017.

Rendering these statistical adjustments results in an estimate that PMC technologies drove about \$9.1 billion in construction activity in 2019.

PMC Market Shares, 2015-2019

Year	PMC Firm Revenues	Value of PMC Projects	Construction Starts Value	3-Year Moving Average of Construction Starts Value	PMC Market Share
2015	\$2,040,500,000	\$3,710,000,000	\$173,729,905,578	\$152,848,424,717	2.43%
2016	\$3,301,664,172	\$6,003,025,767	\$244,509,444,333	\$188,939,551,127	3.18%
2017	\$3,979,680,268	\$7,235,782,305	\$246,089,662,933	\$221,443,004,281	3.27%
2018	\$4,943,067,948	\$8,987,396,269	\$243,316,997,946	\$244,638,701,737	3.67%
2019	\$5,025,355,734	\$9,137,010,425	\$255,013,842,707	\$248,140,167,862	3.68%

Source: Modular Building Institute, Construct Connect

Based on a combination of industry survey data and data characterizing construction starts, projects using PMC technologies accounted for 3.68 percent of the value of commercial construction starts in the key North American segments that serve as the focus of this report.

Disclaimers:

In preparing this report, there are numerous variables, adjustments, and calculations that are necessary to arrive at the final numbers.

Not all the 252 firms engaged in commercial permanent modular

construction in North America are exclusively serving the commercial sector. Several also manufacture single-family residential modules or relocatable (temporary) products.

Another challenge is that some manufacturers are engaged in three-dimensional volumetric modular construction while others are primarily two-dimensional panelized factories, making comparisons and calculations difficult.

MBI is also aware of multiple PMC projects that were fabricated by companies outside North America and incorporated into projects

here. While the value of these projects is most likely captured in the overall new construction starts (baseline measurement), MBI did not attempt to include this production and revenue data for purposes of this report. MBI included only revenue and production data from North American manufacturers.

Using the averages provided by the MBI survey and manufacturers input of data, it is possible to estimate certain information about the industry as a whole. The calculated information is reliable only to the extent the data provided by the industry participants is accurate.

Trends & Forecast

As reported in Dodge Data and Analytics' *Prefabrication and Modular Construction 2020 SmartMarket Report*, 203 architects, engineers, and general contractors were asked how often they planned to use volumetric modular construction over the next three years. The results were segregated by company type, revenue, and region.

General contractors:

Fifty-nine general contractors answered the question "how likely are you to use volumetric (three-dimensional)

modular construction over the next three years?”

Only 14 percent answered that they were not likely to use it while 63 percent said they intend to use it for more than 10 percent of their total projects. Additionally, 24 percent of all respondents indicated that they planned on using modular construction for more than half of all their projects.

For the 31 larger general contractors answering (over \$100 million in annual revenue), only 6 percent indicated that they had no plans to use modular construction over the next three years. In the prior three years, these general contractors had used modular construction for healthcare facilities (42 percent of respondents), multi-family projects (32 percent), hospitality (28 percent) and college dorms and buildings (22 percent).

Architects:

Sixty-three architects answered the same question, with only 17 percent indicating that they did not plan to use modular construction or were not sure. One-third of all architects indicated they plan to use modular on 25 percent or more of their projects in the next three years.

Engineers:

Only 20 engineers answered the question, but did so with less optimism about modular construction. Thirty-five percent said they did not plan to use it or were not sure. However, ten percent said they planned to use it on 75 percent or more of their projects (compared to five percent of architects answering the same), indicating that perhaps more engineers will specialize in this field compared to architects.

Regional:

Of the 203 total respondents, eight percent of companies in the West will use modular construction almost exclusively, compared to four percent in the East, South, and Midwest. Thirty-two percent of all companies in the East will use modular construction on at least 25 percent of their projects, compared to 29 percent of companies in the West, 28 percent in the Midwest, and 25 percent in the South.

Perhaps the most telling signal of the modular industry’s growth potential is that nearly half of all contractors responding to the Dodge report indicated they plan to add a prefabrication operation to their business model over the next three years.

Key Takeaways

- In 2019, the industry drove just over nine billion dollars in construction activity, up two percent from 2018.
- Estimated market share for PMC in key North American markets is approximately 3.68 percent up slightly from 3.67 percent in 2017.
- Overall average revenue per manufacturer grew slightly from \$19,615,349 in 2018 to \$19,941,888 in 2019.
- A total of 252 North American firms were included for this report, including companies that modify shipping containers for use as permanent building components.
- Modular construction projects demonstrated measurable improved results on cost, quality, safety, and environmental impacts.



