

# **Executive Summary**

Modular construction is rapidly emerging as a groundbreaking approach to address the pressing challenges faced by the real estate and construction industries. Rising construction costs, labor shortages, and a lack of available housing can be mitigated through this method by leveraging shorter construction timelines, greater planning reliability, and enhanced sustainability.

The industrial pre-fabrication of building components in factory settings enables weather-independent, standardized production at a consistently high level of quality. This accelerates project realization, significantly improving the ability to respond to urgent needs in residential, educational, or healthcare construction. Digital tools such as Building Information Modeling (BIM), combined with advancements in automation and robotics, further increase efficiency, reduce error rates, and lower on-site emissions.

A key success factor lies in precise pre-planning. Decisions regarding the construction system must be made in the earliest phases of a project, requiring close, interdisciplinary collaboration among all stakeholders. Material selection also plays a critical role in economic viability: Wood products, for example, stand out for their CO<sub>2</sub> storage capabilities but often come with higher costs compared to steel or concrete-based construction methods. Steel modules, on the other hand, frequently offer a more cost-effective and readily available alternative.

On the regulatory front, positive trends are emerging: Modular construction methods are increasingly receiving preferential approvals and targeted support, particularly in sectors like student housing and educational facilities.

The modular construction market in the DACH region (Germany, Austria, Switzerland) remains highly fragmented and is predominantly composed of small and medium-sized enterprises, creating opportunities for further efficiency improvements.

The modular construction providers analyzed in this study exhibit significant differences in cost structures, construction speed, and sustainability profiles. Selecting the right provider as a cooperation partner depends on a variety of factors, including the intended use (residential vs. non-residential), unit size, sustainability requirements, customization needs, durability expectations, site characteristics, the balance of in-house versus outsourced work, as well as the project's budget and timeline requirements.

Overall, modular construction proves to be a strategically attractive option for high-quality, efficient, and sustainable building projects. Investors, developers, and public-sector clients can leverage this approach to reduce cost and time risks while simultaneously contributing to climate policy goals.

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# **List of Abbreviations**

aBG	General Type Approval
	Working Group for Modern Construction
GFA	Gross Floor Area
BIM	Building Information Modeling
	German Sustainable Building Council
	German Institute for Building Technology
	General Contractor
GÜ	Turnkey Contractor
	Fee Regulations for Architects and Engineers
	Non-residential Buildings
	no date
	Quality Seal for Sustainable Buildings
	Serial, Modular, and Systemic Construction
	Total Contractor
	German Property Federation

#### 1 Introduction to Modular Construction<sup>1</sup>

In times of rapidly escalating construction costs and an acute shortage of affordable housing, particularly in dynamic urban centers, modular construction is gaining increasing importance. This method fundamentally transforms the traditional construction process by shifting value creation from the construction site to the controlled environment of a factory. Here, prefabricated modules or elements are produced with precise timing and later assembled into complete buildings.<sup>2</sup>

The advantages of this construction approach are manifold: in addition to significantly shorter construction times, it offers greater planning and cost certainty as well as an overall more economical building process.<sup>3</sup> Modular construction also addresses key sustainability goals of the federal government: construction site traffic and material waste are reduced, and components can be reused later.<sup>4</sup> This makes modular construction a promising alternative to conventional methods, especially for long-term projects that aim to combine efficiency and quality.

Modular construction is also increasingly being seen as a solution on the political level. The federal government and states are prioritizing this approach to implement new construction projects more quickly and cost-effectively. Efforts are underway to streamline standardization and approval processes, thereby shortening construction timelines. Changes to building regulations are also being pursued: the German Property Federation (ZIA) is calling for a simplification of state building codes through the inclusion of harmonized type approvals, alongside greater digitization and standardization in planning and approval processes. The German Institute for Building Technology (DIBt) is supporting these efforts by establishing General Type Approvals (aBG) for modular buildings, which can significantly simplify the approval process.

In general, the term "modular construction" serves as an umbrella term for both modular construction, which refers to three-dimensional (3D) spaces, and element-based construction, which involves two-dimensional (2D) wall and ceiling modules.

Despite its numerous advantages, modular construction also comes with specific limitations. The standardization of modules, which are typically cuboid in shape, can make efficient use of irregular or unusually shaped plots more challenging. Additionally, the design flexibility of modular construction is often more limited compared to conventional methods, posing challenges for projects with highly individual architectural requirements. Within modular and element-based construction, distinctions are further made based on the intended use (temporary or permanent), the degree of prefabrication of

/ REAL PERSPECTIVES.

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<sup>&</sup>lt;sup>1</sup> All abbreviations used in this report, along with their respective meanings, are listed in the above glossary of abbreviations.

<sup>&</sup>lt;sup>2</sup> Martin & Schmidt, 2024.

<sup>&</sup>lt;sup>3</sup> PlanRadar, 2023.

<sup>&</sup>lt;sup>4</sup> Raurich, 2025.

<sup>&</sup>lt;sup>5</sup> ZIA, 2023.

<sup>&</sup>lt;sup>6</sup> ZIA, 2023.

DABpraxis, 2021; DIBt, 2025.

<sup>8</sup> HPD Consult, 2019.

the modules and elements, and the choice of materials, such as wood, steel, reinforced concrete, or hybrid modular systems.

This whitepaper presents the six most important methods of modular and element-based construction, with a specific focus on system modular construction and system element construction. The goal is to provide investors and project developers with a comprehensive market overview and a well-founded decision-making guide for selecting suitable construction methods and partners. Special attention is given to the differences and potential of the respective methods to enable sustainable, efficient, and future-proof construction for a wide range of applications.

