



Why Modular?

Accelerate construction timelines, save money & reduce environmental impact.

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Simply put, modular construction is an accelerated method of construction where a building is constructed of modules that are prefabricated off site in specialized manufacturing facilities under controlled environments. The pre-engineered modular units are then transported from the factory to the site, and then installed as fitted out and finished building blocks.

The modular units may be room-sized, or they may be parts of larger spaces which are combined together to form complete buildings. Steel, wood or concrete are an integral part of modular construction, and are used as the internal framework of the units to which a variety of cladding and finishes may be attached. The framework is sufficiently stiff and robust that it protects the internal finishes against damage during transportation and lifting into place.

When completed, permanent modular buildings cannot be distinguished from traditional or conventionally built structures.

Three common motivations for using modular construction generally arise because the client wants:

1. Speed of construction
2. Improved quality
3. An earlier return on investment

There is a noticeable trend to use modular construction in where speed of construction is allied to economy of production scale, and to reduce disruption in congested inner city sites. Increasingly, construction is seen as a disruptive operation, which affects neighboring properties and the road network. Modular construction reduces the time onsite, is much less noisy and produces negligible waste. These benefits may be quantified in a holistic assessment of the costs and value of modular construction in relation to more traditional alternatives.

Overview

The application of modular construction is most economical in the repetitive production of a large number of similar units where the economy of scale can be realized. Modular bathroom pods, elevators, service plants etc. can also be introduced into otherwise conventional buildings. The sizes of modular units are dictated by the economics of transportation, and units up to 14-feet wide and 70-feet long can be supplied. Units can also be provided with open sides to create larger internal spaces. All modular buildings are designed to be permanent in terms of compliance with Building Regulations, although they can be—by definition—relocatable and reusable.

Both speed of construction and improved quality create business-related benefits to the client by early return on capital invested, or less down time in use of existing facilities in building expansions. Quality implies fewer callbacks and warranty problems.

The general benefits of modular construction may be expressed as those to the client, the contractor and to society in general. The economic benefits to the client can be calculated relatively easily, depending on the business-related costs. In renovation applications, modular units can extend the life of the existing building and can improve the quality of life for the users.

Adoption and Usage

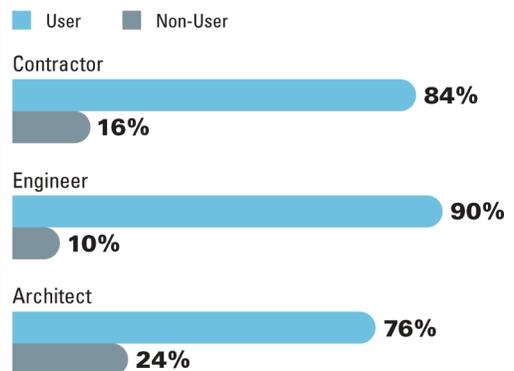
Prefabrication and modular building processes are not new activities—63% of those that are using these processes have been doing so for five years or more.

By 2013, nearly all players (98%) expect to be doing some prefabrication/modularization on some projects. Over the next two years, usage on projects is expected to grow moderately, with high or very high usage reaching 45% by 2013.

Among all players surveyed, the highest level of current and future usage is among fabricators, mechanical contractors and design-builders.

Percentage of Prefabrication/Modularization Users Today (2011)