Custom 2-Storey Office Complex.
Built by Black Diamond Group.
*Honorable Mention: Permanent
Office Over 10,000 Sq. Ft.*

To what code are modular buildings constructed?

It is helpful to think of “modular” as a construction process rather than a building type. A modularly-constructed building simply means that the materials were delivered to an off-site location (the modular manufacturing facility), assembled into components or three-dimensional building modules, then transported to the final site for assembly. As such a building constructed in this manner must still meet all the same building codes and requirements as if it were built on-site. This is most commonly a version of the International Building Code (IBC) in the U.S. or the National Building Code (NBC) in Canada.

Do the buildings last as long as site-built? Same quality?

A building constructed using modular methods will last as long (if not longer than) a traditional site-built structure. Again, the building is constructed to the same building codes and must meet the same wind, snow, and seismic conditions. While there is limited research to prove this point, one such study does exist. Following Hurricane Andrew in 1992, FEMA commissioned a study called “Building Performance: Hurricane Andrew in Florida” comparing site-built, modular, and manufactured housing. In that report, FEMA found “Overall, relatively minimal structural damage was noted in

Seasons Cambridge Retirement Residence.
Built by A-LINX Buildin Technologies.
Honorable Mention: Permanent Modular Healthcare.



wood-framed modular housing developments. The module-to-module combination of the units appears to have provided an inherently rigid system that performed much better than conventional residential framing.”

Is modular construction cheaper/less expensive?

Generally speaking, yes. There are a lot of variables with a modular project, just as there are with a conventional construction project. The availability and cost of on-site labor is a key factor. In larger urban areas where labor is scarce and/or more expensive, shifting construction to an off-site (often rural) location can yield significant cost savings.

Additionally, the overall efficiency of the process can lead to cost savings. Fewer labor hours are needed to complete a comparable project and waste is significantly reduced.

Lastly, the shortened construction schedule can reduce the time needed for a construction loan and can dramatically advance the oc-

cupancy date, critical considerations for revenue-generating businesses such as hotels and fast food restaurants.

MBI partnered with other organizations to fund research conducted by Professor Ryan Smith at the University of Utah to analyze several modular projects compared to similar site built “peer” projects. In all but one of the comparisons, the modular project was found to be more cost effective.

McGraw-Hill published a SmartMarket Report titled “Prefabrication and Modularization: Increasing Productivity in the Construction Industry.” Through an internet survey of hundreds of AEC professionals, the report found: “Sixty-five percent report that project budgets were decreased—forty-one percent by six percent or more.”

Isn't this a new, untested method for construction?

Far from it! A report from 1670 indicates a prefabricated building was shipped by boat from England to the United States. In the 1800s, demand for modular housing increased as the

country expanded westward. During the Gold Rush of 1849, more than 500 preassembled homes were shipped from factories in New York to destinations in California.

In the 1920s, Sam Kullman began manufacturing the popular “Kullman Diners” along the northeast coast.

In 1933, the first of Franklin Roosevelt’s New Deal communities, Arthurdale, West Virginia, was established. All types of modular structures were shipped there: post offices, stores, homes, and schools. After World War II, modular construction offered fast and low-cost homes to returning servicemen.

In the 1940s, the industry began to expand into commercial projects with the founding

of industry giants Williams Scotsman (now WillScot) in Baltimore, Maryland, and ATCO in Alberta (now a multibillion-dollar global corporation).

In 1969, Zachry Construction utilized modular construction techniques to complete a 21-story modular hotel on the Riverwalk in San Antonio. The hotel, still in operation, was the tallest modular building in North America until the recent completion of the 32-story Pacific Park building in Brooklyn, New York.

Disney Corporation followed with completion of its Contemporary and Polynesian Resorts in 1972, constructed by U.S. Steel. There is a long history of innovative companies successfully utilizing modular construction techniques.

I have heard about “pop-up” or project specific manufacturing plants. Is that the same as a modular factory?

The modular factories detailed in this report are not project specific plants. Rather the companies build for several clients within a given geographic region (typically about a 500-mile radius from the factory). MBI has seen some examples of general contractors renting vacant warehouses near larger project sites and using these “pop-up” factories for some preassembly work and for materials staging and coordination. These are not automated plants and often do not incorporate assembly-line processes or lean manufacturing techniques. Rather these locations are often just an extension of the existing job site.

Do prevailing wages apply for work done in a modular factory?

