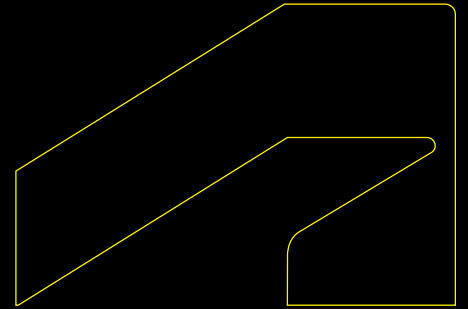


# Industrialized Construction

The blueprint to disrupt and transform  
the construction industry



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#### INSIGHT 1

**Construction productivity has declined by 15.7 percent since 1995, underscoring the industry's inability to address challenges with its current setup.**

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#### INSIGHT 2

**Industrialized Construction builds on the capabilities of productization, DfMA, and prefabrication for measurable benefits.**

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#### INSIGHT 3

**Industrialized Construction requires mastering six elements and shifting the value chain to the left.**

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**This white paper on Industrialized Construction was co-created by Autodesk and Porsche Consulting, combining their specialized expertise on the subject.**

Porsche Consulting GmbH is a leading German management consultancy and employs 950 people worldwide. The company, leading in putting strategies into practice, is a subsidiary of the sports car manufacturer Porsche AG. In addition to its headquarters in Stuttgart, the consultancy has offices in Hamburg, Munich, Berlin, Frankfurt am Main, Milan, Paris, São Paulo, Shanghai, Beijing, Atlanta, and Palo Alto. The experts in the areas of strategy and organization, brand and sales, development and technology, as well as operations, advise clients globally in the automotive, consumer goods, aerospace, industrial goods, life sciences, energy, construction, and transportation sectors. Following the principle of “Strategic vision. Smart implementation,” the management consultancy has a clear mission: generating competitive advantage based on measurable results – always with a focus on people.

# Introduction to the AEC industry and Industrialized Construction

The architecture, engineering, and construction (AEC) industry is a cornerstone of the global economy, shaping the built environment while grappling with profound challenges. It is valued at \$15 trillion and employs over 25 million people worldwide, with the EU alone contributing \$1.1 trillion annually – 9.6 percent of its GDP<sup>1</sup>. Despite its size and significance, the industry faces mounting societal, environmental, and operational pressures, especially as global urbanization surges and housing shortages persist.

By 2050, the global population is expected to reach 9.7 billion, with 68 percent of people living in cities. This rapid urbanization drives an urgent demand for affordable housing.<sup>2,3</sup> By 2030, the world will need to construct 96,000 new homes daily, equivalent to building a city the size of New York every month.<sup>4,5</sup> Yet regional disparities highlight the scale of the crisis: in 2023, Germany needed 400,000 new homes<sup>6</sup> but managed only 250,000, while England faces a backlog of 2.5 million homes.<sup>7</sup> Emerging economies fare worse; India has a housing deficit of up to 50 million homes,<sup>8</sup> and Africa must build 70 percent of its future infrastructure by 2040.<sup>9</sup>

This growth in demand also underscores the environmental burden of the AEC industry. Responsible for 37 percent of global carbon emissions and 55 percent of electricity use, the sector generates 100 billion tons of construction waste annually, 35 percent of which ends up in landfills. Building emissions alone constitute 28 percent of the global total. With one-third of today's building stock nearing the end of its lifespan by 2040, massive retrofitting efforts are essential to meet net zero goals. Yet, less than 1 percent of building stock is retrofitted annually, far below the required 2 percent.<sup>10</sup>

The industry's challenges extend beyond environmental concerns. Internally, low productivity – which has declined by 15.7 percent since 1995 – hampers growth, as fragmented value chains prioritize individual profits over project success while at the same time the complexity of buildings rises.<sup>11</sup> Externally, labor shortages compound the issue. In advanced economies, tight labor markets and an aging workforce have left 82 percent of U.S. AEC firms citing hiring difficulties, while Europe lists construction labor and civil engineers among the top shortage-prone occupations.<sup>12</sup> These issues inflate labor costs and delay projects, further straining the sector.

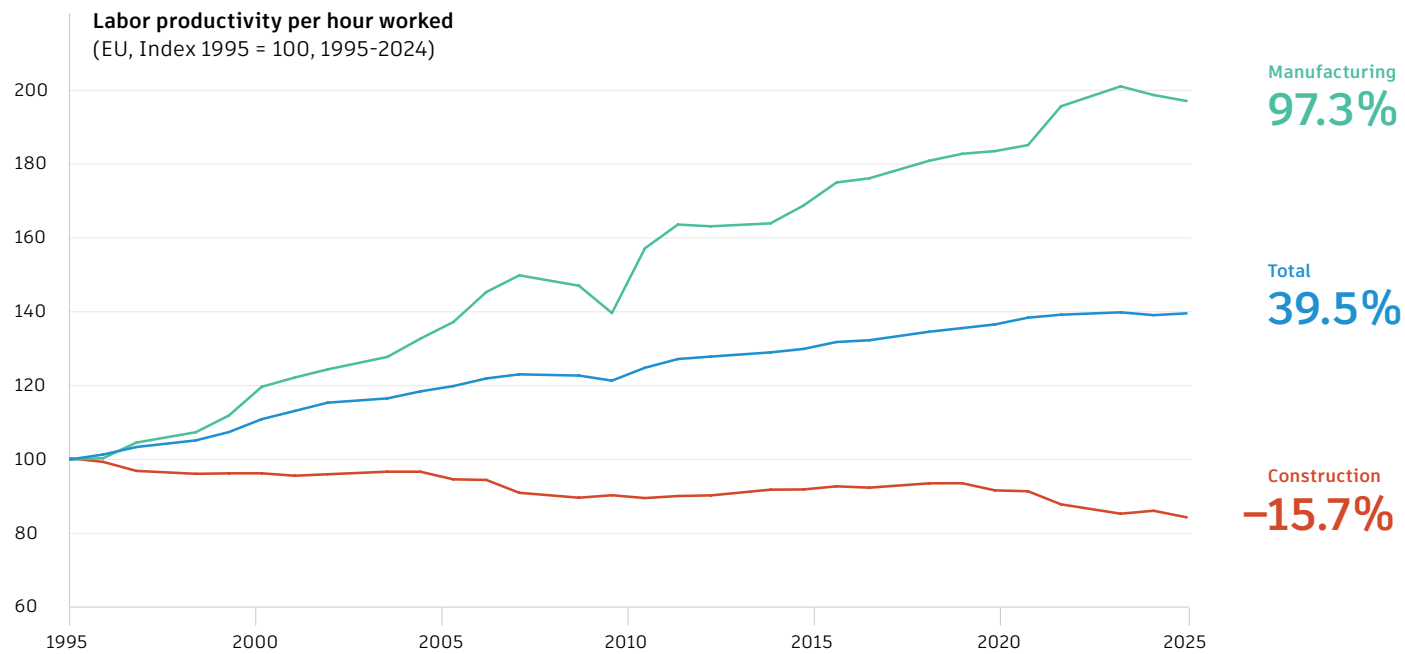


Fig. 1. Productivity in construction industry has declined by 15.7 percent since 1995.

Innovation, or the lack thereof, exacerbates these challenges. Digitalization and transformative solutions remain underutilized, while risk-shifting practices and regulatory pressures deter collaboration and efficiency. Without a shift towards disruptive technologies and integrated value chains, the AEC sector risks falling short of its decarbonization targets and failing to meet escalating housing and infrastructure needs.

Despite these hurdles, the demand for skilled AEC professionals is expected to grow by over one million in the next five years. With strategic investments in sustainable practices, advanced technologies, and workforce development, the AEC industry can turn its challenges into opportunities, ensuring it remains a vital force in shaping a sustainable and inclusive future. One of those opportunities is the adoption of Industrialized Construction (IC).

### **Industrialized Construction is defined by the combination of three capabilities**

The definition of Industrialized Construction and all the processes and methods within has, historically, been challenging. There are numerous regional differences in terminology and locally adopted definition frameworks. For example, the term modular can be used to describe the modular volumetric delivery method as well as to describe an approach to repeatable (modular) design.

Rather than attempting to detail a full nomenclature for all terminology used in this space, the approach taken here is to simplify Industrialized Construction as the combination of three pillars: productization, design for manufacture and assembly (DfMA), and prefabrication.



## Productization

is defined as the application of standardized, repeatable, and configurable products, assemblies, and systems to the design and construction of a project. Typically, the fabrication or manufacturing supply chain will define, constrain, catalogue, and group products that can be combined into kits-of-parts, ready for discovery and inclusion at an earlier stage of the design process. By applying productization, decision-making can shift from a lagging decision by the general contractor and supply chain to a leading decision by the owner and designer while allowing for flexibility of design and ensuring a high focus on the customer's desires and requirements.

## Design for manufacture and assembly (DfMA)

is defined as the rules-based process that incorporates productized prefabricated elements into a building design ensuring that the design allows for efficient manufacturing, logistics as well as assembly and construction. The process facilitates early decision-making to apply prefabrication and productization. This approach enables data from the building design to ultimately flow freely into the fabrication process, reducing the need for rework and redesign often found with lagging decision prefabrication.

