KPMG

Brick by brick

How modular construction will rearrange industry profit pools

Modular is finally taking off, but the economic benefits are not likely to be evenly distributed. Without changing status quo business models, owners and developers stand to gain while construction firms and their suppliers could lose.

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Executive summary

After a number of false starts, modular construction finally seems to be on the rise. The supporting technology and risk management analytics have improved, participation has increased across construction types, and operational adoption of modular techniques has taken root across a broader swath of the construction ecosystem.

While discussions about modular construction typically focus on its value in reducing cost, time, and labor compared to traditional building processes, we believe there is another important issue that needs to be considered: how modular construction may reallocate profit pools across the industry. For participants already operating on notoriously thin margins, it could constitute a long-term existential threat.

In this paper, we outline the factors we believe will drive this reallocation of industry profits, and we discuss the impact of modular construction on the business models of:


Engineers and designers


General contractors


Trades


Building material manufacturers and distributors


Services and equipment renters


Developers


Building owners

In companion papers, we will explore the strategies and business model refinements that each type of player can use to mitigate—and even gain value from—the shift from traditional to modular construction.

Defining modular

Modular has been used to refer to a range of prefabricated technologies, including components, panels, and modular structures. Modular is a subset of off-site manufacturing that more broadly includes planning, designing, fabrication, and assembly of a building at a location other than the actual area for rapid assembly at the site. These broader practices have always existed for certain project types (e.g., offshore oil rigs), but now impact a wider array including data centers, semiconductor fabs, hospitals, and others that were once the exclusive territory of traditional construction.

In this paper, we use the term "modular" to refer primarily to volumetric modular structures, although panel structures may exhibit many of the same behaviors and trends:

Exhibit 1 – Prefabricated technologies

01 Prefabrication components

Most of the components used in buildings today use some form of prefabrication (e.g., pre-cast structural elements, panels, etc.

02 Panels

Components that are composed of prefabricated elements such as windows, door assemblies, or wall panels, but do not enclose usable space themselves **Panel manufacturers may also offer modular structures**

Our focus

03 Modular structures

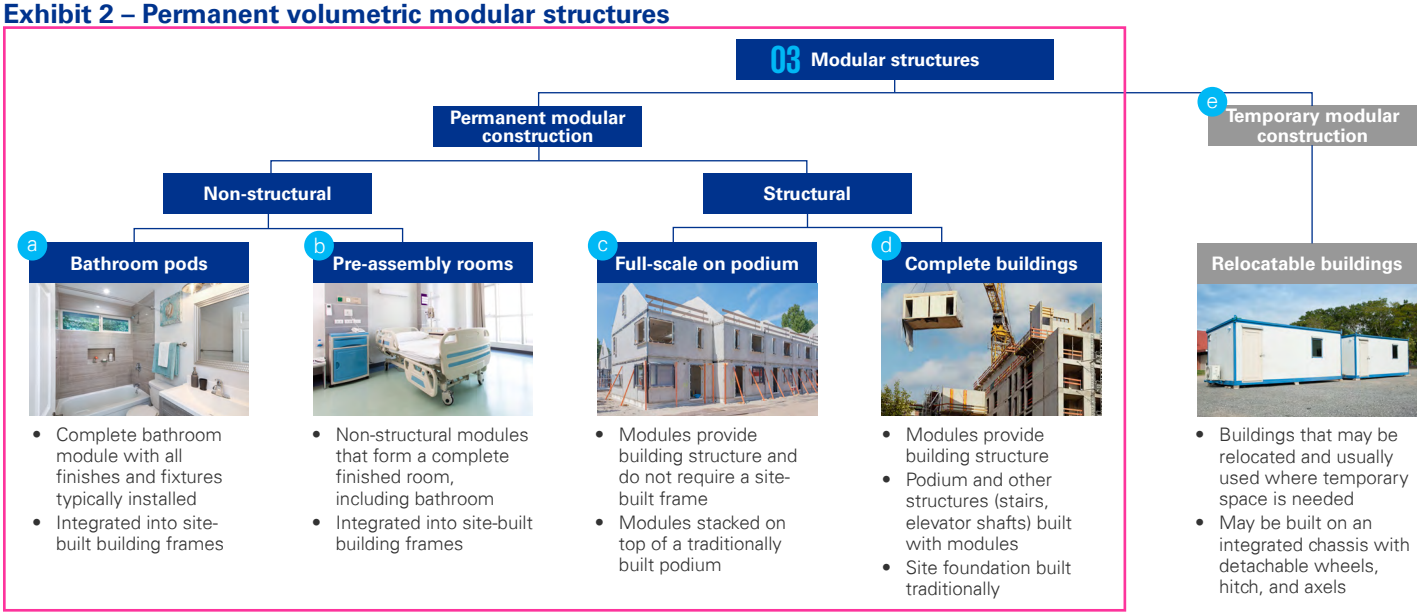
Components that are in volumetric shape and that form a completed part of a building (or a building in itself) and typically involve and exterior surfaces