Source: McGraw-Hill Construction, 2011

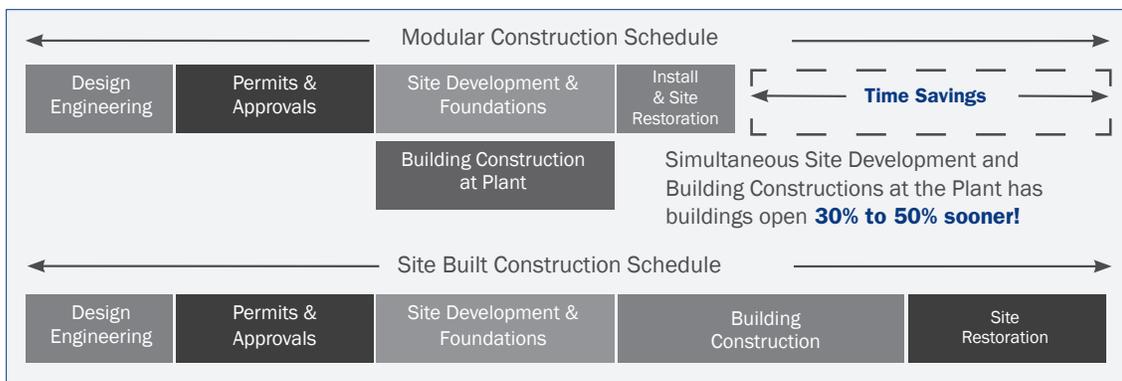


The (6) Key Benefits of Modular Construction

1. Accelerated Construction

The major advantage of modular technology is accelerated construction. When compared to traditional site built construction, the time savings could be as high as 50%. This varies from project to project but if we examine a conventional construction schedule, we see the traditional design and construction activities occurring in a sequential manner. In modular construction time savings are realized as a result of the concurrent activities of site preparation and offsite building construction.

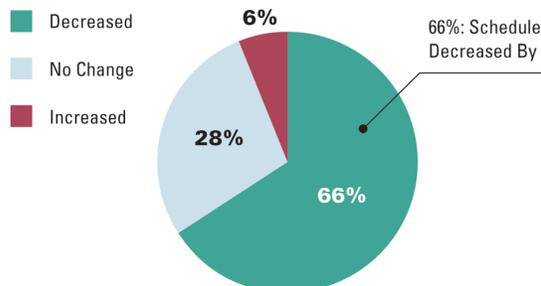
This allows earlier occupancy of a building and faster revenue generation that leads to a higher ROI.



A shorter project schedule is the most commonly reported productivity benefit of modularization, as well as the one with the largest reported payback. Two-thirds of firms who currently use modularization experience reduced project schedule, with 35% experiencing decreases of four weeks or more. Prefabrication can yield time savings through the ability to conduct work simultaneously onsite and offsite, as well as helping with better coordination among different trades. In addition, less onsite staging, such as scaffolding, is frequently involved. Regionally, the ability to avoid severe weather can reduce construction delays. Site conditions factor significantly in the ability of prefabrication to impact schedule. Additional time may be spent in the design phase on complex projects to coordinate the use of prefabrication and modularization. However, the time saved onsite typically reduces the overall project schedule.

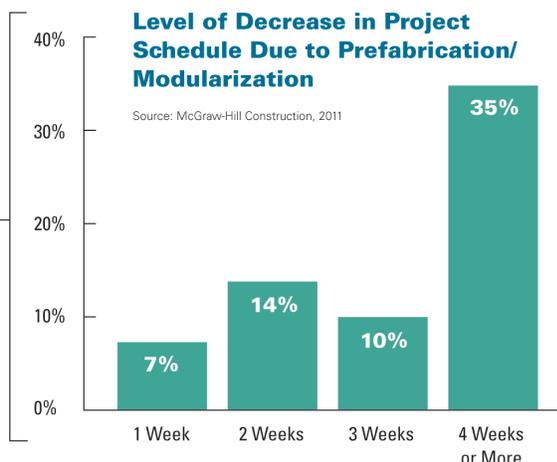
Total Impact of Prefabrication/Modularization on Project Schedule

Source: McGraw-Hill Construction, 2011



Level of Decrease in Project Schedule Due to Prefabrication/Modularization

Source: McGraw-Hill Construction, 2011



2. Cost Savings

Since construction onsite is both labor-intensive and expensive, time savings can yield significant cost savings as well. Modular construction can also provide critical assistance with scheduling in-market sectors where project deadlines are frequently inflexible. Also, for buildings on active sites, like a new building in a hospital complex, a reduced schedule minimizes the impact on the rest of the business.