## Prefabrication

is defined as the methodology for fabrication or manufacture of products, assemblies, and systems in a location away from the final installation on the construction site. Typically, the project has been initially designed for traditional on-site installation and the decision to identify opportunities for prefabrication takes place during or towards the end of the design process. As such, this is often a lagging decision, implemented by the general contractor or their supply chain. Prefabrication benefits the project by the removal of effort from the construction site to a more controlled and predictable environment off-site with the associated improvements in productivity, safety, quality, and waste management as well as the potential for further automatization.

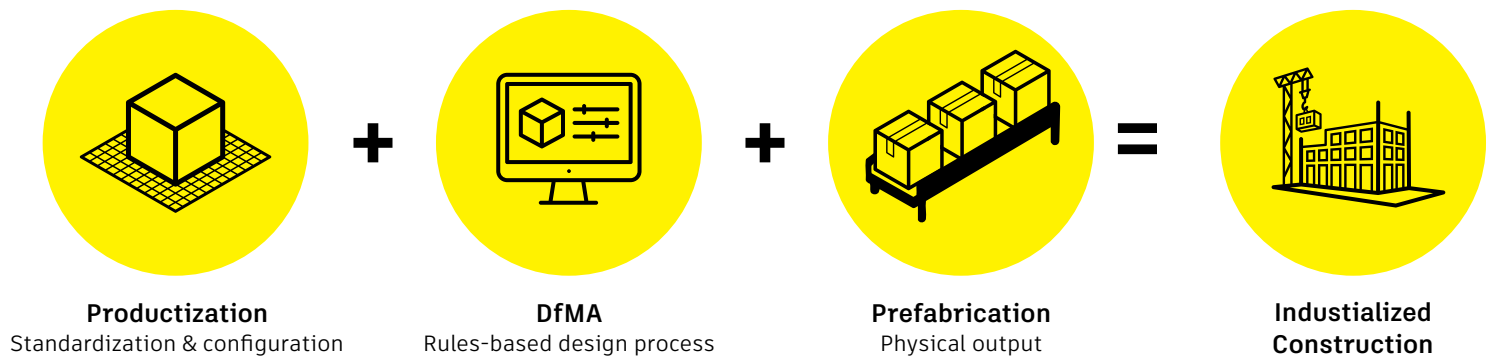


Fig. 2. Definition of Industrialized Construction.

Industrialized Construction emerges as a disruptive approach to address these challenges. Combining three pillars – productization, DfMA, and prefabrication – Industrialized Construction offers a systematic methodology to change the overall approach towards construction projects. Productization standardizes repeatable components tailored to specific needs while prefabrication centralizes manufacturing off-site. DfMA links and integrates design with manufacturing and assembly processes, enabling earlier

decision-making and fostering scalability. Together, these principles extend and restructure the traditional AEC value chain, prioritizing customer and product-oriented outcomes.

The success of Industrialized Construction relies on a structured approach that pre-defines customer requirements using scalable product structures and emphasizes high levels of off-site production. By aligning product design with both on-site and off-site delivery needs, and

implementing all components in a logical sequence with clear interfaces and dependencies, robust design and delivery processes are established. This systematic approach enables scalability and ensures efficient, high-quality outcomes.

By embracing IC, the AEC industry can revolutionize construction practices, closing the gap between housing supply and demand while delivering cost-effective, sustainable, and efficient solutions for a better-built world.

# Current IC landscape

Industrialized Construction is reshaping the building sector despite being a relatively new industry with limited market data. The prefabrication construction market, which forms one element of Industrialized Construction as seen in figure 2, serves as a baseline to understand the industry’s potential. In 2024 the global prefabrication addressable market was estimated at \$1,579 B. Cross-country analysis suggest that the addressable prefab construction market is largest in the USA (\$613 B), followed by China (\$366 B) and Japan (\$193 B).<sup>13</sup>

Among all countries considered for the study, Japan is the most developed country in terms of prefab construction, with an average market share of 41.2 percent followed by Singapore, the Netherlands, and Germany, ranging from 27.2 to 24.4 percent. The prefabrication industry is still in the nascent stage in the GCC region, with the lowest market share (3.7 percent) among the target countries. However, the GCC prefabrication construction market is expected to grow at a CAGR of more than 8 percent during 2024–2028,<sup>13</sup> significantly driven, among other things, by Saudi Vision 2030.

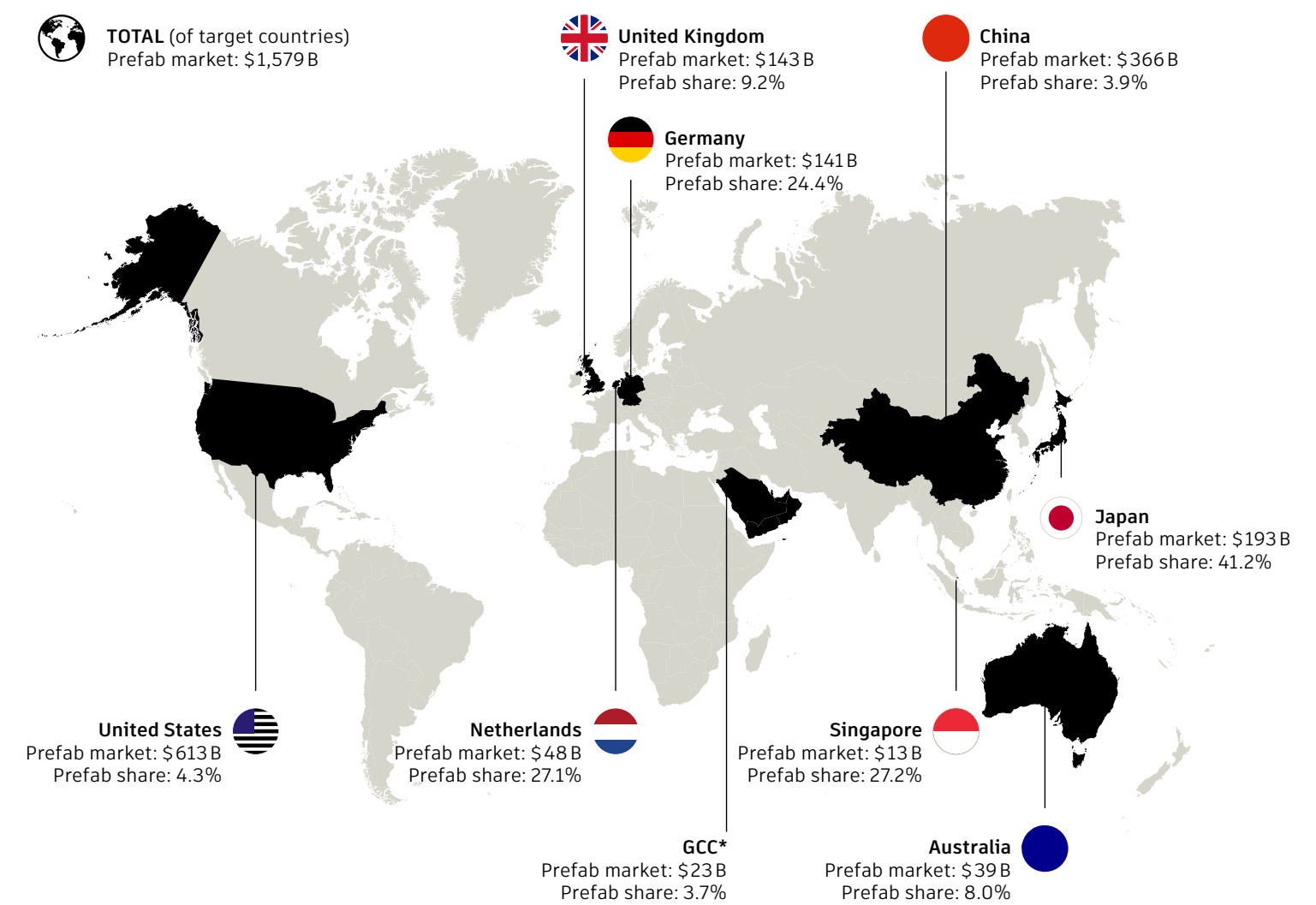


Fig. 3. Global prefab addressable market.<sup>13</sup>

\* GCC: UAE, KSA, Bahrain, Qatar, Oman, Kuwait

Regional trends reveal distinct adoption patterns for Industrialized Construction. Sweden leads with the highest penetration rate of productized construction solutions, where 45 percent of all new homes are prefabricated. For single-family homes, this figure climbs to nearly 80 percent. Japan, meanwhile, produces the largest number of prefabricated homes annually, with 150,000–180,000 units, representing 15–20 percent of its new housing market. Denmark also shows significant adoption, with 40 percent of residential buildings constructed using prefabrication methods.<sup>14</sup>

The global trend is mirrored in industry sentiment. By analyzing the annual reports of the 60 largest general contractors worldwide you can find that 82 percent show at least intent for adoption of Industrialized Construction by relating to key methods such as off-site construction, modular construction, prefabrication, and DfMA.<sup>15</sup>

As Industrialized Construction gains traction, its transformative potential is evident in addressing critical industry challenges, including labor shortages, cost efficiency, and sustainability goals.