Degree of prefabrication increases

On-site construction time and labor decreases

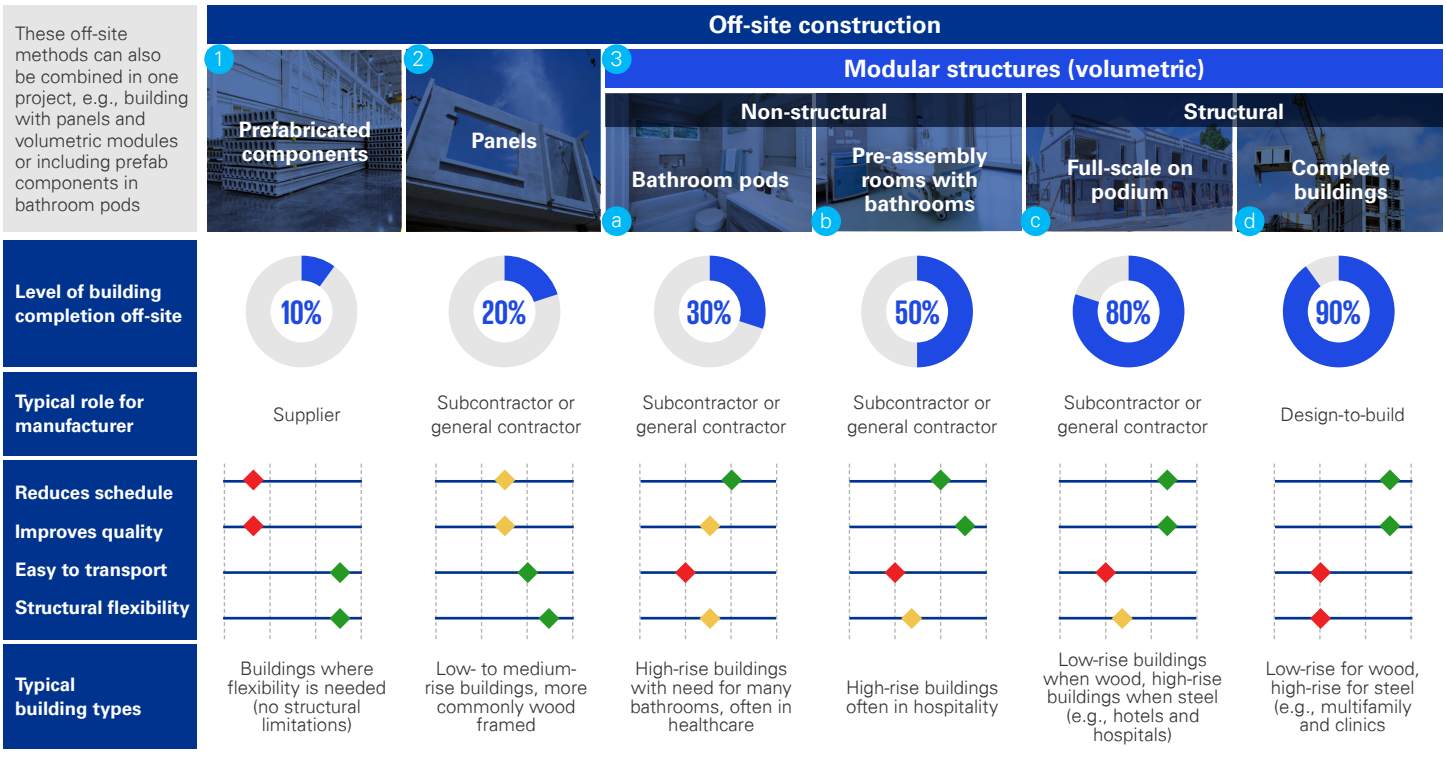
Permanent volumetric modular structures can be divided into two types—non-structural and structural (see Exhibit 2 on following page). The former type requires a building frame that is built on-site, and can include either entire rooms or specific pods (e.g., a bathroom). In the latter case, the modules themselves provide the structure and can either rest on a traditional site-built podium or directly on the foundation. Buildings may also incorporate a mix of technologies, e.g., begin with a concrete building frame around the lower floors but then rely on self-supporting modular structures for the higher floors.

Exhibit 2 – Permanent volumetric modular structures



There are pros and cons to each of the construction methodologies. For example, panels offer more structural flexibility and lower logistics costs, while volumetric modular structures can do more to streamline the construction schedule and improve quality control thanks to off-site completion. Some contractors are blending methods—for example, European contractors have led the way by combining panels with bathroom pods and other prefabricated components to minimize labor and reduce construction build time.