# 1.1 Differentiation and Potential of Modular Construction in the Context of SMS

In light of increasing demands for sustainability, efficiency, flexibility, and cost-effectiveness, alternative construction methods are gaining greater relevance. Modular construction plays a key role in this context, having established itself as an umbrella term for various prefabricated building approaches. To better capture the diversity and systematic nature of these methods, the term SMS – serial, modular, and systemic construction – has been adopted as a structuring categorization.

Serial construction refers to the repeated production of building elements or modules with consistent quality and form. It focuses on efficiency and scalability, particularly for projects with a high degree of repetition, such as residential complexes or public facilities. Modular construction, on the other hand, goes beyond mere serial production: it involves the creation of self-contained functional units – so-called modules – which can range from a single wall to a fully equipped room. These modules are self-sufficient, incorporating technical installations as well as interior finishes (often even including furniture), and can be directly assembled into a building. Systemic construction describes the integration of modular or serial components into a coordinated, overarching modular system. Here, the focus is on interfaces, compatibility, and long-term expandability.

The definition of the term "module" is critical: a module is a functionally self-contained building unit that can operate independently of its surroundings. This could be a prefabricated wall with integrated technology or a fully equipped room that serves as part of a larger building. Modularization thus refers not only to geometry (2D or 3D) but also to functional autonomy and the ability to combine with other modules.

The following table, along with subsequent explanations, provides an overview of the different forms of modular and element-based construction as well as their characteristics in terms of geometry, degree of automation, and flexibility.

Table 1: Overview of Modular and Element-Based Construction

Source: Own representation

TERM	GEOMETRY	DEGREE OF AUTOMATION	EVALUATION
ARTISANAL ELEMENT CONSTRUCTION	2D	Manual to Semi-Automated	Flexible, Craft-Oriented
INDUSTRIAL ELEMENT CONSTRUCTION	2D	Fully automated	High degree of standardiza- tion
SYSTEM-BASED ELE- MENT CONSTRUCTION	2D	Semi-automated	Semi-automated with adapta- bility
ARTISANAL MODULAR CONSTRUCTION	3D	Manual to Semi-Automated	Workshop-Based Module Production with High Flexibility
INDUSTRIAL MODULAR CONSTRUCTION	3D	Fully automated	Serial high-volume production with minimal variance
SYSTEM-BASED MODU- LAR CONSTRUCTION	3D	Semi-automated	Semi-automated with adapta- bility

# 1.1.1 Manufacture Element Construction (2D Geometry)

Manufacture element construction is based on the artisanal production of building elements in a workshop or manufacturing facility. The elements are typically prefabricated in 2D geometry, meaning flat components such as wall, ceiling, or façade elements. Production is carried out individually, often custom-made and tailored to specific customer requirements. This allows for a high degree of flexibility, which is particularly advantageous for renovations, historically protected buildings, or unique construction projects.

Quality assurance is performed directly by skilled personnel, ensuring a high level of precision and adaptability. However, production capacities are limited, and the process is relatively time- and cost-intensive. Logistics and on-site assembly require careful coordination, as the elements are often heavy and cumbersome.

Manufacture element construction is especially suitable for projects with low production volumes, high complexity, or specific architectural demands. This method combines traditional craftsmanship with modern manufacturing techniques, enabling a high level of customization while maintaining controlled quality.

# 1.1.2 Industrial Element Construction (2D Geometry)

Industrial element construction utilizes industrial manufacturing processes to produce 2D building elements such as walls, ceilings, or façades. Unlike manufacture element construction, production is carried out on a large scale, often automated and

standardized. This enables high precision in repetition, short production times, and efficient use of resources.

The elements are fabricated in factory halls under controlled conditions, improving quality and ensuring independence from weather conditions. While standardization limits design possibilities, modular system frameworks allow for the realization of various design variants. Logistics are optimized, as the elements are prepared for transportation and on-site assembly.

This method is particularly suited for scalable standard buildings in residential construction, office spaces, or schools, where high production volumes and rapid construction timelines are required. However, challenges arise with flexibility for custom adaptations and the integration of technical installations.

Overall, industrial element construction offers an economical solution for serial construction projects with clearly defined requirements.

# 1.1.3 System Element Construction (2D Geometry)

System element construction combines the advantages of industrial manufacturing with modular systems. The modular building elements are part of a coordinated modular framework that includes various fully functional components such as walls, ceilings, installation shafts, or even complete room modules, such as bathroom modules.

Production is highly automated and standardized, enabling fast and efficient manufacturing. The elements are designed for easy assembly and connection on-site, significantly reducing construction time and minimizing potential errors.

System element construction is particularly suited for less intricate building types, such as residential or office buildings, with many low-tech spaces like living rooms or children's rooms. Flexibility arises from the wide range of combinable system elements that can be individually adapted.

However, challenges include planning and coordinating interfaces as well as integrating technical systems. Overall, system element construction offers an innovative solution for sustainable, efficient, and flexible construction.

# 1.1.4 Manufacture Modular Construction (3D Geometry)

In manufacture modular construction, complete room modules are individually and artisanally crafted. Each module is produced in a specialized workshop or factory, allowing for customization based on specific customer requirements, unique architectural demands, or complex installation situations.

The modules are fully equipped, including building services, sanitary facilities, interior finishes, and surfaces, and are then transported to the construction site for assembly into a complete building.

This method is particularly suitable for projects with low production volumes, high levels of customization, or special requirements, such as high-end residential buildings, exclusive hotel projects, or vertical extensions. Challenges include the complex planning process, limited scalability, and logistics for transporting large, heavy modules.

# 1.1.5 Industrial Modular Construction (3D Geometry)

Industrial modular construction is based on the automated and standardized production of room modules in industrial manufacturing facilities. The modules are produced in series, enabling high precision, short production times, and efficient resource utilization.

After being fully equipped in the factory – including technical systems, sanitary installations, and interior finishes – the modules are transported to the construction site, where they are assembled into complete buildings.