Prefabrication offers a promising avenue to improve project delivery timelines, enhance quality, and reduce waste, marking a pivotal shift in the way the world builds.

Government initiatives are playing a crucial role in driving the adoption of modular construction worldwide. Just as the adoption of Building Information Modeling (BIM) accelerated when mandated by governments, one can expect similar results for Industrialized Construction.

**Australia** has committed up to \$2 million to develop a collaborative lab aimed at helping manufacturers design innovative prefabricated buildings.<sup>16</sup>

**Singapore** is reducing employer taxes for off-site construction workers to incentivize greater automation, with modular techniques already accounting for 20–33 percent of new homes.<sup>14,18</sup>

The **UK** has made modular methods a cornerstone of its housing strategy. Homes England has invested millions in Modern Methods of Construction (MMC) and launched an £800 million framework to support social landlords in adopting these techniques.<sup>21</sup>

**Ireland** has introduced a government-led road map to increase MMC adoption in public housing. Over 1,500 social homes are set to be constructed using modular methods between 2023 and 2024 as part of an accelerated delivery program.<sup>17</sup>

**Germany** has seen its housing industry association, “Gesamtverband deutscher Wohnungsunternehmen (GdW),” partner with the German Construction Industry Association to launch Framework Agreement 2.0. This initiative aims to raise modular construction’s market share to 10 percent among GdW member companies through the implementation of 25 innovative housing concepts.<sup>19,20</sup>

In **China**, the government promotes prefabricated buildings via policies like the 13th Five-Year Plan, aiming for a 15 percent prefabrication share in cities of over three million people and 20 percent in key urban areas. Financial incentives, including subsidies, tax breaks, and favorable loans, reduce up-front costs and drive adoption for sustainability.<sup>22</sup>

These initiatives demonstrate that governmental support, through incentives and strategic planning, is pivotal in scaling the adoption of Industrialized Construction. By creating favorable conditions for prefabrication and modular construction, governments worldwide are laying the foundation for more efficient, sustainable, and innovative building practices.

# Opportunities and benefits of IC

Industrialized Construction addresses many of the critical challenges in the AEC industry. By leveraging the three core pillars productization, DfMA and prefabrication, the IC-approach delivers significant benefits across direct project outcomes, broader project impacts, and wider societal contributions.\*

## 01

### Direct project impacts

- Cost
- Time
- Quality
- Labor requirements
- Health and safety

## 02

### Broader project impacts

- Environmental considerations
- Life-cycle considerations
- Local disruption

## 03

### Wider societal impacts

- Workforce quality of life
- Industry benefits
- Community benefits

Fig. 4. Areas of impact of Industrialized Construction.

### Direct project impacts

Industrialized Construction (IC) enhances efficiency, cost-effectiveness, and safety while ensuring high-quality project delivery. By leveraging prefabrication and automation, IC optimizes key factors such as cost, time, quality, labor, and health and safety.

Industrialized Construction significantly reduces construction, design, and tendering costs, while lowering risk, financing expenses, and design change costs. This leads to greater cost certainty and fewer budget overruns. Prefabrication also improves time efficiency by shortening total program duration, minimizing on-site time, and mitigating weather delays. Enhanced program and design certainty streamline project execution, increasing productivity.

Significant cost reductions compared to traditional on-site construction methods are achievable by improving six cost categories. Within the category of construction labor, including on- and off-site and logistics, the savings potential lies between 20–50 percent due to efficiency in automation with increased degree of prefabrication, increased on-site efficiency by applying DfMA principles, and reduction of rework. Within material, the potential lies between 5–15 percent due to standardization of materials and bundled procurement options. Within planning and design, it is possible to reduce costs by 10–20 percent due to application of kit-of-parts and the configure-to order approach combined with automated designs. The cost category of financing can be reduced by 10–20 percent thanks to lower financing costs due to faster project completion (between 35–50 percent faster completion possible). Project management costs can be reduced by 10–25 percent due to automation and digitalization during planning and production as well as faster project completion. Other costs such as permits, site operations, services, or inspections can be reduced by 2–5 percent due to digitalization, waste reduction by efficient material handling.

### Broader project impacts

IC significantly improves environmental sustainability by reducing waste generation, embodied carbon, and water and energy usage in construction. Controlled factory environments minimize water pollution and ensure more efficient resource consumption.

Life-cycle considerations also benefit from IC, as it enhances building durability and longevity, improves future adaptability, and promotes recyclability and reuse potential of materials, contributing to circular economy principles.

Additionally, IC reduces local disruption by lowering noise pollution, vehicle movements, and air quality impacts around construction sites, creating a more livable urban environment.

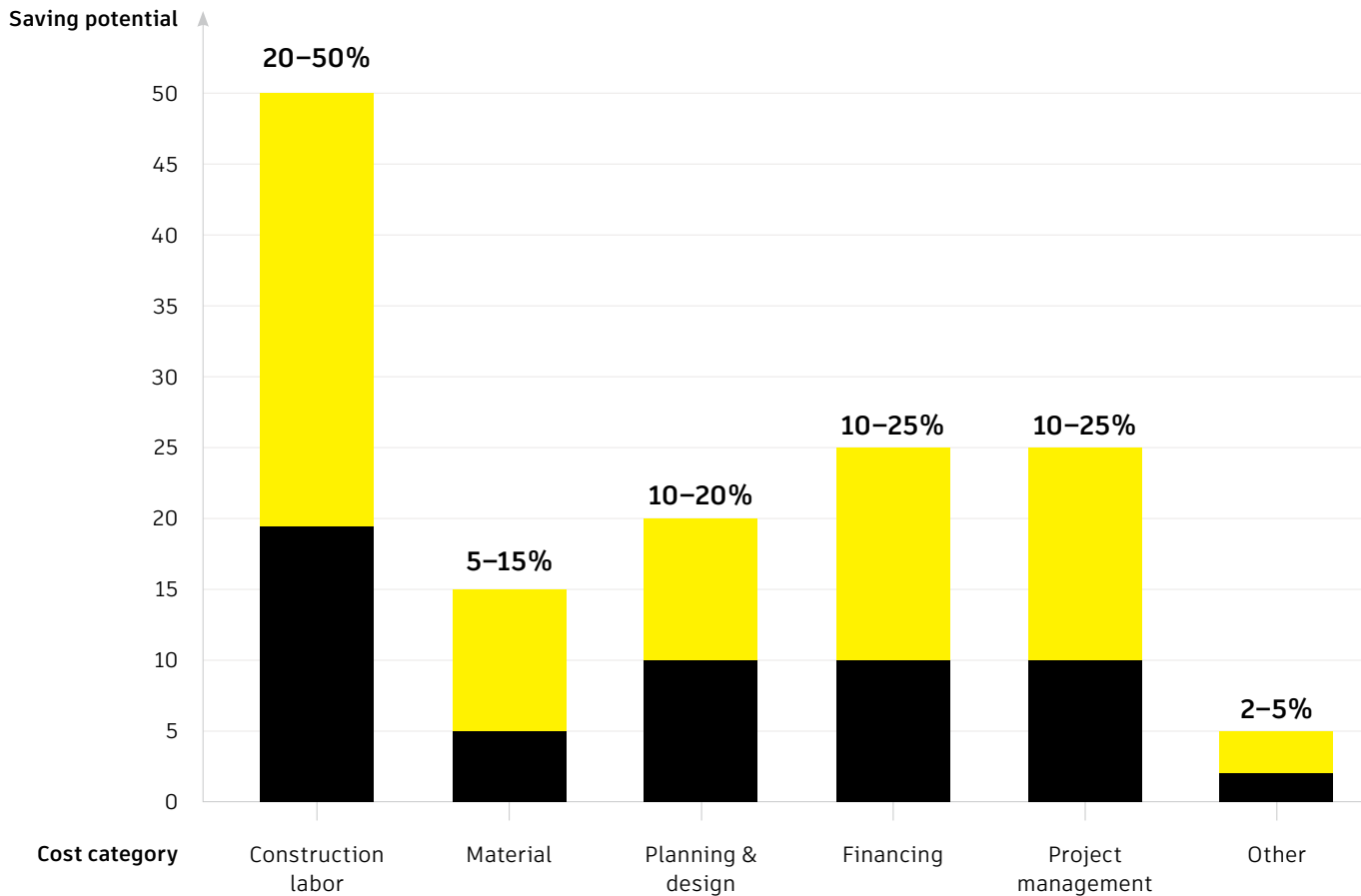


Fig. 5. Cost-saving potential for each cost category.

## Wider societal impacts

IC enhances workforce quality of life by providing job security, permanent work locations, and a more comfortable work environment with less manual labor. It also fosters diversity and stability for families and communities by offering predictable employment opportunities.

For the industry, IC enables repeatability, standardization, scalability, and stronger supply chain partnerships, ensuring more resilient and efficient construction processes. Risk management is also improved through better planning and execution.

At the community level, IC supports local investment, social acceptance (“social license”), and regional economic uplift, fostering economic growth and long-term prosperity.