Exhibit 3 – Pros and cons for each construction methodology

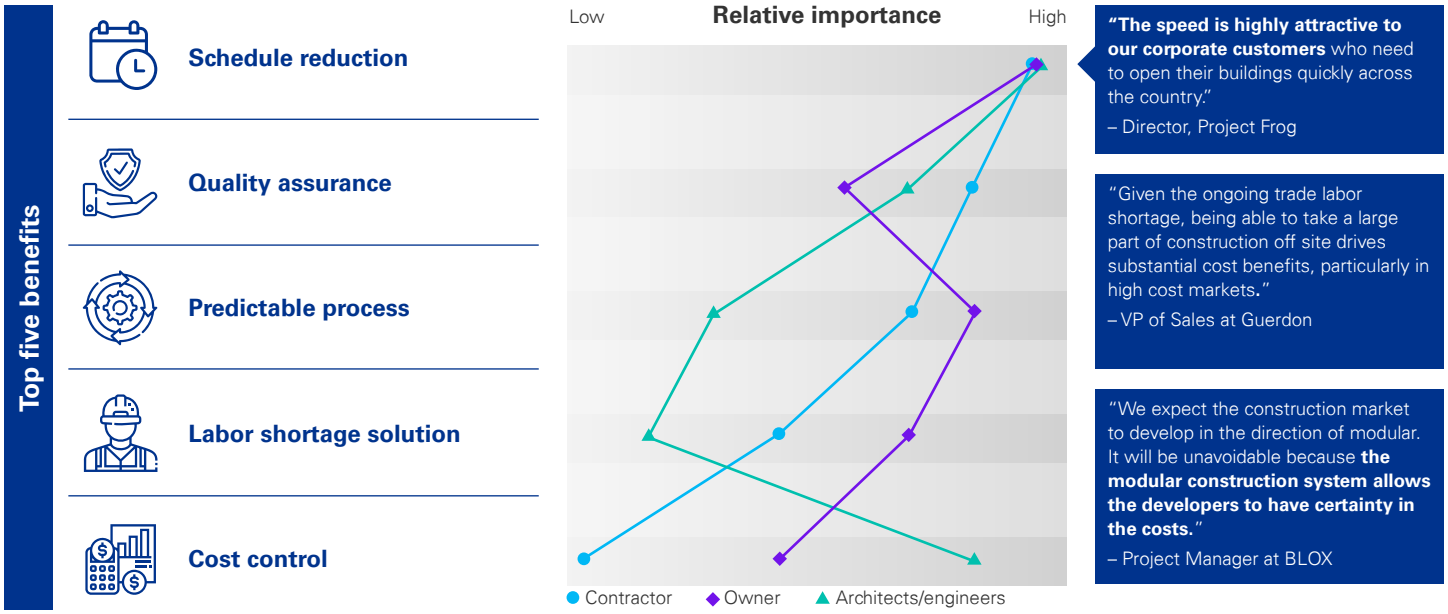


Source: KPMG project experience, subject matter professional interviews

Why the sector needs to pay attention

Many industry analysts believe modular will be a boon for the construction industry, saving time and cost, improving quality assurance and predictability, and reducing the need for labor.

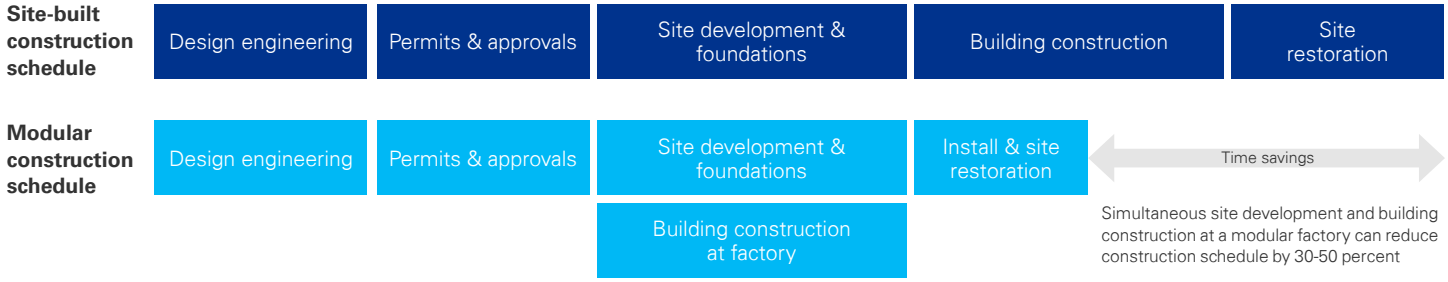
Exhibit 4 – Top five benefits of utilizing permanent modular construction



Note: The figure includes only the top five benefits mentioned in the survey—relative importance is based on the number of mentions. Each survey groups has equal weights (contractors, owners and architects/engineers). Sample size for the survey was 191 North American architects/engineers, contractors, and owners that have utilized permanent modular construction in one or more projects.

Many consulting firms and industry observers have estimated the time savings of modular construction schedules. According to the Modular Building Institute, building schedules can be compressed by approximately 30–50 percent due to simultaneous site development and construction.

Exhibit 5 – Time savings in modular versus traditional construction according to MBI analysis



Based on what we have seen at our clients, modular construction has led to time savings of up to 16 percent, and we anticipate additional time savings will be realized as maturity in this space grows. The impact of cost savings—harder to quantify over the past three years given pandemic-related cost inflation and shortages—is expected to be significant once the supply chain stabilizes and once those savings have been clearly realized in pre-pandemic projects.

However, the impact on the construction industry will be far more profound. By removing cost and shifting the complexity and risk of construction upstream (out of construction, into design), this technology has the potential to fundamentally reshape industry profit pools.

In the table below, we outline the expected impact on stand-alone construction players as modular construction takes hold, and the actions each player can take.

Two themes clearly emerge:

There are "first mover" advantages for players who develop the capabilities and expertise in this nascent technology and who can address customer concerns around construction quality through their experience—enabling them to gain share.

There are "integrator" advantages for players who combine design, manufacture, and build capabilities for consistency of design and quality of execution. This could be achieved through partnerships or M&A, enabling them to reduce cost and risks to retain a higher share of profits.

Architect/design firm and structural engineers

Non-modular construction

Traditional profit drivers

- Hours spent on design
- Billable rework hours due to change orders

Modular construction

Changes to profit drivers

Negative

- More overhead/sunk costs to understand modular tech before designing (may not be charged through)
- More detailed designs due to automated manufacturing requirements
- More liability risk on up-front design accuracy
- Less rework due to fewer change orders
- Fewer total hours billed for design of "high repeatability" builds

Positive

- More predictable design time for repeated builds

Potential mitigation actions

- Develop specialized modular teams to build and retain expertise (and do not let design control shift to the trades)
- Form alliances with trades and modular suppliers to create stable database of design elements
- Update pricing models to:
  - Recover modular-related overhead and learning curve costs
  - Move from per hour to fixed fee or per-design fee
  - Differentiate pricing between repeatable ("kit of parts") versus customized design elements
  - Include non-design services, such as plan approval (per local regulations and requirements)

General contractors (GC) and construction managers (CM)

Non-modular construction

Traditional profit drivers

- In time and materials (T&M) contracts
  - Hours spent on project management
  - Oversight of fieldwork
  - Markup on subcontractor and supplier costs
- In fixed-fee (FF) contracts
  - Profit driven by from ability to control costs and timetable
- \+ Performance incentives based on cost, timing, and quality

