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ADVANTAGES AND DISADVANTAGES OF MODULAR HOUSING (A SYSTEMATIC ANALYSIS)

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Abstract: This article examines the role of modular housing within contemporary construction systems and provides a systematic analysis of its advantages and disadvantages. The study highlights the key strengths of modular construction—such as speed, economic efficiency, and environmental safety—alongside its limitations, including design constraints, transportation issues, and aesthetic challenges. Practical opportunities for implementing modular housing and prospects for its future development are also discussed.
Keywords: modular housing, prefabrication, modern construction, technology, systematic analysis, advantages, disadvantages.

Introduction.

In recent years, modular housing has rapidly advanced within the construction industry amid globalization, economic demand, and accelerated urbanization. With this technology, houses can be produced in a short timeframe, at relatively low cost, and with high precision. Modular homes additionally offer significant benefits such as energy efficiency, ease of assembly, and seismic resistance.

However, modular technologies are not limited to positive aspects alone. They also involve challenges related to structural design, thermal performance, transportation logistics, design flexibility, and regulatory frameworks. To enable large-scale adoption, it is essential to systematically analyze both the advantages and limitations of modular housing.

Methods.

The research was carried out using the following methods:

- **Systematic analysis** – advantages and disadvantages were grouped and evaluated based on structural, economic, environmental, climatic, and technological criteria.
- **Comparative analysis** – modular housing was compared with conventional construction.
- **Study of international practices** – experiences from the United States, Japan, South Korea, Türkiye, and Kazakhstan were analyzed.
- **Regulatory and legal analysis** – gaps in standards and requirements related to modular construction were examined.

Discussion and Results.

Systematic analysis demonstrates that the advantages of modular housing provide a strong foundation for viewing it as a construction technology of the future. Fast assembly, energy efficiency, precise manufacturing, and economic benefits offer significant competitive advantages. However, transportation challenges, dimensional limitations, thermal-bridge issues at connection points, and the underdeveloped regulatory framework hinder widespread adoption of modular technologies.

The findings indicate that the highest performance is achieved when modular houses are adapted to local climatic conditions—specifically, when insulation, ventilation, façade systems, and foundation solutions are appropriately designed.

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Below, the advantages and disadvantages of modular housing are presented systematically across five main categories.

From a structural standpoint, the advantages and disadvantages are presented in **Table 1**.

Table 1

No.	**Advantages**	**Disadvantages**
1	Rapid assembly	Dimensional limitations
2	High geometric precision	Transportation constraints
3	Lightweight structure	Heat loss at connection joints
4	Seismic resistance	Sound transmission
5	Possibility of disassembly and relocation	

Advantages:

1. Rapid assembly – modular houses can be installed within 10–30 days.
2. High geometric precision – factory production ensures an accuracy of ±1 mm.
3. Lightweight structure – reduced load on the foundation.
4. Seismic resistance – modules act as rigid frames, effectively distributing seismic forces.
5. Disassembly and relocation capability – if necessary, the house can be moved to another location (Table 1).

The structural advantages of modular houses are primarily linked to the production technology. Since these buildings are manufactured with high precision in factory conditions, the strength and dimensional accuracy of each structural component are better controlled compared to conventional construction methods. Modules are assembled on steel frames or durable composite materials, which enhances the overall stability of the structure. Their lightweight nature reduces foundation loads, thereby lowering foundation construction costs.

Another key advantage is their earthquake resistance. When modules are interconnected, the loads are evenly distributed across the entire system, allowing the building to withstand dynamic forces. This makes modular structures safer than traditional buildings in seismically active regions. Furthermore, since critical joints are pre-tested during manufacturing, the likelihood of deformation during operation is significantly reduced.

Modular construction also accelerates the building process. Prefabricated blocks are transported to the site and assembled rapidly, with minimal dependence on weather conditions, as most work is completed indoors beforehand. The high degree of factory precision ensures that modules fit together seamlessly, reducing errors during installation.