By addressing these broader and societal impacts, IC not only revolutionizes construction but also contributes to a more sustainable, efficient, and inclusive built environment.

Industrialized Construction delivers tailored advantages across the AEC industry, benefiting all key stakeholders

For developers and owners, IC ensures cost predictability, faster time to market, improved quality, and sustainability, reducing overall project risks. Architects and designers benefit from enhanced collaboration and efficiency, enabling the creation of innovative, manufacturing-aligned designs that streamline production.

General contractors gain from increased labor efficiency, reduced on-site complexity, improved safety, and scalable project delivery, optimizing resource utilization. Meanwhile, subcontractors access specialization opportunities, steady workflows, and advanced technologies, enhancing skill development and long-term stability.

For suppliers and manufacturers, the growing demand for prefabrication fosters innovation and global market expansion, while end users enjoy cost savings, faster delivery, and improved quality and comfort.

At a regulatory level, governments and regulators benefit from economic growth, infrastructure development, better compliance, and sustainability progress. Lastly, investors see lower risks, scalable returns, and ESG alignment, strengthening both financial and reputational value.

By addressing diverse stakeholder needs, IC drives efficiency, innovation, and long-term success across the entire construction ecosystem.

# Populous's innovative use of Industrialized Construction in sports and entertainment projects

Populous is a global design firm with around 30 offices, with regional headquarters in Brisbane, London, and Kansas City, with Kansas City serving as the global headquarters. Populous has historically faced challenges with traditional construction methods, including low margins, extensive rework, a narrow talent pool, and time constraints, particularly for major renovations and events like the Olympics, where schedules are non-negotiable.

To address these challenges, Populous has implemented various Industrialized Construction methods, including modular construction, prefabrication, and productization. For example, precast concrete slabs are commonly used for seating bowls in stadiums, minimizing the number of different slabs needed. Populous has also developed baseline products, such as a FIFA-compliant stadium design that can be adjusted for capacity while maintaining compliance with stringent requirements.

The IC approach has brought significant benefits, including faster construction times, cost savings, and enhanced sustainability. For Populous, IC techniques encapsulate complex project elements, making projects easier to manage and more efficient. For clients, the benefits include flexibility, cost control, and the ability to deliver high-quality experiences in temporary venues.

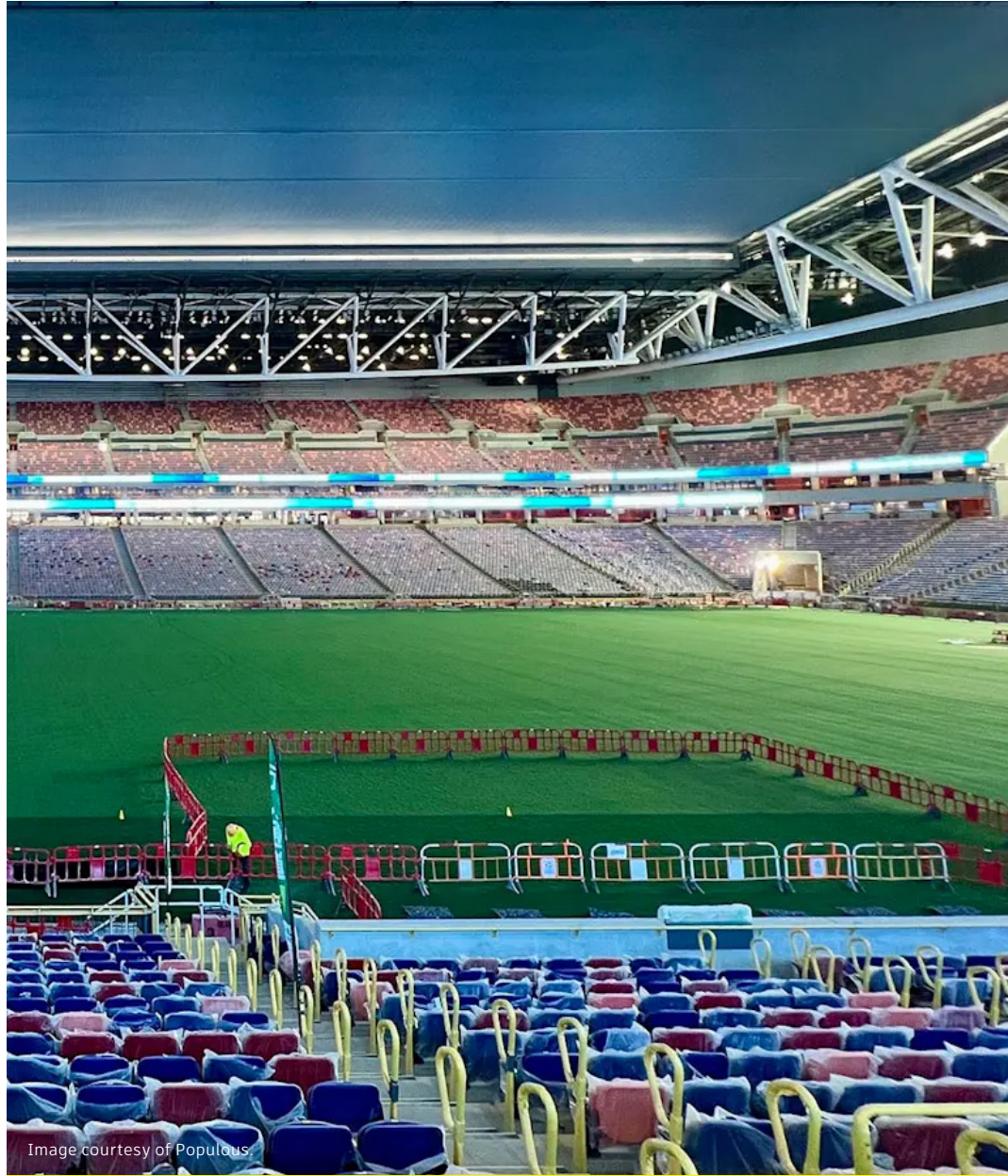


Image courtesy of Populous.

“The technology and approach of Industrialized Construction is relatively straightforward, but the people are not.”

# Challenges in IC adoption

The adoption of Industrialized Construction is often hindered by misconceptions and structural as well as procedural challenges that need to be addressed.

One common misconception is that IC limits design flexibility, but this can be resolved through productization, which allows for both customization and efficiency. Another myth is that IC leads to higher costs; however, early procurement, scalable planning, condensed delivery times, and increased efficiency through off-site manufacturing significantly reduce expenses. Additionally, IC is often thought to be applicable only for highly standardized structures, but by combining productization with modularization and defining clear interfaces between elements, it can support a wide range of designs, from unique, one-off projects to high-repeatability, low-complexity structures.

Beyond misconceptions, several structural challenges slow IC adoption. Many projects only implement certain IC elements while largely sticking to conventional planning and construction methods. To fully benefit from IC, all work packages must be aligned, and the three core pillars of IC – productization, DfMA and prefabrication – should be implemented holistically. Procurement and contractual structures also pose a challenge; while IC works best when products are selected early in the design phase, traditional construction often delays product selection until the last possible moment. This can be mitigated by developing platform-based products that

multiple manufacturers can deliver and creating generic product frameworks while finalizing specific solutions at later stages. Additionally, alternative collaboration models like Integrated Project Delivery (IPD) can enhance alignment between stakeholders.

Another major hurdle – often the most challenging in many countries – is the fragmented value chain. The traditional “plan, build, operate” model splits an integrated customer project into isolated roles, responsibilities, and compensation structures. This creates silos among developers, architects, planners, suppliers, and contractors, leading to communication breakdowns, delays, and inefficiencies. Additionally, execution experts are brought in too late – only after planning is complete – thus missing opportunities for better execution strategies and innovations. Profit and risk are also unequally distributed: contractors bear the highest financial risk yet operate on thin margins, while developers, suppliers, and material producers enjoy higher profits with lower exposure. The solution lies in consolidating supply chain networks and partnerships to create an end-to-end Industrialized Construction delivery system – integrating product development and project execution – so that all stakeholders benefit from overall project success.

Another challenge is the need for up-front investment in R&D, product development, and prefabrication facilities. This can be addressed either through direct investment supported with a realistic business case or by building a strong partner network within the supply chain.

Regulatory constraints also hinder IC adoption, particularly due to a lack of type approvals, insurance schemes, and regulatory frameworks tailored to new construction methods. These issues must be addressed by regulators to facilitate broader implementation. Additionally, the lack of end-to-end IT solutions creates inefficiencies in data transfer between platforms, manufacturing technologies, and building design systems. Improved digital integration is essential to streamline processes and maximize IC benefits.

Finally, the construction industry faces a skill and education gap in areas such as DfMA, production, and automation. One solution is to recruit talent from other industries with expertise in manufacturing and industrialized processes, ensuring the workforce is equipped for the transition to IC.



By addressing these misconceptions and challenges through strategic solutions, Industrialized Construction can unlock its full potential, driving efficiency, sustainability, and innovation in the built environment.

# IC approach: changes in the value chain and ecosystem

Industrialized Construction represents a fundamental shift in how buildings are designed, constructed, and manufactured. It replaces the inefficiencies of traditional methods with standardized, automated, and highly controlled processes.