No. Davis-Bacon rates and state prevailing wages laws typically are limited to the

work performed “at the site.” By definition, work done in a modular factory is “off-site.” That said, there are many considerations and nuances to understand about the applicability of prevailing wages. Often state laws vary on this subject, so when in doubt, seek a legal opinion. Also, if a factory is established for a specific project and intended to only serve that project (see the pop-up example above), it will be considered an extension of the jobsite and prevailing wages will likely apply.

So, why hasn’t it caught on before now? Why the sudden interest?

Until recently, developers and contractors seemed content with the status quo, regardless of the inherent and understood inefficiencies. Planning and preparing for those inefficiencies seemed easier than learning a different way of building for many. Today, developers and owners are facing the “perfect storm” in the construction sector, including:

- A widely recognized skilled labor shortage that will not get better anytime soon;
- High housing costs and low housing availability in urban areas, a condition that is worsening;
- A widely documented lack of productivity in construction; and, as previously mentioned,
- The increasing need for shorter construction schedules.

Adding to those factors, the construction industry has more fully embraced innovations and technologies that are leading towards more of an “industrialized construction process.”

Lastly, consumers (especially younger, more environmentally-conscious ones) are demanding greater accountability regarding wasted resources and the massive amount of construction debris that ends up in landfills annually. Modular construction is a proven solution to reduce construction waste.

Where is the industry headed? What other trends do you anticipate? Will this interest lead to greater adoption of modular construction?

Over the past five years, MBI has seen a shift towards more steel frame modular construction. Five years ago, about 80 percent of the North American industry was utilizing wood-frame modules. Today, it is about 70 percent wood-frame. We are also seeing a trend towards taller modular buildings here, also contributing to the increased use of steel.

North America lags several countries in terms of construction innovation and advancement. In places like the United Kingdom, Singapore, Australia, Japan, Sweden, and China, industrialized construction processes are more widely accepted. Many of these countries faced the same challenges we have in North America today. Not surprisingly, we have seen several examples where the building modules were fabricated outside North America and imported and incorporated into projects

here. The concept will catch on. It is really a question of whether the North American construction industry is concerned enough to get onboard.

If history is any indication, we will see a significant shift towards modular and off-site construction techniques over the next five years as greater numbers of the skilled labor force retire. The construction industry will (and must) evolve into a more industrialized and automated process – it is just inevitable. Every major industry has undergone this same transformation. The construction industry is the last holdout while clinging to a lost cause. The companies that build modular now and build it into their strategic plans will be more successful sooner.

In North America, the movement has begun. We are seeing some large general contractors establish their own modular divisions, while others partner with existing modular manufacturers.

How many square feet does the typical manufacturer produce in a year?

This is where the averages can be misleading. The number of modules a particular manufacturer produces in a given year depends on a few variables such as the type of project the company is building, the level of customization involved in

the project, and the scope of the manufacturer’s contract (i.e., whether the customer wanted certain work to be completed on-site). Based on overall data obtained from 37 manufacturers in the U.S. and Canada, the average square footage produced in 2017 was 122,000. At roughly 800 sq. ft. per module, which equates to about 152 modules

annually. However, this figure should not be used as a measurement of a company’s efficiency or success.

Where can I learn more about modular construction?

The Modular Building institute’s website, www.modular.org is loaded with case studies, research, articles, and links to companies in your area.



Martin Marietta In-plant Breakroom.
Built by Ramtech Building Systems, Inc.
Honorable Mention: Permanent Modular Special Application.

Building Envelope – The physical separator between the interior and the exterior environments of a building. It serves as the outer shell to help maintain the indoor environment (together with the mechanical conditioning systems) and facilitate its climate control. Building envelope design is a specialized area of architectural and engineering practice that draws from all areas of building science and indoor climate control.

Building Site – A lot, the entire tract, subdivision, or parcel of land on which industrialized housing or buildings are sited.

Building System – The design and/or method of assembly of modules or modular components represented in the plans, specifications, and other documentation which may include structural, electrical, mechanical, plumbing, fire protection, and other systems affecting health and safety.

Closed Construction – A building, component, assembly, subassembly, or system manufactured in such a manner that all portions cannot be readily inspected at the installation site without disassembly or destruction thereof (source: Louisiana Industrialized Buildings program).

Commercial Structure – An industrialized building classified by the building codes for occupancy and use groups other than residential for one or more families.

Compliance (or Quality) Control Program – The manufacturer’s system, documentation, and methods of assuring that industrialized housing, buildings, and modular components, including their manufacture, storage, handling, and transportation conform with this chapter.