Modular construction

Changes to profit drivers

- **Negative**
  - Smaller percentage of the project value overseen by GC (as owners contract directly with modular suppliers)
- **Negative for T&M, positive for FF and incentives**
  - Fewer hours spent on project management (including a mix shift away from construction site and with more up-front management, which requires higher skill levels)
  - Less rework due to change orders
- **Positive**
  - Fewer quality issues due to construction in a factory/controlled environment

Potential mitigation actions

- Partner with modular manufacturers to develop a joint approach to modular (and to avoid being demoted to site administrators)
- Transition all contracts to fixed fee to collect cost and time-savings efficiencies
  - Requires a "lean construction" approach that may be a mindset shift for some players—with an opportunity to obtain extra margins from leadership ESG benefits (waste, emissions, etc.) of modular construction

Trades

Non-modular construction

Traditional profit drivers

- In FF contracts
  - Profit driven by from ability to control costs and timetable
- In T&M contracts (mostly limited to high-complexity projects)
  - Profit driven by hours worked

Modular construction

Changes to profit drivers

- **Negative**
  - Additional costs from creating "shop drawings" based on architect and engineer (A/E) inputs that provide insufficient details
  - Scope of on-site work decreases, effort limited to connecting the assembly and performing final inspections
  - Off-site work (i.e., at modular factory) can offset some hours, but will be at lower pricing (assemblers do not require same permits/certifications as tradespeople in most states), and for total fewer hours (higher productivity in factory environment, cross-training of staff), and may present other potential other challenges (e.g., union reaction)

Potential mitigation actions

- Develop modular capability for both manufacture and on-site install of panels, bathroom pods, mechanical electrical plumbing units (MEPs), etc.
- Contract directly by the owner (cutting out the GC) in partnership with other trades
  - Revise people strategy, as modular-led ESG and in-factory "benefits" can attract and retain talent in face of shortages

Building materials manufacturers and distributors (Note: not modular manufacturers)

Non-modular construction

Traditional profit drivers

- Quantity of material purchased
- Applicable fees/surcharges for delivery, minimum order quantity (MOQ), etc.

Modular construction

Changes to profit drivers

− Negative

- Less material required on a job means lower waste (more efficient planning, better reuse of small pieces and scraps)
- Lower surcharges from higher volumes ordered (due to continuous manufacturing) and delivery efficiencies (due to single site delivery)

+ Positive for manufacturers, negative for distributors

- Direct sales to modular manufacturers (versus through distributors)
- Substitution of materials due to modular construction needs (e.g., concrete frame replaced by wood or steel), impact varies by category

Potential mitigation actions

- Develop modular capability for both manufacture and on-site install of panels, bathroom pods, MEPs (mechanical electrical plumbing units), etc.
- Contract directly by the owner (cutting out the GC) in partnership with other trades
  - Revise people strategy, as modular-led ESG and in-factory benefits can attract and retain talent in face of shortages

Services and equipment renters

Non-modular construction

Traditional profit drivers

- Days rented to the site, including during delays

Modular construction

Changes to profit drivers

− Negative

- Fewer rental days due to shorter construction time
- Less equipment due to fewer laborers on site and fewer jobs to be performed

Potential mitigation actions

- Modify inventory to increase equipment that would be used in modular (e.g., cranes) and minimize equipment that may become obsolete

Building owners and developers would therefore seem to be the top beneficiaries, as the reduction of complexity also reduces the overall cost of construction. However, changes to contract structures move risk upstream on to the building owner or developer. As early pioneers of modular technology discovered, this may increase the variance in outcomes of any single construction project. For this reason, having a large, repeatable portfolio (as opposed to a single building) will be critical to distribute risk and gain benefits of learning on subsequent buildings.

That being said, the benefits of modular construction are manifold for building owners and developers; we expect they will find it difficult to return to traditional construction methods once they gain more experience and confidence in the technology and understand the use cases in which it can be highly effective.

Developers

Typical profit drivers

- Land appreciation

Benefits of modular

- Reduced construction costs and timelines, with more predictability (once model has scaled)
- Shorter time to sale, reducing exposure to real estate price and/or economic volatility
- Marketable ESG benefits—across building construction and operations

Risks of adopting modular

- Potential delays to obtain occupancy certifications, if local governments/ inspectors are unfamiliar with modular technology
- Balancing customer centricity (customization) with the factory-led standardization—with potential to develop a product-based approach that is tailored to segment (e.g., hospital rooms)

Building owners

Typical profit drivers

- Efficiently running their primary business, which may not be real estate related

Benefits of rise of modular

- More predictable construction costs
- Faster time to productive building
- Less on-site construction and associated risks
- Means to achieve ESG objectives (both on building construction and operations) and simplified tracking and reporting due to repeatable model and known building components

Risks of adopting modular

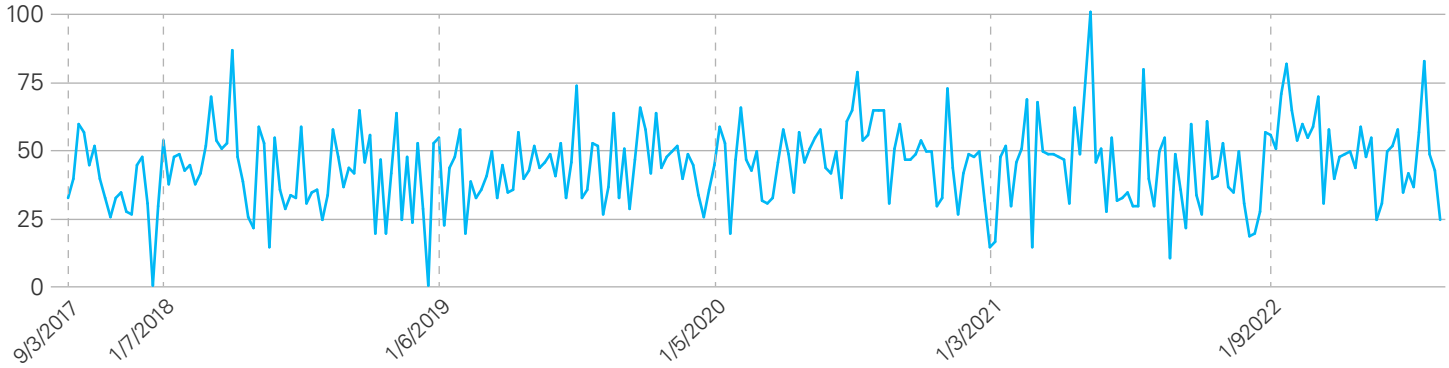
- If project contains multiple contracts, owner may be left with interface risk for any challenges between the modular components (as opposed to the GC historically being the single contract-holder and assuming that risk)
- Potential delays to obtain occupancy certifications, if local governments are unfamiliar with modular technology
- Front-loading of the costs that is unfamiliar to financing companies, which may impact access to financing and terms (partially offset by shorter overall financing period)