### Design

Traditional construction offers bespoke designs with little opportunity for data reuse, leading to inefficiencies and inconsistencies across projects. In contrast, Industrialized Construction enables standardized, repeatable, and configurable designs, using assemblies and systems that promote data reuse and process standardization.

### Construction

In traditional construction, work occurs in an unsafe and unpredictable environment with high risk and low productivity. Industrialized Construction shifts labor to controlled factory settings, where safety and productivity are continuously improved through the use of standardized products and automation.

### Manufacturing

Traditional construction engages subcontractors and manufacturers late in the process, with low visibility into demand pipelines offering bespoke products for bespoke projects. Industrialized Construction, however, provides line of sight into demand pipelines, enabling the production of more standardized products, better factory utilization, and improved productivity.

This transformation enhances efficiency, safety, and scalability, making construction more predictable, cost-effective, and aligned with modern manufacturing principles.

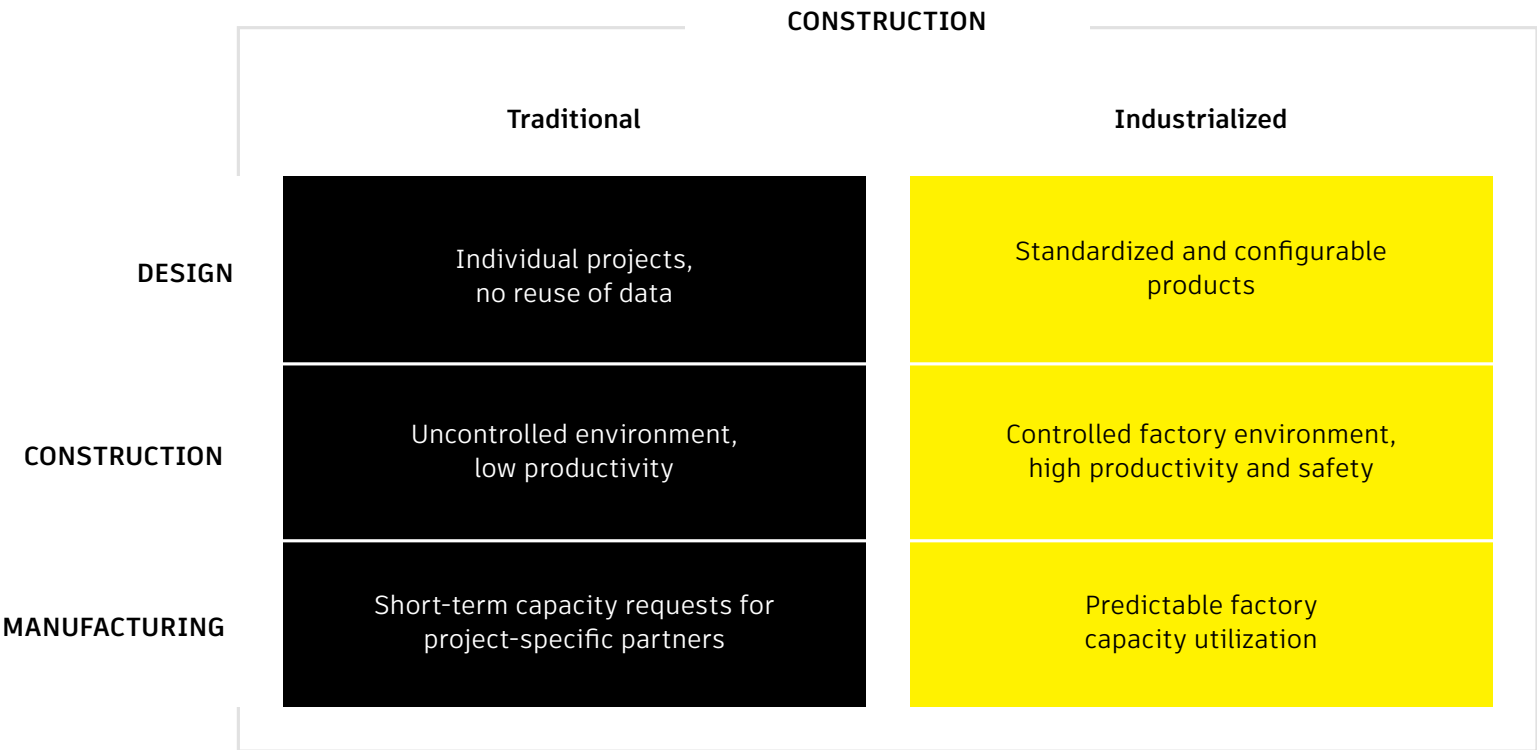


Fig. 6. Differences between traditional and Industrialized Construction.

# Buro Happold's application of Industrialized Construction at Südkreuz

The Südkreuz project is located in Berlin, near the Südkreuz train station, one of the main transportation hubs in the city. The project comprises two buildings with a total area of 38,000 square meters, including an underground parking facility. Buro Happold, a multidisciplinary engineering consultancy with over 3,500 employees worldwide, was tasked to implement industrialized construction methods.

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The IC approach brought several benefits to the Südkreuz project.

Despite the irregular shape, the modularization approach aimed not only to maximize the use of equally shaped elements but also to standardize connection details.

The modular system enabled faster construction with fewer workers on site, as prefabricated elements were directly unloaded from trucks and assembled.

As lessons learned, the project also demonstrated the need for early collaboration with contractors to optimize the design for modular construction. Moving forward, Buro Happold plans to apply these lessons to other projects, such as the research science hub in western Germany and the new campus buildings in Nuremberg. The company is also developing an automated floor plan generator to optimize modular designs and minimize variations.



Image courtesy of Buro Happold.

“Modular construction helps us utilize workflows better, allowing for repetitive and efficient design processes.”

Industrialized Construction also has a fundamental impact on the value chain compared to the traditional AEC value chain. With what can be described as a “left shift,” IC introduces core activities such as customer and market research combined with the development of products; the activities start even before a specific project is awarded. It then enters the phase of product discovery, in which a proactive sale of the pre-developed products is key. Due to the customer-specific product development, it is now possible to target exactly those customers and allow for achievement of sales plans. During this phase the initial interaction between the customer and the product comes into play, often supported by a configurator. The first

three phases encompass the IC capabilities of DFMA as well as productization. These are followed by the design phase, in which the pre-developed product is customized to meet the specific project requirements. This needs to follow the already pre-defined and now detailed rules of DFMA to ensure efficiency in manufacturing and assembly on site. Afterwards adhering to the Industrialized Construction pillar of prefabrication, the project is manufactured off-site and assembled and constructed on-site.

Once the building is completed, the operations phase ensures the effective management and use of the facility. This includes ongoing operational services and the application

of building systems, with an emphasis on predictive maintenance, the optimization of long-term building performance as well as continuous data gathering and management for the iterative and continuous development of the real estate product.

This approach in the altered value chain integrates the right competences and skills of different people at the right time and breaks up silo thinking and the everlasting division between planning and execution. It puts the final product and thus the customer at the center. For this approach to gain traction, certain roadblocks need to be removed and the regulators need to adjust the incentives.