This method is particularly suitable for standard or serial projects with high production volume requirements, such as residential complexes, hotels, hospitals, or temporary structures. Advantages include high quality, short construction timelines, and cost efficiency. Challenges arise in flexibility for custom adaptations, logistics during transportation, and the on-site assembly of modules.

# 1.1.6 System Modular Construction (3D Geometry)

System modular construction integrates the advantages of modular building into a comprehensive, modular construction kit system. The modules are part of a coordinated system that enables various building types and sizes. Production and outfitting are highly automated and follow clearly defined standards. The modules are designed to be flexibly combined, expanded, or replaced, allowing for a high degree of adaptability to diverse uses, such as compact apartments, hotels, or specialized buildings. On-site assembly is particularly efficient, as the modules are precisely aligned to fit together seamlessly. Challenges lie in planning the interfaces and integrating technical systems. System modular construction offers an innovative, sustainable, and scalable method of building for a wide range of applications.

## 1.2 Modular Manufacturing Process

The path to a move-in-ready module begins in the factory hall and follows an optimized process similar to that of automobile production, based on lean management principles. First, a cuboid steel frame structure is manufactured as the foundation and then treated

for corrosion protection.9 The subsequent construction takes place along a synchronized production line (see process flow in Figure 1).

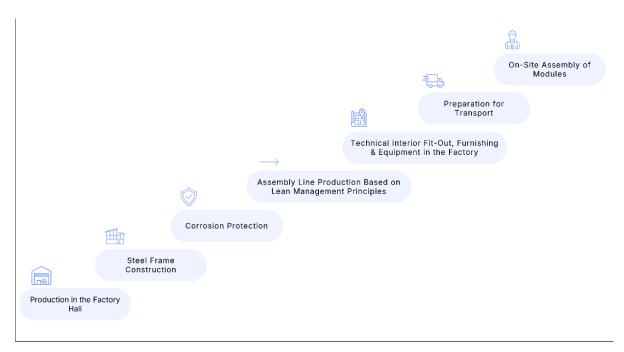


Figure 1: Process Flow of Modular Construction Source: Own illustration, based on purelivin; ADK Modulraum

With the help of this standardized manufacturing process, many steps in modular construction can be carried out in parallel. This not only results in significantly shorter onsite construction times but also reduces noise and dirt at the construction site. Another major advantage is the weather-independent production, which simplifies meeting project deadlines.<sup>10</sup> Depending on the system provider, the interior fit-out can already be almost entirely completed in the factory. This includes:

- The installation of walls, ceilings, insulation, and floor structures
- Complete pre-installation of electrical, plumbing, and ventilation systems
- Installation of windows, doors, and, if necessary, furniture elements
- Surface finishing (e.g., flooring, painting, tiling)

The result is largely move-in-ready room modules that are transported to the construction site after final inspection at the factory and assembled on-site. The final connection of the modules, integration into utility networks, and minor finishing tasks are completed during the final assembly phase at the construction site.<sup>11</sup>

This precise manufacturing process is enabled by comprehensive pre-planning using digital design models such as BIM (Building Information Modelling). The 3D planning integrates all trades, visualizes complex workflows, and minimizes coordination errors.

<sup>11</sup> Büdenbender, 2024.

<sup>9</sup> Floerke et al., 2014.

Deutsche BauZeitschrift (DBZ) B, 2018.

Additionally, it serves as a communication platform for planners, manufacturers, and contractors. Extensive quality controls are carried out at each stage of production in the factory, ensuring a consistently higher standard of execution.

Increasingly, the process incorporates automation and robotics, making production even more precise, cost-efficient, and faster. The use of artificial intelligence in prefabrication holds the potential to further optimize workflows and significantly boost efficiency.<sup>12</sup>

In contrast to modular factory production, where a large portion of the value creation occurs industrially within the factory, traditional on-site construction follows a predominantly sequential process carried out at the construction site (see Figure 2).



Figure 2: Process Flow of Conventional Construction Source: Own illustration, based on Hainley & Meibers (Inspire Homes), 2023

The process begins with detailed planning and obtaining the necessary permits, followed by site preparation and earthworks. Next comes the visible structural framework, followed by the roof construction and façade installation. Only after these steps are completed does the installation of building services and the interior fit-out with surfaces, windows, and doors begin. This is followed by surface finishing, the development of outdoor areas, and finally, official inspections and the formal handover.<sup>13</sup>

13 Hainley & Meibers, 2023.

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<sup>&</sup>lt;sup>12</sup> Hager, 2025.

# 1.3 Advantages, Opportunities, and Challenges of Modular Construction<sup>14 15 16</sup>

As previously mentioned, modular construction offers numerous advantages over conventional building methods. However, certain challenges must also be taken into account:

#### **ADVANTAGES**

#### Social

- Addresses the skilled labor shortage by shifting production steps to industrial production
- Reduces housing shortages through faster and more cost-effective construction
- Reduces noise and dust levels at construction sites

#### **Materials & Environment**

- Up to 90% recyclability
- · Reduced concrete usage
- Resource conservation through minimized construction waste
- Use of wood: insulation properties and active CO<sub>2</sub> storage

#### **Construction Time**

- Shortened construction periods (typically 60-70% faster than conventional methods)
- Process flow optimization through standardized procedures
- Efficient utilization of the building permit phase

#### Costs

- · Generally lower costs
- · Fewer workers required
- Government subsidy programs

#### **DISADVANTAGES**

#### **Infill Development**

- Building plots must match the module dimensions
- Difficult accessibility in urban centers
- Reduced design flexibility

#### **Transport Costs**

 Heavy-duty transport and logistics can increase overall costs

#### **Reduced Living Space**

 Doubling of interior walls reduces usable floor area

#### **Cost Distribution Over Time**

 High upfront costs due to industrial prefabrication

# Need for Collaboration & Digital Competence

- Higher prefabrication levels require early coordination and integration of trades
- The construction industry lags behind in digitalization

Source: Own illustration

Figure 3: Advantages and Disadvantages of Modular Construction

<sup>&</sup>lt;sup>14</sup> PlanRadar, 2023.