Are we there yet?

For many years now, modular has been touted as either the upcoming revolution, an evolution, or as the end of the construction industry, but somehow none of those predictions has ever materialized. Skeptics might well point out that prefabricated construction has been around for decades—from off-site floor assemblies to relocatable buildings—without much of a discernible uptick in use.

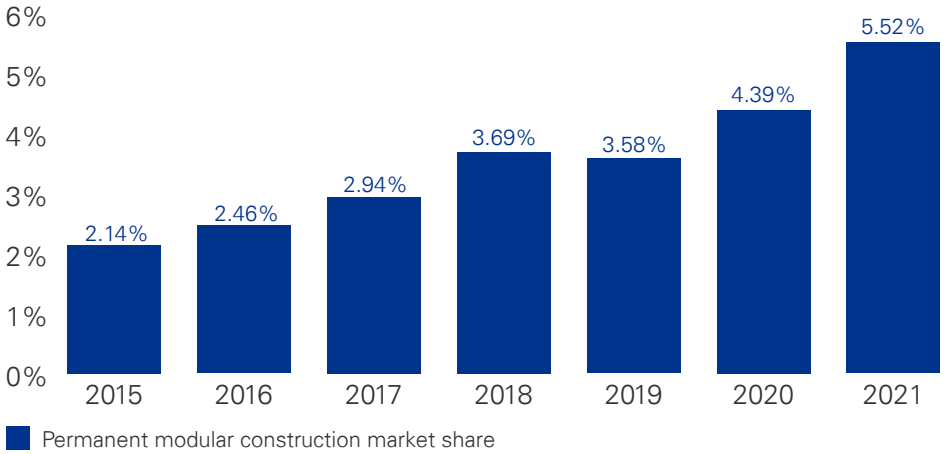
In fact, Google searches for "modular construction" and related terms are remarkably constant over the past five years:

Exhibit 6 – Interest over time



Modular construction, though increasing, is still estimated to make up approximately 5 percent of total construction market share, per Modular Building Institute's Permanent Modular Construction 2022 report:

Exhibit 7 – Permanent modular construction market share percentage

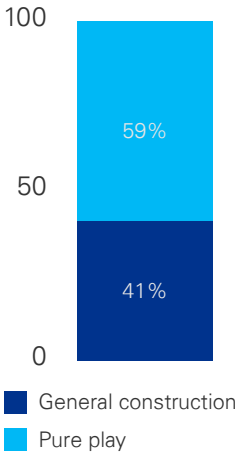


Source: Modular Building Institute, Construct Connect

So what is different now? In our work and discussions with clients, we have noticed exciting changes at all steps of the value chain, suggesting we may be approaching some market "tipping points."

Design and build: There is supply of modular components in the construction value chain

Exhibit 8 – Companies that offer modular construction services in the U.S.



In partnership with Grata,[1] a private company intelligence engine, we "crawled" the internet to find which companies were offering modular construction services in the U.S. The search returned 446 companies, of which 59 percent were modular pure plays, but 41 percent are companies that span traditional and modular construction methodologies. (Note: This includes all types of modular, not only permanent volumetric.)

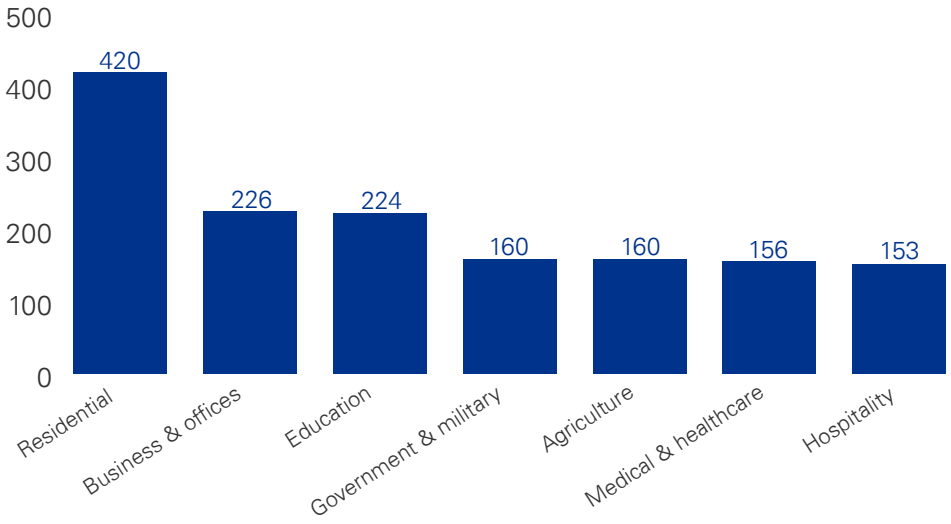
The overwhelming majority (89 percent, or 399 companies) of the companies offering modular construction services are still "bootstrapped," but we are starting to see modular offered by more established firms—this includes 16 by public companies, nine by private subsidiaries of larger businesses, and 21 by PE and investor-backed entities.