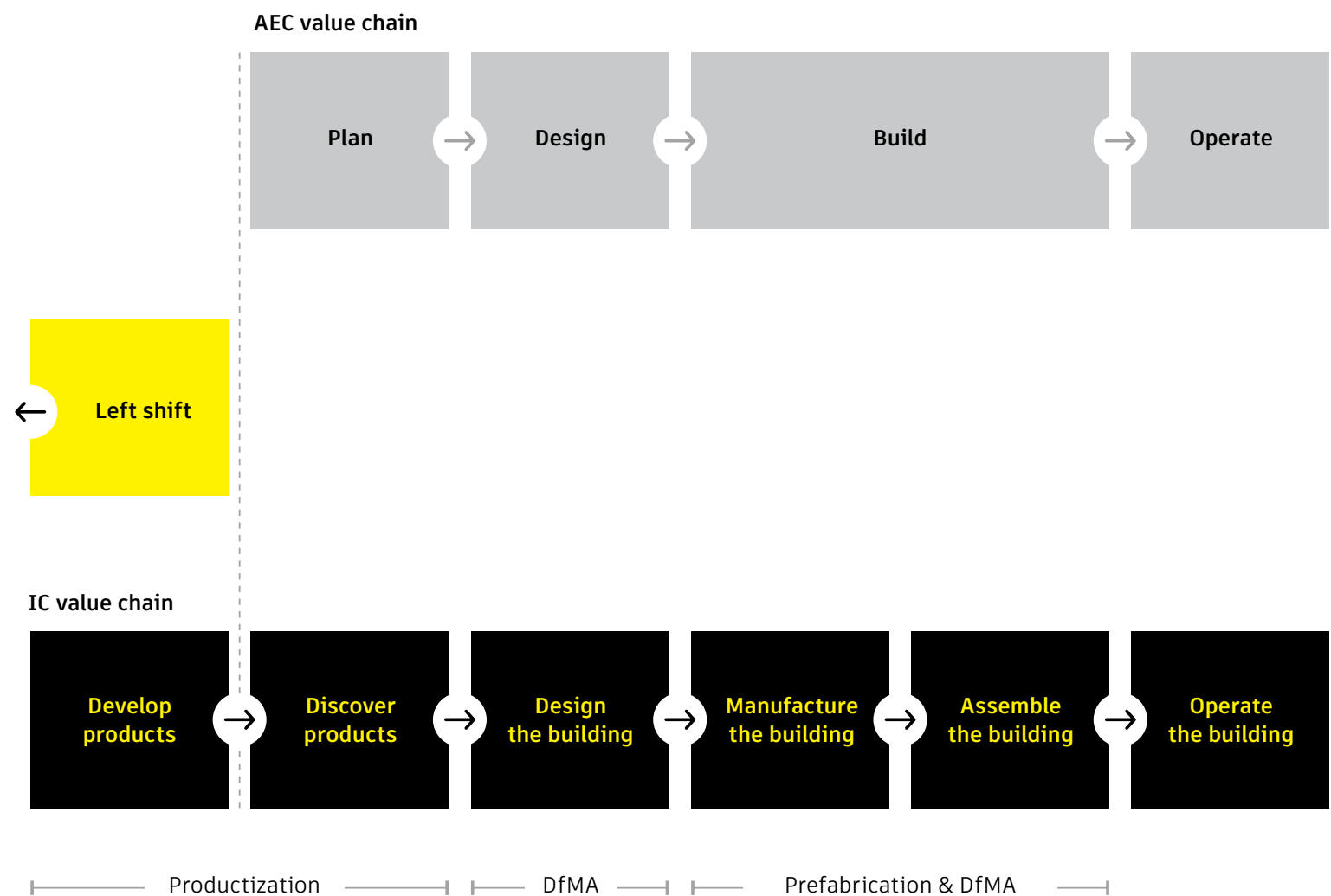


Fig. 7. Left shift and changes in the value chain.

## Supporting changes in regulations and labor to speed up adoption of IC

To integrate IC, governments and industry must take key actions. Updated building codes are essential to accommodate new methods while ensuring safety, environmental, and accessibility standards. Incentives, subsidies, and tax breaks should encourage investment in IC technologies, especially those enhancing sustainability, energy efficiency, and affordability.

R&D investment is crucial for advancing IC technologies and establishing scalable, high-quality standards. Governments should prioritize research to create a robust framework for widespread adoption.

On the labor side, upskilling programs are necessary to prepare workers for modular construction, robotics, and BIM. Labor unions

should support retraining, and collaboration between companies, educational institutions, and governments will ease the transition from traditional roles to factory-based environments.

Cross-disciplinary teams can bridge the gap between on-site construction and manufacturing. By combining expertise from both fields, companies can enhance collaboration and streamline IC integration.

## Industrialized Construction requires companies to master six elements

Successfully adopting Industrialized Construction requires companies to rethink their strategies and operating models to unlock new business opportunities, drive growth, and enhance operational efficiency. Both vertical and horizontal integration are being re-evaluated in a rapidly changing

landscape. Proximity to investors grants greater influence over execution models, partner selection, and, consequently, higher profit potential. In contrast, positions in the value chain that reduce a company to an indistinguishable, easily substitutable service provider risk being left behind.

To remain competitive, it is essential to reimagine business models and strategically define the role within the value chain: deciding where to play and how to win. For Industrialized Construction specifically, this means identifying the optimal strategy and implementation approach across the following six building blocks:

01

Strategic ambitions  
& business model

02

Product  
strategy

03

Supply  
chain

04

Data &  
systems

05

Processes

06

People &  
organization

Fig. 8. Six elements to master for successful application of Industrialized Construction.



## 01 Strategic ambitions and business model

This building block addresses the long-term vision and positioning of an organization within the industrialized construction landscape. Key questions include: “What are the strategic goals for adopting IC,” and “how does it align with the company’s broader objectives? What business model will support these ambitions?” Companies clearly state their ambition towards their IC journey, as it comes with an investment of money and people. Understanding IC as a business case in which companies invest money and need to plan for a return on that investment is crucial to ensure the execution with a certain dedication and rigor.



## 02 Product strategy

The product strategy focuses on defining a standardized yet flexible portfolio of offerings that meet market needs. Questions such as “What product solutions align with targeted market segments?” and “How can a product strategy leverage modularity while catering to diverse customer requirements?” are critical. This involves creating a product structure listing all elements of your products in a hierarchy and understanding how to apply platform thinking to reuse as many parts as possible for different products to enable efficiency and customization while maintaining economies of scale.



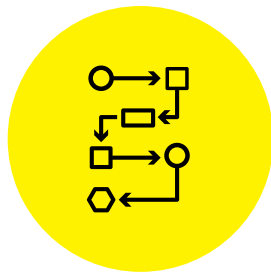
## 03 Supply chain

This building block explores how the IC approach redefines traditional value chain roles and relationships. It asks: “How will the organization collaborate with suppliers, manufacturers, and contractors to optimize efficiency?” and “Which parts of the value chain will generate the most value and competition?” A crucial differentiation to traditional construction is to understand that you and your suppliers must enter long-term strategic partnerships building on trust, fair profit pool allocation, process integration, and system alignment. This goes for your up- and downstream supply chain.



## 04 Data and systems

For each company, it is becoming more and more crucial to have a digital backbone and system structure in place that allows for an efficient digital workflow within your end-to-end processes. At the same time, it is crucial to understand your interfaces to other systems within your supply chain. The value of final products will be increasingly valued by the quality of the digital twin. As this goes for the complete building, it is crucial for any supplier that delivers products into the building to adhere to that as well.



## 05 Processes

Processes form the backbone of industrialized construction operations, focusing on creating standardized workflows. Questions like “What processes need to be developed or reengineered to support IC?” and “How can digital tools and technologies streamline operations?” guide this building block. Key processes impacted the most by IC are product development, sales, design, and manufacturing. Those need to be included into the overall end-to-end business process model of each company, as this is the foundation to achieve scalable and efficient operations.



## 06 People and organization

This block addresses the organizational structure and skillsets required to successfully implement IC. It considers questions such as “What capabilities are essential for Industrialized Construction?” and “How should the organization be structured to support these capabilities?” Core areas include upskilling employees in modular assembly, automation, and digital design, as well as fostering cross-disciplinary collaboration between teams specializing in construction, engineering, and manufacturing.

# GOLDBECK case study: systematic element-based construction.

GOLDBECK is a German-based company fully adopting industrialized construction generating €6.4 B (2023/24 financial year) in revenue with over 13,000 employees. GOLDBECK confirms the major inefficiencies along the whole value chain within the AEC industry. Quite similar projects are being redesigned and rebuilt with great effort, whereas an industrialized approach could deliver the same result at a fraction of the effort, time, and cost.

GOLDBECK's strategy follows a careful selection of markets, products, and systems and then rigorously sticking to them. They continuously improve their products and systems, but never deviate from them for a single project. Key to GOLDBECK's business model are in-house integrated design and in-house production, allowing for efficient delivery, cost-effective, and sustainable buildings with tailored functionality. By running a systems-based approach, processes can be streamlined accordingly. GOLDBECK is able to define a best practice, far more advanced than in traditional construction. This detailed process landscape is the basis for many efficiency gains.

Comprehensive design expertise, in-house industrial prefabrication, and the incorporation of leading technologies are only some of the success factors of GOLDBECK's approach: systematic element-based construction.



GOLDBECK follows the approach of only planning what the company builds and only building what GOLDBECK plans. With that, GOLDBECK is able to deliver projects significantly faster than traditional construction.

# The role of technology

Technology alone does not drive Industrialized Construction, but as an enabling and supportive mechanism it does have the potential to drive efficiency in the IC value chain. Improvements in technology are essential to help break down data silos and thus reduce

digital waste at every stage of the design, construction and manufacturing process.