<sup>&</sup>lt;sup>15</sup> Bayerische Ingenieurkammer-Bau, 2024.

<sup>&</sup>lt;sup>16</sup> Simon, 2023.

# 1.4 Building Permits in Germany

The approval process in the construction sector is a key indicator of market development. While traditional construction projects are often burdened with lengthy permitting procedures, modular construction methods can benefit from standardized type approvals and serial construction processes. These advantages are also being supported by the German federal government in the 2025 coalition agreement through the introduction of the "Building Type E" and the promotion of serial, modular, and system-based construction.<sup>17</sup>

Data on approved residential and non-residential buildings constructed entirely using modular methods is currently limited and not systematically reported. A key reason for this is that the official building permit statistics do not sufficiently differentiate construction methods (modular) for residential and non-residential buildings. However, the Federal Statistical Office defines prefabricated construction as a broad term that explicitly includes modular and serial construction. Accordingly, a building in structural construction is classified as prefabricated if it is primarily realized using prefabricated modules (including entire rooms). Such prefabricated components are equipped with the necessary connection elements as load-bearing structures and are typically manufactured off-site. This implies that the statistics categorized under "prefabricated buildings" by the Federal Statistical Office already include relevant modular construction projects. 19

Nevertheless, to gain a comprehensive understanding of developments in the field of prefabricated construction, it is important to distinguish conceptually between modular construction and the broader category of prefabrication. While modular construction involves the preassembly of entire three-dimensional room modules, prefabrication refers to the factory production of individual building components such as walls, ceilings, or façades, which are then assembled on-site. Modular construction is thus a specialized form of prefabrication with a higher degree of preassembly.

The number of building permits in Germany has recently declined. In 2024, only 215,900 residential units were approved, marking the lowest level since 2010 and falling far short of the German federal government's previously announced target of 400,000 approved housing units per year.<sup>20</sup> Building permits for commercial and warehouse buildings have also recently declined.<sup>21</sup>

<sup>&</sup>lt;sup>17</sup> Coalition Agreement, 2025.

<sup>&</sup>lt;sup>18</sup> Federal Statistical Office of Germany, 2025 A.

<sup>&</sup>lt;sup>19</sup> Federal Statistical Office of Germany, 2025 B.

<sup>&</sup>lt;sup>20</sup> Note: The data on approved residential units refers to the total number across all construction methods. A separate recording of purely modular residential buildings is not currently conducted in official statistics. As a result, the actual number of approved modular construction projects can only be approximated through individual research or project registries.

<sup>&</sup>lt;sup>21</sup> Federal Statistical Office of Germany, 2025 C.

# 1.4.1 Building Permits for Non-Residential Buildings

The data on non-residential buildings (NRBs) from 2019 to 2024 shows varied developments, as illustrated in Figure 4:

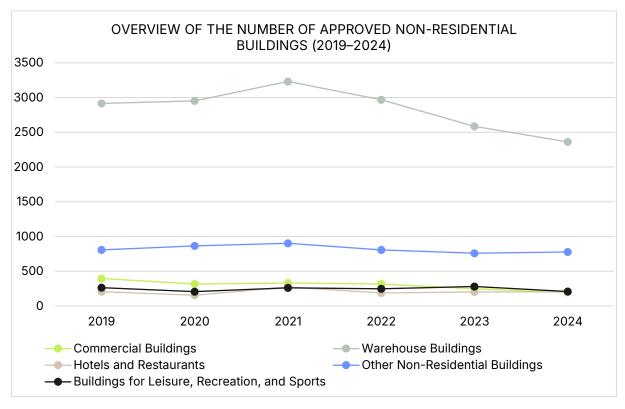


Figure 4: Overview of Approved Non-Residential Buildings

Source: Own illustration, based on Destatis

Retail buildings experienced a significant decline of -50.63% between 2019 and 2024 (from 395 to 195 buildings), which may be attributed to the ongoing shift toward online retail. Warehouse buildings saw a moderate decline of -18.97% over the same period (from 2,915 to 2,362 buildings), despite the increasing demand for logistics. While buildings for leisure, recreation, and sports recorded an overall decrease of -20.61%, and hotels and restaurants showed a minimal decline of -0.98% from 2019 to 2024, interesting dynamic trends emerged within this timeframe.

# 1.4.2 Building Permits for Residential Buildings and Housing Complexes

When examining the development of residential buildings and housing complexes, which are also categorized under the broader term of prefabricated construction, a mixed picture emerges for the period from 2020 to 2024 (see Figure 5).



Figure 5: Approved Prefabricated Modular Buildings, Residential

Source: Own illustration, based on Destatis

The underlying data for approved residential units covers the period from 2020 to 2024. Residential buildings experienced a sharp decline in approvals, dropping by -49.39% from 24,570 buildings in 2020 to just 12,435 buildings in 2024. In contrast, housing complexes showed positive growth, with an increase of +35.71%—rising from 56 buildings in 2020 to 76 buildings in 2024. This highlights a clear trend indicating that modular construction methods are particularly prominent in schools, daycare centers, refugee and emergency accommodations, and increasingly in residential construction, especially for housing complexes.<sup>22</sup> The increase in housing complexes could be a strong indicator of growing acceptance and application of modular construction methods in this specific segment.