While most players offer modular for residential, we see much greater participation in other sectors including offices, medical, and hospitality.

Residential has long been the testing ground for modular technologies, but we believe the true opportunities will lie in commercial and industrial applications (see next section: Broad adoption…in specific niches).

In summary, we see a broader set of companies expanding their modular-related offerings into more verticals as a sign of increased demand and investment in the market.

Exhibit 9 – Opportunities for modular technologies in residential and other sectors



[1] Source: Grata is a private company intelligence engine that streamlines the process of finding information on private companies, making it easier and faster to gain visibility into the entire market, and to get relevant insights and intelligence into target companies. We would like to thank Grata for their partnership in this research study.

GCs: External pressures driving adoption

The growing importance of environmental, social, and governance (ESG) initiatives encourages builders to reduce waste, limit local pollution, and enable greater transparency for the general environmental footprint of construction materials.

Buildings alone represent approximately 40 percent of global energy-related carbon emissions. Several countries have begun efforts to report on embodied carbon emissions.[2]

Sweden requires the calculation of embodied carbon emissions for new building permits, and France not only mandates analysis of emissions but will also set embodied carbon limits that will tighten over the upcoming decade. Some anticipate that there will be required ESG reporting across the European Union (EU) within the next five years.

> Modular is a **more sustainable** way to build than traditional on-site construction."
>
> —Project Manager, Pivotek

> If I'm doing traditional project X and same project modular, I achieve sustainability two ways, **material waste is significantly reduced**, that's a piece of it, less carbon, etc. The other piece is **during operations, things are built to reduce heating and AC costs."**
>
> —Director, Full Stack Modular

> The main benefits of modular include **increased sustainability, safety, and time-efficiency."**
>
> —Sales Manager, Guerdon

> Permanent modular construction is a better solution than traditional construction since it **reduces waste, is a more sustainable way of building, and the buildings are more energy friendly."**
>
> —Product Manager, Modular Genius

Typically, GCs are on the hook to report and manage against the ESG requirements. In the U.S., regulatory changes—both enacted and upcoming—are likely to increase GCs' requirements in this area. For example, the Environmental Protection Agency (EPA) has received funding under the 2021 Infrastructure Investment and Jobs Act (IIJA) to fund a new program on Solid Waste Infrastructure for Recycling (SWIFR). This program focuses on all post-consumer waste, two thirds of which is generated by Construction & Demolition (C&D) activities, accounting for more than 600 million tons annually.[3]

One example of this is being proposed in New York State, which would ban C&D debris processing facilities in certain areas to protect drinking water quality—thereby increasing the complexity, and cost, of traditional construction site management. Another example is President Biden's executive order in December 2021 for the U.S. government to achieve net-zero emissions. This includes the launch of a Buy Clean initiative for low-carbon materials, which will force movement towards strategies such as modular to reduce embodied carbon.

It is well established that modular technologies support ESG objectives, including reducing energy consumption and CO_2 emissions by approximately 40 percent, in addition to generating up to 80 percent less material waste.[4]

In addition, the factory production setting simplifies reporting and compliance management compared to a more variable job site environment. Calculations to establish emissions and build up overall ESG reporting can be completed once and replicated for modular components.

Some GCs have previously (e.g., Katerra) or are (e.g., DPR) leaning into the trend, but our experience suggests that this section of the value chain is less open to change than some others.

[2] Source: Embodied carbon refers to the greenhouse gas emissions associated with the extraction, manufacturing, transportation, construction, and end-of-life phases of buildings.

[3] Source: "Sustainable Management of Construction and Demolition Materials," EPA, July 9, 2022

[4] Source: Dr. Mohamed Al-Hussein, PhD, PEng, "North Ridge CO_2 Analysis Report – Executive Summary and Conclusions, Comparison between Modular and On-Site Construction," Sturgeon Foundation, September 2009

Trades: There is interest in modular

The trades play a critical role in the success of any construction technology. In the case of modular, the trades will be essential to guarantee successful on-site installs (e.g., proper electrical and water connections).

In Dodge Data & Analytics' research (2020 Prefabricated and Modular Market Report), architects/engineers, GCs/CMs and trades surveyed all expected to be doing more projects with modular technology than they had done in the past.