Existing technology solutions typically serve to address discrete challenges (e.g., how to model light gauge steel to enable automation in cold forming machinery, how to support the production management environment with prefabrication-focused manufacturing execution systems, how to model reinforcement steel in concrete to

automate bar bending and welding equipment). What the industry has been lacking is more holistic connectivity between technology to ease data transfer from design to manufacture to assembly whilst creating a feedback loop to enable continuous improvement. One of the key challenges with technology to support IC workflows is the need for building design tools to better integrate with product design tools. Historically, these have been disconnected with a level of interoperability but lacking true integration. An idealized workflow underpinning the three pillars of IC is shown:

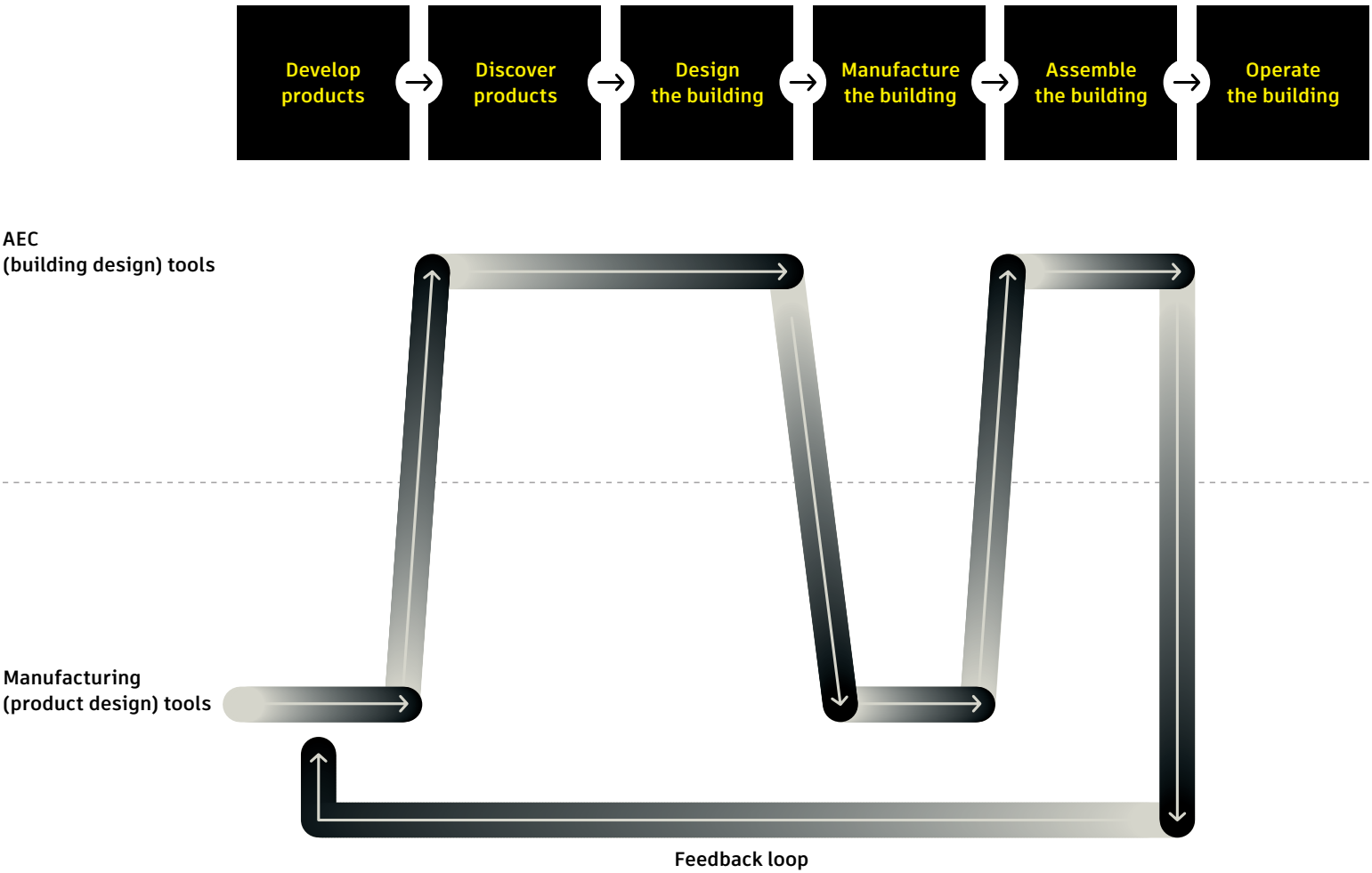


Fig. 9. IC value chain needs to span both AEC and manufacturing tools.

Technology for industrialized construction is evolving; there's significant activity and investment from both existing large-scale software providers and a number of emerging start-ups. Progress is taking place in a number of focus areas:

### **Product complexity and configuration**

Configuration tools will mature in the scale and complexity of products configured. At the base level this allows the configuration of discrete building products (e.g., fixtures and fittings) developing to products with a level of interface in the project (e.g., windows or doors), developing to systems of products (e.g., wall panel or façade assemblies) to more complex systems (e.g., MEP distribution) to volumetric modular (e.g., bathroom pods) to whole building configuration. All of these capabilities require a level of standardization but enable customization within defined boundaries.

### **Product placement and automation**

How products are placed within a building is expected to develop from discrete product placement at the foundation. Procurement methods won't always allow for simple placement of selected manufacturer data, so there will be a need for placing generic or placeholder data defined by performance specifications and not just geometry to ultimately be replaced by actual manufacturer's data. This process will require technology to support the validation of products for best fit and compliance. This opens the gateway to applying generative design technology to assess multiple product choices and ultimately support the optioneering between them, enable the intelligent routing of systems, and provide AI-based design recommendations and provide a feedback loop of product placement insights to the manufacturers.

### **Product access and selection**

Selection of products is expected to evolve from simple project-based access where selected supplier data is available from project data management tools. The next step of evolution will be publicly accessible data where suppliers can make their product data and geometry available for projects to select and configure or customize. This will ultimately form the basis for emerging technology to

form a marketplace, enabling bid preparation and new forms of purchasing contacts and payment methods.

### **Product data**

While product geometry is important for design coordination, visualization, and construction, the data derived from manufacturers has additional value in providing an effective BIM experience. Technology will evolve from transferring and updating BIM data from manufacturers' products into the building model to other forms of data such as accurate carbon calculations and estimating/cost data. Inclusion of these other forms will enable optimizing between choices for better project outcomes.

### **Project to product life cycle**

Underpinning all these improvements in technology in support of Industrialized Construction is the connection between project and product life cycle. As AEC and manufacturing software tools become better integrated, we will see a continuous thread of data flowing from manufacturers' products into early-stage conceptual design, to more detailed design, into the manufacturing process, the project assembly process, and ultimately into building operation and disassembly at the end of the project life cycle.



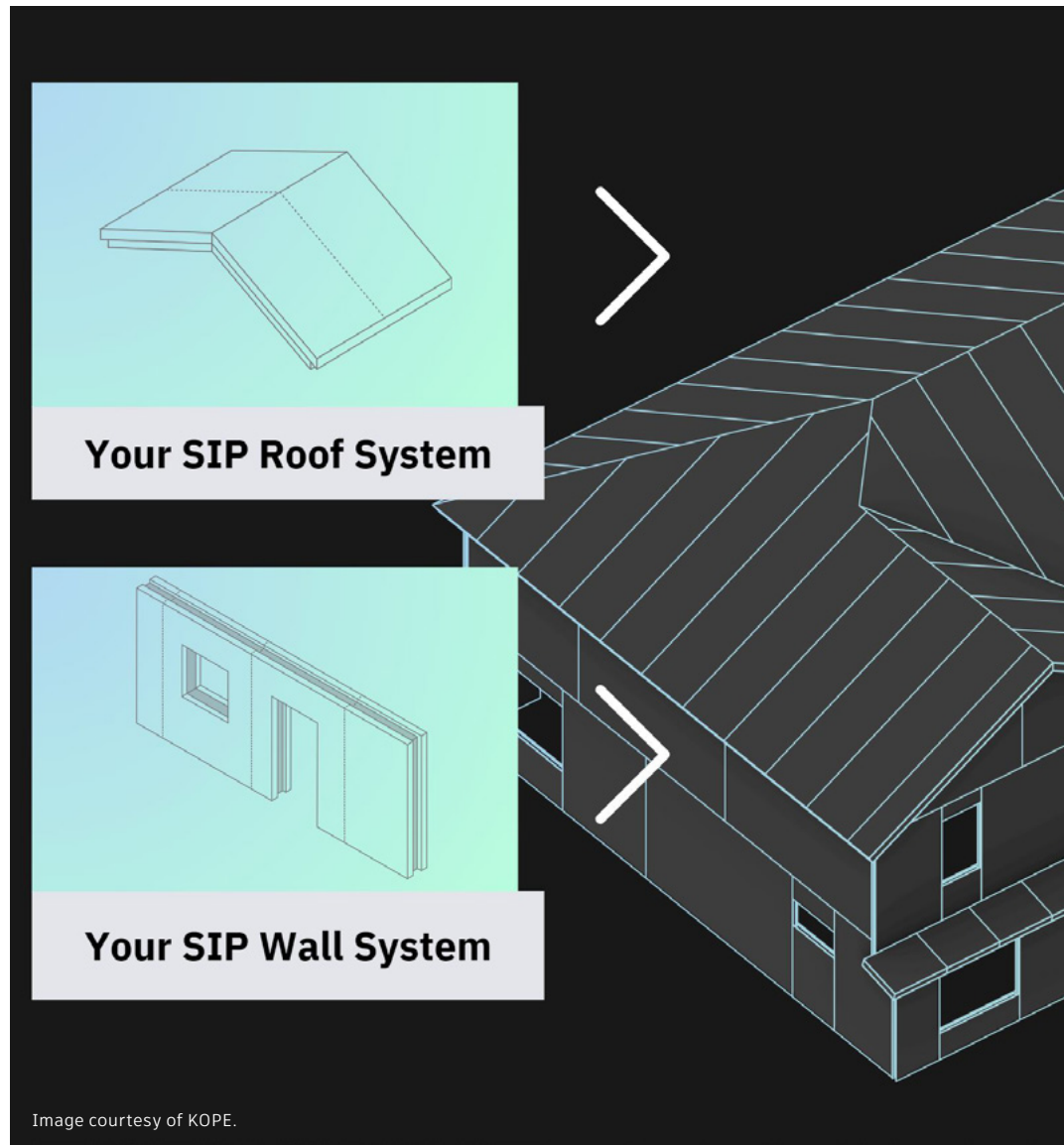
# KOPE enabling IC with technology

KOPE is a technology company specializing in industrialized construction workflows, headquartered in London. As a venture capital-funded start-up, KOPE has built its business around providing software solutions to address the challenges of IC.