In the area of single-family and two-family homes, the prefabrication rate reached 26.1% in 2024 (+1.6 percentage points compared to 2023). This means that more than one in four newly approved single-family homes in Germany is now being built using prefabricated construction methods. The share of modular and serial construction in multi-family housing construction stood at 8.2% in 2024, up from 7.0% in the previous year. This confirms the trend that there is still significant potential for modular construction, particularly in residential buildings with greater height and multiple stories.<sup>23</sup>

The building permit analysis reveals that modular construction, as part of prefabricated building methods, operates within an overall challenging approval environment.

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<sup>&</sup>lt;sup>22</sup> Deutsche BauZeitschrift (DBZ) C (2024).

<sup>&</sup>lt;sup>23</sup> Schäfer, M. (2025).

However, it has shown moderate positive growth in specific segments, such as housing complexes and certain non-residential buildings (like hotels since 2020).

## 1.5 Introduction to Construction and Material Costs

Modular construction is characterized by significant cost-saving potential and generally offers cost advantages compared to conventional solid construction methods. This cost efficiency is based on several key factors: the standardization of processes and components, a high degree of prefabrication in controlled factory environments, shorter construction times on-site, and economies of scale in larger projects. However, the overall structure of construction and material costs is highly dependent on the specific construction method, the level of prefabrication, and the targeted sustainability objectives.

While modular construction presents an attractive alternative due to these advantages, project-specific challenges must also be considered, particularly during the planning phase. Modular construction requires increased planning intensity from the early stages of a project. Unlike conventional construction, where detailed decisions are often made in later project phases, modular construction necessitates key decisions regarding modular systems as early as performance phase 2 (preliminary planning). This includes decisions on grid layouts, typologies, technical systems, and the assembly of modules or elements. As a result, planning responsibilities are significantly shifted to the early stages, reducing flexibility for later design adjustments or variant comparisons.<sup>24</sup>

# 1.6 Cost Analysis: Steel, Concrete, and Timber Construction Compared

Modular and element construction utilizes a variety of structural materials, particularly timber, timber-hybrid, steel, and concrete. Timber and timber-hybrid solutions are considered especially sustainable and environmentally friendly, as they sequester  $CO_2$  and are primarily made from renewable raw materials.<sup>25</sup>

DIN 276 regulates the classification of construction costs into standardized cost groups (KG) to enable planning, comparability, and evaluation of construction projects. In the context of modular construction, the construction costs are composed of the so-called KG 300 and KG 400.<sup>26</sup> KG 300 includes the costs for the building structure, encompassing all load-bearing and space-forming components such as the structural framework,

<sup>&</sup>lt;sup>24</sup> Note:The HOAI distinguishes nine service phases (LPH). While LPH 1–3 primarily cover basic evaluation, preliminary design, and design planning, LPH 4–7 include approval planning, execution planning, and the preparation and participation in contract awarding. Modular construction often requires a binding decision as early as LPH 2, which complicates parallel market inquiries ("competitive benchmarking") compared to conventional procedures. Mosebach, S. (2025).
<sup>25</sup> Kleusberg, n.d..

<sup>&</sup>lt;sup>26</sup> Note: Construction costs, including basic structural work and technical installations with simple foundations (€500/m² GFA), as well as module costs including the roof (€1,940–2,335/m² GFA), PlanRadar (2023).

insulation, facade, basement, and roof. KG 400, on the other hand, covers technical building equipment, including electrical, heating, plumbing, and ventilation systems.<sup>27</sup>

However, timber construction, particularly in Germany, is associated with higher material costs, which is also reflected in modular construction. A key reason for this is the high prices and strict requirements for construction timber, such as those related to moisture content, load-bearing capacity, and fire protection.<sup>28</sup> This not only increases material costs but also raises requirements for processing and quality assurance.

For instance, the world's largest modular construction provider, Daiwa House, has deliberately (for now) refrained from using timber in Europe. Among the reasons cited are doubts about the long-term durability of timber (over 50 years), particularly due to osmotic processes, pest infestations, and moisture exposure, which can pose challenges under German environmental and climatic conditions. Instead, Daiwa House currently focuses on steel-based constructions in Europe, offering longer lifespans and lower maintenance requirements.<sup>29</sup>

This assessment is further supported by market data from ARGE e.V. (Working Group for Modern Construction): In recent years, Germany has faced a high proportion of timber affected by bark beetles, which has reduced the availability of high-quality construction wood.30 However, volatile commodities such as iron and steel also exert significant cost pressure on residential construction, especially during supply bottlenecks and periods of high demand. This can particularly impact modular production models, which are highly sensitive to such fluctuations.31 For investors and operators with a longterm investment horizon, these are critical factors influencing capital commitment and the evaluation of future maintenance and replacement investments.

Another major cost driver is the construction period and the associated interest expenses, as well as the demand for skilled labor. A balloon construction loan, which accrues linearly over 2.5 years, incurs higher interest costs compared to a comparable loan with a duration of only 1 or 1.5 years.

Element construction is based on the factory prefabrication of individual building components, such as walls, ceilings, or roof elements, which are then assembled on-site. While the high degree of prefabrication allows for a reduction in construction time compared to conventional methods, a significant portion of the work still takes place on the construction site.

Modular construction, on the other hand, takes this a step further: complete room units (modules) with installed building services, interior finishes, and façades are pre-produced in the factory. This enables an even higher degree of standardization and further

<sup>&</sup>lt;sup>27</sup> G&W Software AG, 2023.

<sup>&</sup>lt;sup>28</sup> Umweltbundesamt, 2020.

<sup>&</sup>lt;sup>29</sup> Okita, 2025.

<sup>&</sup>lt;sup>30</sup> ARGE eV, 2023.