Materials used in modular construction are protected from moisture, extreme temperatures, and external environmental factors during production. As a result, weather conditions such as rain, cold, heat, or dust do not negatively affect material quality. This contributes to the long-term durability, functionality, and environmental performance of modular houses.

Disadvantages:

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1. Dimensional limitations – modules are generally restricted to 2.5–4 meters in width.
2. Transportation constraints – transporting large modules can be difficult and expensive.
3. Heat loss at joints – "thermal bridges" may form at frame connections.
4. Potential sound transmission – especially if insulation is insufficient.

Despite their numerous advantages, modular houses also present certain structural limitations. Most importantly, their dimensions are constrained by factory capabilities and transportation standards. Module length, width, and height must comply with logistical requirements, which may restrict complex architectural designs or unique project specifications.

Transportation and installation also pose challenges. Delivering completed modules requires specialized trucks and sometimes heavy-lifting cranes. In regions with poorly developed road infrastructure, transportation costs can be high or the process may be infeasible. Additionally, modules risk deformation during transport, potentially requiring adjustments during assembly.

Another structural drawback is the presence of connection joints between modules. If these joints are not properly assembled or adequately insulated, thermal losses, sound transmission, or moisture accumulation may occur. Moreover, the project must be designed with high precision; even small inaccuracies can slow down the entire assembly process.

Modular systems also offer less flexibility in interior planning compared to traditional buildings. Because frame elements are pre-positioned, relocating walls or adding openings for doors and windows can be difficult, limiting future renovation or redesign options.

Furthermore, performance indicators such as fire resistance, thermal retention, and acoustic insulation depend heavily on manufacturer quality. Poor production practices can result in faster deterioration or reduced structural stability over time, increasing maintenance costs.

Overall, the structural disadvantages of modular houses stem from technological constraints, logistical challenges, and the need for highly precise design. However, with proper manufacturing quality and skilled installation, many of these limitations can be minimized.

From an economic standpoint, the advantages and disadvantages are presented in **Table 2**.

Table 2

No.	Advantages	Disadvantages
1	Fast construction	Initial investment may be relatively high
2	Minimal material waste	Transportation costs may offset affordability
3	Lower unit cost with large-scale serial production	Prices remain high in regions where the local market is underdeveloped
4	Low operational (maintenance) costs	

From the perspective of energy efficiency, the advantages and disadvantages are presented in **Table 3**.

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No.	Advantages	Disadvantages
1	High thermal insulation performance	If insulation quality is poor, the house

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		heats up or cools down quickly
2	Good airtightness	The metal frame may create thermal-bridge effects
3	Easy to implement ventilated façade systems	Improperly designed ventilation can lead to condensation
4	Easy integration with solar panels	

The architectural and design aspects are presented in **Table 4**.

Table 4

No.	Advantages	Disadvantages
1	Unlimited combinations of modules	Dimensional constraints limit architectural freedom
2	High flexibility in interior planning	If assembled incorrectly, the exterior may appear “block-like”
3	Wide range of façade options	In some countries, building codes do not fully recognize modular houses as conventional dwellings

The environmental aspects are presented in **Table 5**.

Table 5

No.	Advantages	Disadvantages
1	Low construction waste	Some modules contain chemically intensive materials
2	Low energy consumption	If production facilities lack environmental oversight, negative impacts may increase
3	Factory manufacturing enables stronger environmental control	
4	Possibility of reuse and relocation	

Conclusion.

1. Modular houses demonstrate structural, economic, and environmental advantages that significantly surpass those of traditional construction.
2. The major drawbacks include transportation challenges, dimensional constraints, and thermal-bridge formation at connection points.
3. When proper insulation and installation technologies are applied, the energy efficiency of modular homes can increase by **30–40%**.
4. In Uzbekistan, the key benefits of modular housing are rapid construction, seismic stability, and low operational costs.

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5. For modular homes to become one of the leading construction approaches in the future, improvements in regulatory frameworks, development of local manufacturing, and advancements in transportation logistics are essential.

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