Compliance Assurance Agency (aka third-party inspection agency) – An architect or professional engineer, or an organization, specially qualified by reason of facilities, personnel, experience, and demonstrated reliability, to investigate, test and evaluate modular buildings; to list such buildings complying with standards; to provide adequate follow-up services at the point of manufacture to ensure that production units are in full compliance; and to provide a label

as evidence of compliance on each manufactured section or module. (source: Virginia Industrialized Buildings Program).

Component – A subassembly, subsystem, or combination of elements for use as a part of a building system or part of a modular component that is not structurally independent, but may be part of structural, plumbing, mechanical, electrical, fire protection, or other systems affecting life safety.

Decal (insignia or label) – The approved form of certification issued by the state administrative office to the manufacturer or builder to be permanently affixed to the module indicating that it has been constructed to meet or exceed the code requirements.

Deconstruction – The process of taking a building or structure, or portion thereof, apart with the intent of repurposing, reusing, recycling, or salvaging as many of the materials, products, components, assemblies, or modules as possible.

Design Package – The aggregate of all plans, designs, specifications, and documentation required by these sections to be submitted by the manufacturer to the design review agency or required by the design review agency for compliance review, including the compliance control manual and the on-site construction documentation. Unique or site-specific foundation drawings and special on-site construction details prepared for specific projects are not a part of the design package.

Erection/Installation/Set – The process of blocking, leveling, and anchoring a modular building unit on the building site upon delivery.

Installation – On-site construction of industrialized housing or buildings (see definition of on-site construction).

Local Building Official – The agency or department of a municipality or other local political subdivision with authority to make inspections and to enforce the laws, ordinances, and regulations applicable to the construction, alteration, or repair of residential and commercial structures.

Manufacturer – A person who constructs or assembles modules or modular components at a manufacturing facility which are offered for sale or lease, sold, or leased, or otherwise used.

Manufacturing Facility – The place other than the building site, at which machinery, equipment, and other capital goods are assembled and operated for the making, fabricating, constructing, forming, or assembly of industrialized housing, buildings, modules, or modular components.

Marriage Wall/Cross Over Connections – The joint between the modules in a complex, commonly called a mate-line or mod-line.

Module – A three-dimensional section of industrialized housing or buildings, designed and approved to be transported as a single section independent of other sections, to a site for on-site construction with or without other modules or modular components.

Off-Site Construction – The planning, design, fabrication, and assembly of building elements at a location other than their final installed location to support the rapid and efficient construction of a permanent structure. Such building elements may be prefabricated at a different location and transported to the site or prefabricated on the construction site and then transported to their final location. Off-site construction is characterized by an integrated planning and supply chain optimization strategy (source OSCC).

Permanent Modular Construction (PMC) – An innovative, sustainable construction delivery method utilizing off-site, lean manufacturing techniques to prefabricate single or multi-story whole building solutions in deliverable module sections. PMC buildings are manufactured in a safe, controlled setting and can be constructed of wood, steel, or concrete. PMC modules can be integrated into site-built projects or stand alone as a turnkey solution, and can be delivered with MEP, fixtures, and interior finishes in less time, with less waste and higher quality control compared to projects utilizing only traditional site construction.

Prefabricated – The manufacture or fabrication of sections of a building at an off-site location which are delivered to and assembled at the building site.

Relocatable/Industrialized building – A partially or completely assembled building that complies with applicable codes and state regulations and is constructed in a building manufacturing facility using a modular construction process. Relocatable modular buildings are designed to be reused or repurposed multiple times and transported to different sites.

Repurpose – To divert a material, product, component, module, or building from the waste stream for use for an application that is different than its original use or occupancy.

Reuse – To divert a material, product, component, module, or building from the waste stream in order to use it again for a purpose that is consistent with its original use or occupancy.

State Administrative Office (SAO) – The designated representative for the enforcement of this chapter and shall act as the building official for registered industrialized buildings.

Site or Building Site – A lot, the entire tract, subdivision, or parcel of land on which industrialized housing or buildings are sited.

Third-Party Inspection Agency (TPIA) – An approved person or entity determined by the state or program to be qualified by reason of facilities, personnel, experience, demonstrated reliability, and independence of judgment to inspect industrialized housing, building, and portions thereof for compliance with the approved plans, documentation, compliance control program, and applicable codes. Also known as “Approved Testing Facility or ATF,” or “Compliance Assurance Agency.”

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