<sup>31</sup> ARGE eV, 2023.

reduces construction time.<sup>32</sup> In addition to the interest savings from the shortened construction period, there is also a reduction in labor costs. Automated factory production, combined with a lower demand for skilled labor during on-site assembly, unlocks the greatest savings potential. However, a potential limitation lies in the utilization rate of automated production facilities. Low utilization rates necessitate higher cost allocation per product, which can distort cost evaluations of the different construction methods.

To provide clarity and guidance, the following table presents average cost estimates per gross square meter of living space for non-basement buildings, using the two most important system construction methods with their respective dominant building materials. Cost rates for handcrafted or industrial construction methods have been deliberately excluded, as these methods are primarily applied to custom and specialized buildings and are not competitive for the residential construction sector discussed here:

Table 2: Construction Cost Comparison of Element and Modular Construction Source: Own illustration

#### EURO/SQM GROSS RESIDENTIAL AREA WITHOUT BASEMENT OR UNDERGROUND PARKING

	3-4 Rooms	2 Rooms	1 Room	Hotel
SYSTEM ELEMENT CONSTRUCTION WOOD 2D	2,600	2,800	3,300	3,500
SYSTEM ELEMENT CONSTRUCTION CONCRETE 2D	2,200	2,400	2,800	3,300
SYSTEM ELEMENT CONSTRUCTION HYBRID 2D	2,400	2,700	3,200	3,300
SYSTEM MODULAR CONSTRUCTION WOOD 3D	3,000	3,000	3,100	3,200
SYSTEM MODULAR CONSTRUCTION CONCRETE 3D	2,900	2,900	3,100	3,200
SYSTEM MODULAR CONSTRUCTION HYBRID 3D	2,700	2,900	3,000	3,100

It is notable that the cost per square meter of living space in element construction is often significantly lower than in modular construction. This difference can likely be attributed to the higher degree of factory prefabrication and the integration of technical installations in modular construction, which are not required for many room types. Additionally, logistics and transportation costs are considerably higher in modular construction due to the transport of empty space within the modules. The previously

<sup>32</sup> Brauchli AG Luzern (o.J.).

mentioned factor of factory utilization may also play a role, as the general utilization of facilities at the time of cost assessment was relatively low.

When a basement is included (cost groups KG 300–400), the cost structure shifts accordingly:

In general, the following hypothesis can be made: the cost advantage of 2D or 3D systems depends on the room type. The more technical installations a room requires, such as bathrooms, kitchens, or built-in furniture, the more competitive factory-produced 3D modular systems become. In contrast, for simpler rooms with minimal installations, such as living rooms or children's rooms, 2D system elements are more advantageous due to their lower transport volume and faster on-site assembly.

Timber modular construction is significantly more expensive than steel modular construction and is often even costlier than traditional solid construction methods.

Another critical cost factor is labor costs. These include all trade-specific services, such as structural work, finishing, building services, façades, or interior installations, whether performed on-site or in the factory. According to industry data, this cost component averages between €700 and €900 per square meter of living space, regardless of the construction material.

Construction costs vary significantly depending on the provider and the construction concept. Key factors influencing these costs include the choice of material, the degree of prefabrication and automation, and regional cost differences, such as labor expenses.<sup>33</sup>

# 1.7 Interim Conclusion

Modular and element construction are increasingly establishing themselves as forward-looking building methods, offering a promising solution to pressing challenges such as rising construction costs and the shortage of affordable housing. The core principle—shifting significant value creation to the controlled environment of the factory—enables highly optimized and weather-independent production. This leads to significantly shorter construction times as well as greater planning and cost certainty.

The use of digital planning tools like BIM and advancing automation minimizes coordination errors, enhances execution quality, and reduces environmental impacts at the construction site.

Despite these efficiency advantages, modular construction requires particularly intensive and precise pre-planning, with key decisions about the system design needing to be made in the early stages. This fundamentally distinguishes it from conventional

<sup>&</sup>lt;sup>33</sup> Note: The prices shown are average values and should be understood as a guideline. Actual construction costs can vary significantly depending on the region, degree of prefabrication, level of equipment, and specific property characteristics.

construction and demands integrated, interdisciplinary collaboration as well as the consistent use of digital tools to fully realize the desired productivity gains.

In terms of materials, timber stands out for its sustainability benefits, such as CO<sub>2</sub> storage. However, it typically incurs significantly higher material costs compared to steel or traditional solid construction methods, a factor influenced by the availability of high-quality construction timber. Additionally, modular construction involves higher upfront investments due to industrial prefabrication, whereas costs in conventional projects are more evenly distributed across the construction phases.

Not every plot of land is suitable for modular construction. Optimal topography—especially rectangular and well-connected plots—is critical for efficient land use and the delivery of modules and elements. This can pose challenges in inner-city densification projects.

While the building permit process in Germany remains challenging overall, modular construction has shown positive niche developments, particularly in housing complexes and certain non-residential buildings. Early coordination with local building authorities remains essential, as many municipalities still have limited experience with this construction method.

In conclusion, while modular and element construction are not universal solutions for all building projects, they offer an attractive option for high-quality, efficient, and future-ready construction. With the right strategy, suitable project parameters, and competent partners, their potential can be successfully unlocked.

## 2 Modular and Element Construction Providers in the DACH Region

The market for modular and element construction is currently highly fragmented and difficult to navigate, dominated primarily by small and medium-sized enterprises. This market structure is reflected in the numbers: according to recent industry statistics, such as the Listflix company database, there are currently 103 manufacturers in Germany. The majority of these firms are micro-enterprises (64) and small businesses (29), while only 5 medium-sized and 5 large companies operate in this sector. Leading providers in the DACH region include ALHO and Kleusberg in Germany, Renggli AG and Condecta AG in Switzerland, and Kaufmann Bausysteme in Austria. Renowned timber construction specialists in the DACH region include companies such as Gropyus, LiWooD, NO-KERA, and TRIQBRIQ (see Chapter 2.1). In the field of concrete construction, notable players include Goldbeck with its process-optimized element system and Max Bögl with the Maxmodul. This selection of companies provides a representative overview of the

<sup>34</sup> Listfix. 2025.