KOPE assists its customers by providing a platform that automates and optimizes productization. Their technology allows for rapid scenario testing and decision-making, enabling customers to identify the most efficient and cost-effective construction methods. By partnering with companies like Saint-Gobain, KOPE helps streamline decision-making, reduce manual efforts, and enhance overall project efficiency. According to Dayle Zielentino, Customer Success Manager at KOPE, the platform “allows Saint-Gobain to take a design and apply their product to it, and within about thirty minutes, they can say, yes, this is suitable for us, and let’s actually spend the time now going into optimization.”

KOPE’s platform has brought numerous benefits to Saint-Gobain and other clients. By reducing the design time from four days to a few hours, KOPE has significantly increased efficiency. Additionally, the ability to run multiple scenarios simultaneously has provided valuable insights, allowing for better decision-making and improved project outcomes. The technology also supports early engagement of industrialized construction solutions, enabling Saint-Gobain to influence design changes and optimize their products for better performance.

As a future outlook KOPE continues to refine its platform, emphasizing the importance of flexibility and adaptability in construction workflows.



“Traditionally, validating a building design for this system took about four days of manual work, often resulting in abortive efforts if the project was not suitable. KOPE’s technology reduced this process to approximately 30 minutes.”

# The future of Industrialized Construction: unlocking efficiency, sustainability, and innovation

Industrialized Construction is fundamentally transforming the built environment by shifting from traditional, project-based approaches to scalable, product-based solutions. This paradigm shift leverages standardization, digitalization, and automation to enhance efficiency, sustainability, and quality. As the industry moves forward, embracing these principles will be key to unlocking its full potential and shaping the future of construction.

## Embrace productization for repeatable efficiency

To fully capitalize on scalability, IC must transition toward standardized modular components, reducing excessive customization while increasing repeatability across projects. By treating buildings as configurable products rather than one-off projects, the industry can achieve economies of scale, leading to cost reductions and improved production speed.

One of the key enablers of this transformation is digital twin technology, which facilitates real-time optimization from the initial design phase through to building operation. By creating digital replicas of physical structures, stakeholders can simulate performance, identify inefficiencies, and optimize processes before actual construction begins. This ensures continuous improvement in design iterations, life-cycle performance, and maintenance planning.

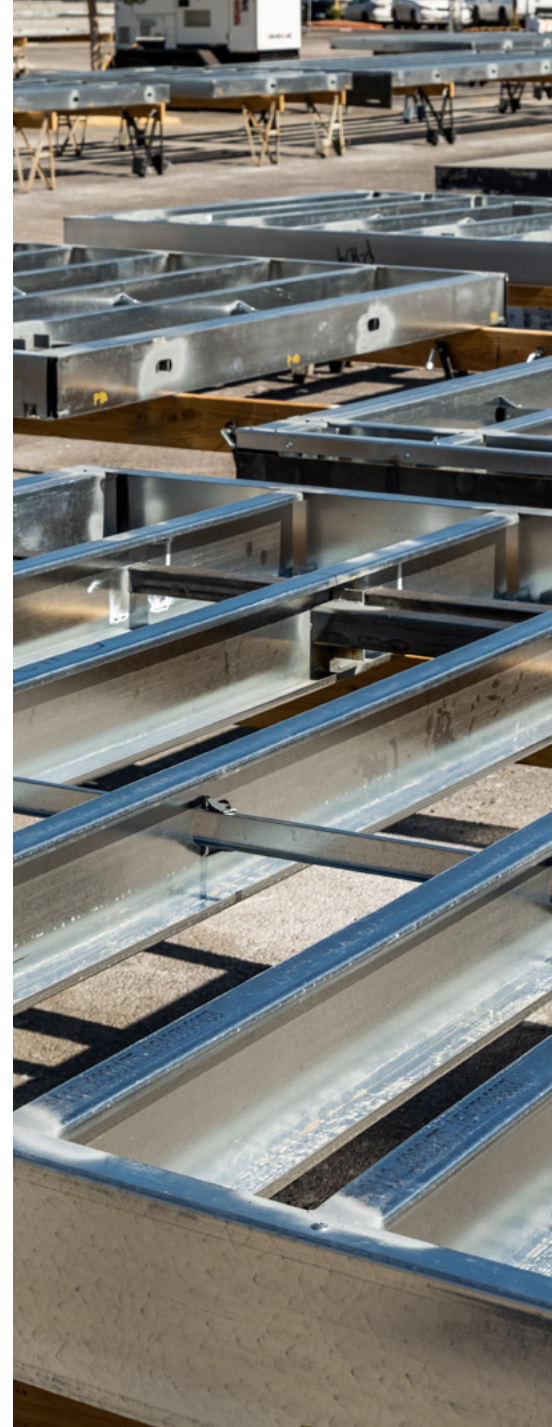
A critical component of successful productization is a closed feedback loop between design, manufacturing, and construction. Insights gained from on-site performance data can be fed back into the design process, allowing for iterative refinements that improve future projects. This integrated approach enhances product life-cycle performance, leading to better buildings that are more adaptable, cost-efficient, and sustainable over time.

## Adopt prefabrication as a core strategy

Prefabrication is at the heart of IC, enabling faster project delivery while simultaneously improving quality and sustainability. Shifting major construction activities from unpredictable job sites to controlled factory environments allows for higher precision, reduced waste, and minimized labor inefficiencies.

Investment in off-site manufacturing facilities with advanced automation technologies – such as robotics, CNC machining, and AI-driven quality control – significantly enhances production accuracy and repeatability. These facilities enable the production of modularized design elements that can be assembled in parallel with site preparation, drastically cutting project timelines and mitigating delays caused by weather or labor shortages.

Moreover, an efficient logistics and supply chain strategy is essential for seamless prefabrication execution. Just-in-time (JIT) delivery ensures that prefabricated components arrive on site exactly when needed, reducing storage costs and minimizing construction downtime. Standardized connections and assembly methods further streamline the construction process, enhancing speed and reliability.



## Ensure design for manufacturing and assembly (DfMA)

Embedding design for manufacturing and assembly (DfMA) principles at the earliest stages of a project optimizes both production efficiency and construction effectiveness. This design philosophy ensures that components are easy to fabricate, transport, and assemble, ultimately leading to improved consistency and reduced complexity.

Early collaboration with manufacturers is crucial to ensuring that design choices align with fabrication capabilities. Engaging fabricators and suppliers at the conceptual stage allows for better material selection, process optimization, and cost control. Simplified, standardized designs enhance repeatability, making it easier to scale production while maintaining quality.

Sustainability is another key advantage of DfMA. By selecting waste-reducing materials and implementing energy-efficient fabrication methods, the construction industry can significantly lower its environmental impact. Additionally, DfMA supports circular economy principles, enabling materials and components to be repurposed or recycled at the end of a building's life cycle.

## Enhance integration through digital tools

Technology plays a pivotal role in maximizing the potential of IC by integrating design, manufacturing, and construction processes. Advanced digital tools such as BIM, artificial intelligence (AI), and the Internet of Things (IoT) are reshaping how projects are conceived, managed, and executed.

Full life-cycle BIM integration fosters seamless collaboration between architects, engineers, manufacturers, and contractors. A centralized, data-rich model provides real-time insights, streamlining decision-making and reducing errors. AI-driven predictive analytics further enhance project management by anticipating risks, optimizing schedules, and improving resource efficiency.

IoT-enabled automation takes quality control to the next level by monitoring prefabricated components throughout production and assembly. Sensors embedded in materials and structural elements provide real-time feedback on performance, ensuring precision and reliability while reducing the likelihood of defects.

## Delivering value for the future

At the core of Industrialized Construction's transformation is a commitment to delivering greater value to customers. By embracing productization, prefabrication, DfMA, and digital integration, the industry can enhance quality, reduce costs, and accelerate timelines – all while improving the user experience.

Industrialized Construction not only delivers better buildings but also fosters stronger, more resilient, and sustainable communities. As the construction industry continues to evolve, those who adopt these principles will lead the way in shaping a built environment that is smarter, greener, and more efficient. The future of construction is industrialized – and the time to embrace this change is now.

Industrialized Construction (IC) is reshaping the built environment by shifting from traditional, project-based methods to scalable, product-based solutions. By embracing standardization, digitalization, and automation, the industry can achieve greater efficiency, sustainability, and quality.



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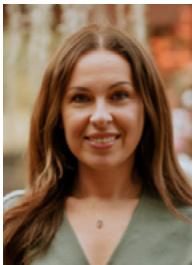
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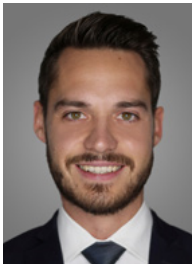
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