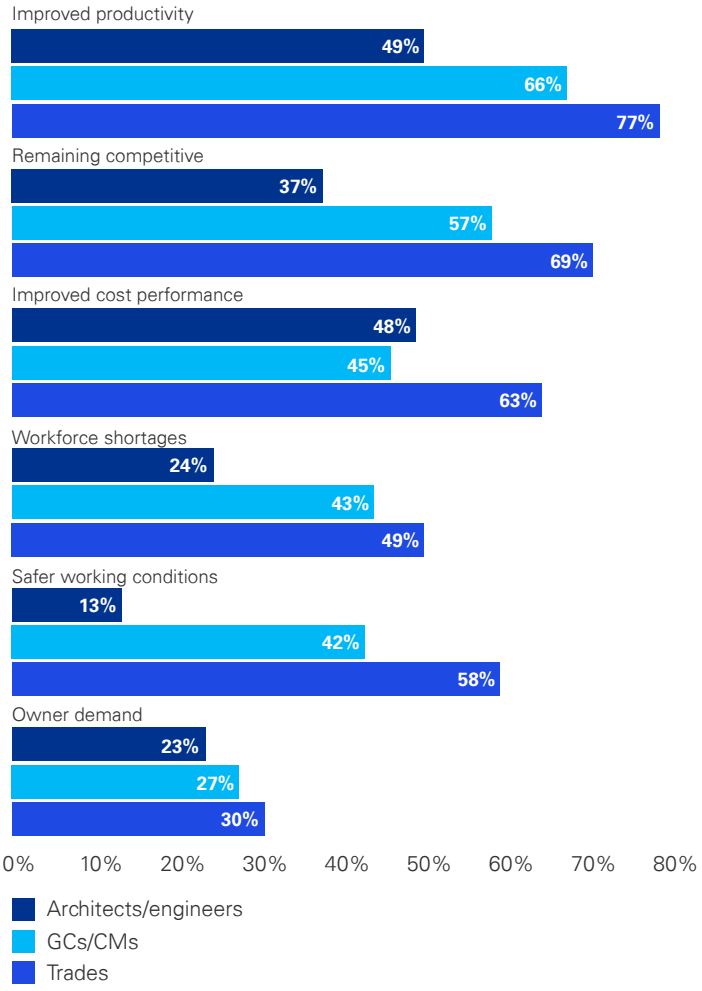
Traditionally, conventional knowledge in the industry described modular as being "imposed" on the project by activist building owners seeking time and cost reductions. Our Capital Projects team, which assists clients with construction (portfolio, program, and project) real estate and operations strategy, highlights that 26 percent of new projects in the past year featured a modular component. This is the result of certain building owners having fully embraced modular technologies—they are now actively writing these into their project specs, and are pushing the ask onto GCs and therefore trades.

However, the Dodge report highlights that the key drivers for increased trade adoption over the past few years have been pressure to increase productivity (77 percent of respondents cited as a top factor influencing use of prefabrication), followed by improvements to cost performance (69 percent), and the need to remain competitive (63 percent). Less than a third of respondents cited owner demand as a top factor.

These results make sense given the long-standing labor shortages (and cost increases) plaguing all aspects of the construction industry. It is worth noting that unions may delay adoption of modular technology in certain geographies. In our opinion, an internally motivated pivot to modular construction technologies is much more likely to be successful than an external one; another favorable tailwind for modular.

Exhibit 10 – Top factors influencing the use of prefabrication in the last three years

(Percentages citing high or very high level of influence)



Source: Dodge Data & Analytics, 2020

All of these factors seem to be removing obstacles that have slowed the ascent of modular across the value chain.

Broad adoption in specific niches

Despite widespread reports of adoption of modular and prefabricated technologies, we believe that modular is unlikely to make major inroads across all areas of construction. Certain characteristics make a project more or less conducive to modular construction. These include:

01 **Site location:** Modular is best suited for areas where:

- Labor is scarce
- Labor costs are high
- Labor productivity is limited (for example, due to extreme temperatures or precipitation)
- Site space and storage are limited (making it harder to move materials in or out)

This applies to cramped, expensive, and unionized cities in the Northeast—but also to San Francisco and other densely populated parts of California.

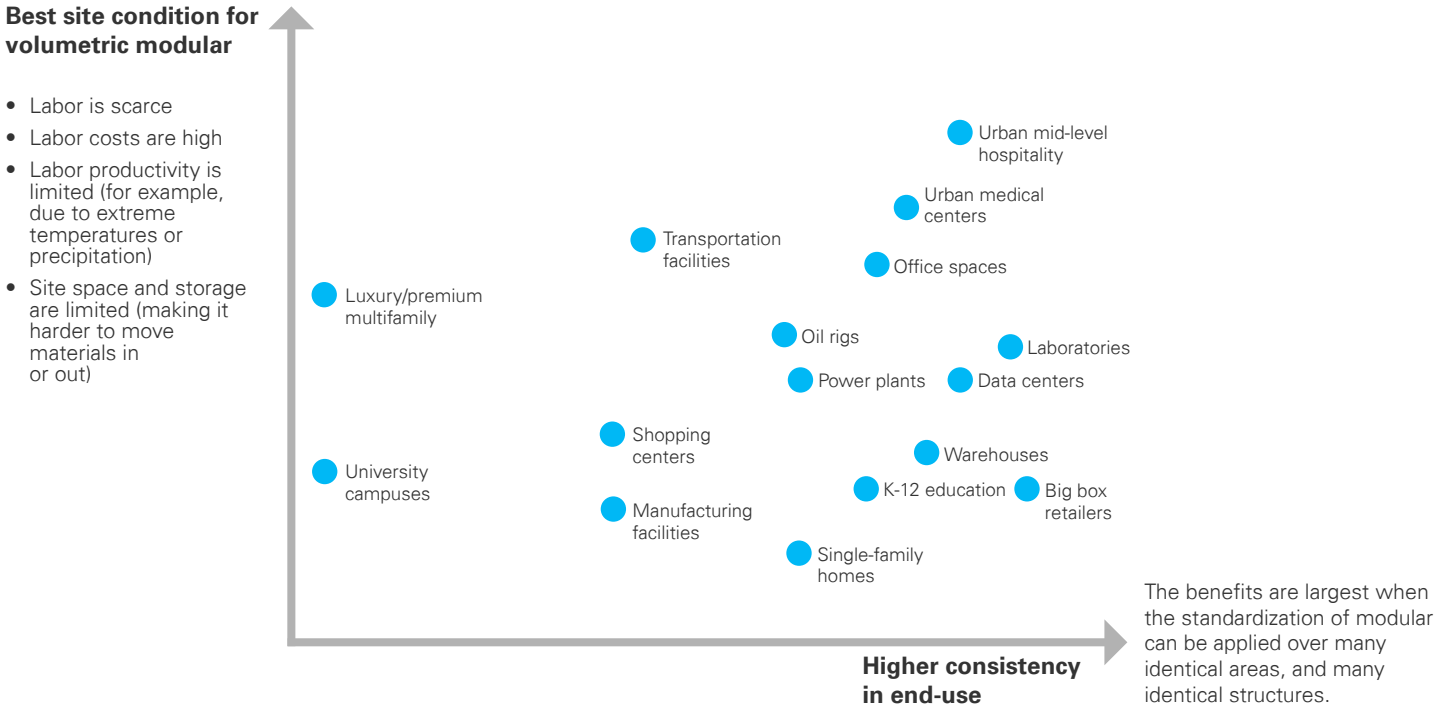
02 **Repeatability:** The benefits are largest when the standardization of modular can be applied over many identical rooms and many identical structures. This makes modular construction a great candidate for:

- Mid-and low-range hospitality
- Commercial
- Medical
- Multifamily developments
- Data centers
- Other highly standardized manufacturing and industrial applications

This is also why some modular players have chosen to test their product on single-family home construction, giving developers the ability to evaluate and refine the plans on a few units before broader rollout.

Lack of repeatability makes high-end finished spaces, highly customized homes, or inconsistently shaped plots better candidates for different modularization technologies, such as panels or subassemblies.

Exhibit 11 – Niches best suited for modular



Conclusion

The adoption of modular construction technologies is increasing, and interest in modularity is growing across the value chain—from architect/designers and GC/CMs to trades and building owners. While we may never see cities and towns dominated by the sci-fi "building in a box" models that have been dreamed of, modular seems well placed to succeed in a number of situations, from challenging locations to high-repeatability building types. In those environments, we expect modular will gain a strong foothold, but the benefits of time and cost savings will be accompanied by a reduction in profit pools for players along most of the value chain. Building owners and developers will have the most to gain financially, but will be exposed to new and unusual contracting risks.

The exact impact will vary based on individual businesses' exposures to risk areas—geographic and end-market concentration and specialization, for example, but most players need to take note now. Business leaders need to be aware of the potential financial impact and plan mitigation strategies. For those most exposed, there may be only a narrow window of time to transform their business model to be modular-friendly. We expect the benefits of a first mover advantage (through acquired knowledge, relationships, and successfully delivered structures and real-world examples) to be significant in this notoriously risk-averse industry.

In our next papers in this series, we will provide more details on the opportunities facing multiple value chain participants.

How KPMG can help

Our specialized teams can help you harness the benefits of modular. Whether you are a building owner considering taking advantage of the cost and timing benefit, a building materials manufacturer looking for opportunities to diversify into assemblies, or a construction engineer looking to redefine your business processes, KPMG's specialist teams can support you on this journey.

Our Strategy teams provide guidance to companies looking for changes to their business models, whether by building modular capabilities in house, or by buying or collaborating with experienced players in the modular space. We work closely with management to design and implement strategies that win in today's competitive markets.

Our Capital Projects teams consists of licensed engineers and construction professionals who draw on their extensive national and global experience to assist clients with construction (portfolio, program, and project) advisory. We help clients identify and mitigate project risks throughout the life cycle, including nascent considerations and opportunities around ESG factors.

Together with our other Deal Advisory colleagues, we work closely with management to design and implement strategies that win in today's competitive markets.

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Managing Director, Advisory

Serena helps clients design and execute winning growth strategies to get and stay ahead of technological disruptions, such as modular construction methodologies. She works with clients across the construction value chain, with a focus on building materials manufacturers. As the U.S. lead for Deal Advisory and Strategy in Construction, she supports clients with both organic and inorganic paths to growth.

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Ramahi leads the Active Portfolio Management functional area for KPMG Strategy. He works with clients across verticals develop business model and value chain strategies to take advantage of disruptive trends and maximize valuations, with a focus on the engineering & construction players and multi-segment industrial companies.

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Colin has spent his career helping owners and contractors navigate their largest and most complex programs and projects. He's passionate about collaborating across industry participants to improve project performance. His experience spans process design and improvement, risk management, data analytics, and project management technologies. Prior to KPMG, Colin worked on construction sites as a general laborer and project engineer.

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Jeffrey has over 7 years of experience in the engineering and construction industry, advising clients across various industries with their capital projects and programs. He has helped clients improve their program management, project oversight and monitoring, process design, risk and controls, data analytics, and technology assessment and implementation.

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Sarah is passionate about helping construction sector players build winning strategies as they move toward industrialized, data-driven, and sustainable approaches. Sarah works extensively with companies throughout the real estate, construction, and infrastructure value chain, including contractors, property developers, modular manufacturers, building products suppliers, building technology system manufacturers, installation companies, facilities managers, and real estate operators. As the Deal Strategy leader for KPMG in Finland, she also supports private equity investors throughout the deal process, especially on construction and technology sector deals.

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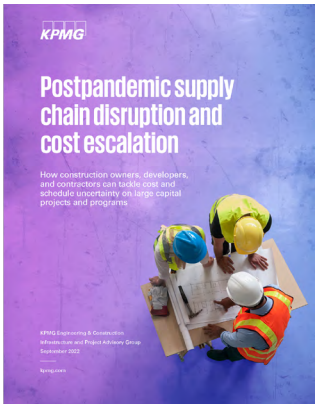
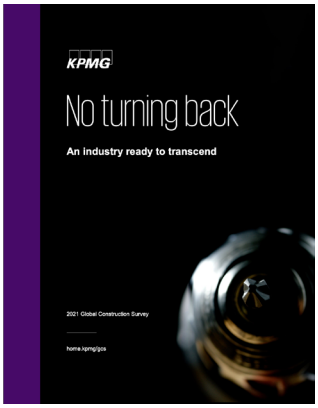


Postpandemic supply chain disruption and cost escalation in Construction



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