<sup>&</sup>lt;sup>35</sup> Fortune Business Insights, 2025; Chik, 2024; Bauwelt, 2018.

diversity of modular construction in the DACH region and includes leading players with an international outlook.

# 2.1 Recommendations for Strategic Cooperation Partners

The use of modular and element construction for property development can, as previously mentioned, be particularly advantageous from a productivity perspective. To identify the right cooperation partner as an investor or developer, it is essential to define the objectives and necessary requirements (e.g., ESG standards) of the investment and to evaluate various criteria. These range from the degree of prefabrication to the choice of materials, references, costs, and regional considerations. Figure 6 illustrates these aspects:

Focus on Providers with High Prefabrication Depth & Planning Reliability

Companies offering fixed prices and reliable cost calculations through industrial production minimize investment risks

Leverage Sustainability as a Long-Term Investment Factor

ESG-compliant concepts utilizing renewable raw materials enhance access to subsidies and tax benefits

Maximize Economies of Scale with Standardized Modules

Providers focusing on optimized modules with high repetition rates reduce their long-term cost per unit

Incorporate Government Subsidy Programs

Investments in KfW40-QNG projects secure subsidies and tax deductions, making them particularly attractive for institutional investors

Consider Regional and Logistical Factors

Modular construction providers with inhouse production facilities or short supply chains offer time and, potentially, cultural advantages compared to imported systems

Figure 6: Criteria for Selecting a Modular Construction Company Source: Own illustration

# 2.2 Provider Selection in the DACH Region

To create the following provider matrix (see Table 3), a strategic selection of modular construction companies in the DACH region was made to offer a representative and well-founded overview of this still highly fragmented market. The providers compared here were selected based on several criteria to highlight their market-shaping roles, specialization in specific materials or usage types, and representation of the diversity of modular construction in the DACH region.

The selection includes leading players who are significantly shaping the modular construction market, some of whom also bring an international perspective. This targeted compilation enables a comprehensive and multidimensional insight into the different technologies, degrees of prefabrication, and cost structures within the modular construction market in the DACH region. The selected providers are objectively reviewed and analyzed in this whitepaper based on comparable criteria:

Table 3: Selection of Modular Construction Companies in the DACH Region Source: Own illustration

PROVIDER	LOCATION	CONSTRUCTION METHOD	SPECIAL FEATURES
ADK Modulbau GmbH	DE	Artisanal Modular Construction, Steel	Specializes in hospital construction, including fully equipped operating rooms
AH Aktiv-Haus GmbH	DE	System Modular Construction, Wood	General contractor for energy-autonomous modular homes, Cradle-to-Cradle certified, with modules produced externally
ALHO System- bau GmbH	DE	System Modular Construction, Steel	Highly industrialized production of steel modules, exceptionally durable and fire-resistant
Daiwa House Modular Europe	DE, NL	System Modular Construction, Steel	Internationally scalable, with in-house production facilities, part of the Japanese Daiwa Group
FH Finnholz GmbH & Co. KG	DE	Artisanal Element Construction, Wood	Focus on sustainable solid timber construction and multi-story buildings
Fuchs System- gebäude GmbH	DE	Artisanal Element Construction, Wood, Concrete	Hybrid high-rise construction, combining "wood and concrete"
Goldbeck GmbH	DE	System Element Construction, Concrete	Nationwide branch network in Germany, so- phisticated processes, and coordinated sys- tems, highly efficient
GROPYUS AG	DE, AUT	System Element Construction, Wood	Each building includes a digital twin, with a strong focus on automated prefabrication and "expandable weather-protection tents"

Hasslacher Hol- ding GmbH	DE, AUT	Artisanal Element Construction, Wood	With the "NORICA TIMBER" brand, the Hasslacher Group specializes in customized timber products
Kaufmann Bausysteme GmbH	AUT	System Modular Construction, Wood	Operates with three module types for various applications
Kleusberg GmbH & Co. KG	DE	System Element Construction, Arti- sanal Modular Construction, Wood, Steel, Con- crete	General contractor with over 34,000 own rental units
Lechner Cube Holzmodulbau GmbH	DE	System Modular Construction, Wood, Concrete	90% prefabricated wood and concrete mod- ules produced at the Bayreuth and Uehlfeld lo- cations
Leipfinger-Ba- der GmbH	DE	Monolithic Construction	Only provider using monolithic brick construction; field factories can be set up directly onsite
LiWooD AG	DE	Artisanal Modular Construction, Wood	Technical integration with a focus on turnkey wood-hybrid solutions
Max Bögl Modul AG	DE	System Modular Construction, Con- crete	Very high, partially automated prefabrication level for stackable concrete modules
NOKERA AG	CH, DE	System Element Construction, Wood	Digitized process chain with a high degree of automation and very high production capacity (up to 30,000 housing units per year)
Nordic Homes GmbH	DE	Artisanal Modular Construction, Wood	100% prefabricated modules; cost-efficient due to production in Latvia
OIKOS Group GmbH	DE	System Modular Construction, Wood	Highly automated production of wall and ceiling modules for various house types up to GK3
Renggli AG	CH, DE	System Element Construction, Wood	Pioneer in ecological timber construction, using weak or damaged wood, marketed in Germany under the brand Timpla
Rhomberg Wood-Rocks Bau GmbH	AUT, DE	Artisanal Element Construction, Wood	Offers tailored solutions in wood-based modular construction for different applications
TRIQBRIQ AG	DE	Artisanal Modular Construction, Wood	System made from compressed wooden blocks using weak wood, fully recyclable
Ed. Züblin AG, Moleno	DE	System Element Construction, Wood, Concrete	Combines traditional construction expertise with industrially prefabricated wall and ceiling elements

# 2.3 Criteria Catalog

To identify the right partner for modular construction, a thorough evaluation of various criteria is essential. This criteria catalog serves as a comprehensive decision-making tool, highlighting the key aspects to consider when selecting a suitable modular construction company in the DACH region. These criteria range from the degree of prefabrication and materials used to costs, references, and regional as well as logistical factors.