The cost saving due to speed of construction onsite may be quantified as follows:

Reduced project overhead

Typically site general conditions are estimated as 8 to 15 % of the total construction cost. Therefore, a 50% reduction in time onsite can lead to a commensurate saving in general conditions and overhead cost to the contractor.

Lower labor cost

Since the majority of the building is constructed offsite in a plant, significant cost savings can be realized when onsite labor rates are dictated by historically higher labor rates, union or Davis-Bacon wages.

Earlier return on investment to the client

This benefit depends on the business operation, but the minimum level of this benefit is the saving in interest charges on the cost of the land and the average construction cost over the reduced construction period. The maximum level of this benefit is the earning potential of the building when in early operation.

Loss of the earning potential of the existing facility

This is a real cost to the client that occurs particularly where existing buildings, such as hotels, are extended or modified. A reduced construction period will lead to commensurate savings to the client.

Construction financing and other soft costs are lower

Construction financing is lower for modular because the construction cycle is up to 50 percent less than the time required to construct a conventional building. This shorter financing period results in lower financing costs and fewer draws from the bank. Builders' risk insurance can be lower as well due to the shortened construction time frame.

Modular costs are fixed

The risk of extra charges, back charges and surprise costs is typically significantly reduced since the majority of the building is fabricated offsite in a controlled environment eliminating typical risk factors encountered onsite, such as weather, labor challenges and unforeseen conditions, that affect overall project cost and schedule.

Modular units can be paid for as needed

Once plans are completed, modular units can be ordered one at a time and then set as they sell, committing to each group of units as the market allows rather than building an entire project and hoping sales will occur.

Lower construction cost in inner cities

According to a recent study by the *When We Fix it Coalition*, a non-profit group of builders, architects and engineer for the City of Philadelphia, the average cost savings for building a 16-foot-wide row-home using modular construction in a major city was 20%, reducing the cost by \$32 per square foot. The average cost savings for a 20-foot-wide row-home using modular construction was 9%, reducing the cost by \$12 per square foot.

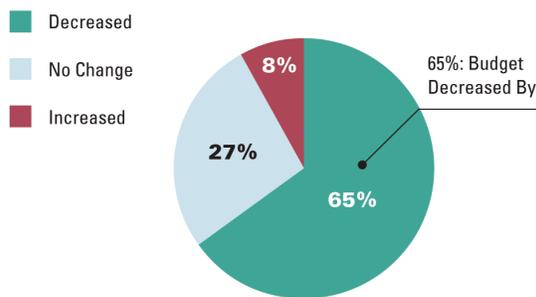
65% of firms who currently use modularization report that it reduces their project budget. Construction work often has tight profit margins, so even relatively small reductions in cost can make a measurable impact on the firms involved.

While prefabricated materials can cost less, in general the cost savings are due to secondary issues, such as reduced reliance on expensive onsite labor, the ability to avoid overtime pay and other unexpected labor costs, and the ability to reduce onsite resources required. With labor offsite, even basic site support facilities like portable toilets can be reduced.

According to the McGraw Hill Construction report “Prefabrication and Modularization: Increasing Productivity in the Construction Industry” budgets for traditional construction projects are infamous for their increases due to change orders during the construction process. Even when prefabrication appears to be slightly more expensive at the outset, the avoidance of unexpected costs during the process is valuable, especially for owners with inflexible budgets like those in the public sectors. This reliability increases in value when combined with the guaranteed, high-quality workmanship also offered by prefabrication/ modularization.