Degree of Automation: Refers to the proportion of machine- or digitally-controlled processes and the use of robotics in prefabrication. A high degree of automation results in lower error rates, predictable costs, and optimized production cycle times particularly crucial for scaling and serial production.

In-House Production vs. Outsourcing: Indicates whether the provider operates as a general or total contractor, managing planning, production, and construction execution internally. A higher in-house production share can lead to better quality assurance, reduced interface risks, and greater schedule reliability—key aspects for institutional investors. The term "carve-out" is used when business units have been spun off.<sup>36</sup>

General Contractor (GU) vs. Turnkey Contractor (GÜ) vs. Total Contractor (TU): A General Contractor (GU) undertakes the pure execution and performs all construction work itself. A Turnkey Contractor (GÜ), however, does not carry out any construction work but assigns all services to subcontractors. They organize the project, coordinate the individual companies, and monitor their work.<sup>37</sup> The Total Contractor (TU) is responsible for the entire construction project—from planning to execution. They serve as the sole contractual partner for the client.<sup>38</sup>

Degree of Prefabrication: In serial construction, the majority of value creation takes place in the production hall. Components or entire modules are manufactured there rather than on-site. The higher the degree of prefabrication, the faster construction can proceed, and the more consistent the quality becomes. The companies analyzed in this whitepaper demonstrate a prefabrication degree ranging from 70% to 100% (see Table 3).

Certifications: Information on existing environmental, quality, or energy certifications (e.g., KfW 40, QNG, ISO 9001, PEFC, DGNB). These certifications not only enhance ESG compliance but also facilitate eligibility for public funding programs and serve as a quality benchmark for investors.

The following matrix serves as an additional decision-making tool to determine which system is best suited for a specific application. The checkmarks at the respective intersections indicate a particularly high suitability of the respective construction system for a building type. For example, 2D concrete system element construction and 3D steel

<sup>37</sup> Ibau, n.d. <sup>38</sup> Implenia, 2025.

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<sup>&</sup>lt;sup>36</sup> Natuvion, 2025.

and concrete modular construction are highly suitable for standard residential buildings with an average apartment size of 60 square meters and an energy standard of 55:

Table 4: Decision Matrix Source: Own illustration

	System element con- struction Timber 2D	System element con- struction Concrete 2D	System element con- struction Hybrid 2D	System modular con- struction Timber 3D	System modular construction Concrete 3D	System modular con- struction Steel 3D	Other element construction Timber 2D	Other element construction Concrete 2D	Other element construction Hybrid 2D	Other modular con- struction Timber 3D	Other modular con- struction Concrete 3D	Other modular con- struction Steel 3D
Standard residential construc- tion, 60 sqm avg., EH55		~			~	~						
Standard residential construction, 60 sqm avg., EH40	~	~	~		~	~						
Standard residential construc- tion, 60 sqm avg., EH40 with QNG	<b>~</b>		~	~								
Individual residential construction, 60 sqm avg., EH55							~	~	~			
Individual residential construction, 60 sqm avg., EH40							~	~	~			
Individual residential con- struction, 60 sqm avg., EH40 with QNG							~		~			
Apartment building, 2 rooms, EH55		~			~	~						
Apartment building, 2 rooms, EH40		~	~	~	~	~						
Apartment building, 2 rooms, EH40 with QNG	~		~	~		~						
Apartment building, 1 room, EH55					~	~					~	~
Apartment building, 1 room, EH40				~	~	~				~	~	~
Apartment building, 1 room, EH40 with QNG				~		~				~		~
New-build hotel				~	~	~				~	~	~

New-build hospital									~	~
New-build school			~	~			~	~	~	~
New-build daycare center			~	~	~		~	~	~	~
Office-to-residential conversion					~		~	~		
Refurbishment	~	~			~	~	~			

#### 3 Conclusion

The market for modular and element construction offers investors attractive opportunities through shortened construction times and potential cost advantages over conventional building methods. At the same time, providers vary significantly in terms of cost structures, construction speed, and sustainability profiles. Therefore, selecting a suitable modular construction company requires careful consideration of both economic factors and requirements for sustainability, durability, and architectural quality. There is no universal standard solution; instead, different provider profiles and typologies can be identified.

A key takeaway is the need to rethink construction processes with modular possibilities in mind. The potential of modular construction is far from fully realized if the approach merely involves integrating modules or elements into existing construction processes. Instead, construction processes must be redefined to leverage modular capabilities. For system modular or element construction, potential remains untapped if manufacturers are expected to calculate prices for pre-existing designs. These systems only achieve their full effectiveness when manufacturers are provided with basic parameters like building dimensions and a room program, allowing them to design using their BIM and AI systems.

As an analogy, consider a car buyer: they do not go to a car manufacturer with a construction blueprint to have their car built. Rather, they compare manufacturers' offerings and order the product that best suits their needs, which is then delivered on time, defect-free, and at the agreed price.

On the other hand, if existing designs are to be priced, handcrafted products may be more competitive than conventional construction. Industrial products, however, offer advantages in standardized mass applications such as temporary accommodations or school buildings.

In conclusion, the highly fragmented market for modular construction holds significant potential for consolidation, economies of scale, and efficiency improvements. Further interesting developments can be expected in this space.

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