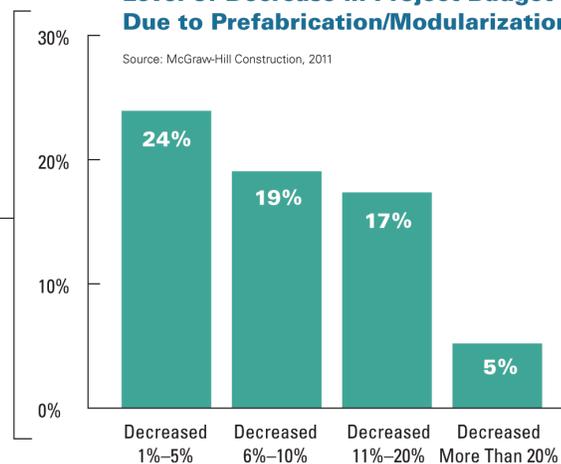
Total Impact of Prefabrication/Modularization on Project Budget

Source: McGraw-Hill Construction, 2011



Level of Decrease in Project Budget Due to Prefabrication/Modularization

Source: McGraw-Hill Construction, 2011



3. Quality

Because the modular structure is substantially completed in a factory-controlled setting, it offers the ability to conduct extensive quality control checks on each piece produced. Prefabricated concrete, for example, can avoid the imperfections frequently found in concrete poured onsite. The lack of exposure to the elements also increases the quality, as does the ability to fabricate in factory conditions rather than on ladders or from scaffolding. Using dry materials can avoid the potential for high levels of moisture being trapped in new construction. In addition, offsite trials can be carried out to prove the system before installation. Temperature-controlled and well-lit manufacturing plants offer productive environments for workers when compared to the variability of outdoor site conditions. In addition, standardized manufacturing and prefabrication systems and allow for streamlined processes that contribute to more efficient and predictable QA/QC program.

A report from the American Institute of Architects (AIA) titled “External Issues & Trends Affecting Architectural Firms, and the AIA” from February 2008 was prepared because “The AIA wants to keep abreast of elements that are known to impact or that may in the future have an impact on the architecture profession and the American Institute of Architects.”

The report states:

“The life expectancy of modular construction is the same as conventional, and in a world where sustainability is gaining momentum each day, there are also several basic principles intrinsic to the modular construction process that make it more eco-friendly than conventional construction. They spend significantly less onsite time, a result of a shortened construction cycle, (the outcome of the simultaneous activities of onsite development and offsite building construction), notably minimizes the overall impact on a site. And finally, modular construction methods and materials allow a building to be more readily “deconstructed” and moved to another location should the need arise, so complete building reuse or recycling is an integral part of the design technology.

“After Hurricane Andrew hit in 1992, FEMA’s Mitigation Assessment Team conducted a study to see how various building types weathered the storm. The team concluded that “overall, relatively minimal structural damage was noted in modular housing developments. The module-to-module combination of the units appears to have provided an inherently rigid system that performed much better than conventional residential framing.”

65% of firms who are not currently using prefabrication or modularization expect them to have at least a medium impact on project quality. Quality of the materials is one of the major benefits of prefabrication. In owner surveys, even those who find no compelling cost benefit to prefabrication/modularization often choose to use it because of the dependable quality. As with budget, owner interviews also indicate that the reliability of the quality is an important factor in their decision.

One factor that may influence higher architect recognition of this benefit is that prefabrication may also allow the architect greater input into the final materials selected for the prefabricated component. While an architect can specify particular types of materials, contractors seeking a cost-effective project may select materials they think are comparable that cost less money. If prefabrication is included as part of an integrated project design process, the architect will have greater influence over the selection of the final products.

4. Safety

Even with the slowdown in overall construction, the fatality rate in the construction industry has remained constant. Improving safety continues to be a challenge industry-wide, which the benefits offered by prefabrication/modularization can help address. Modular construction is a safer alternative. Conventional construction workers regularly work in less than ideal conditions dealing with temperature extremes, rain, wind, or any combination of natural conditions. This, by its very nature, is a much more challenging environment to work safely in. Additionally, the potential for injury including falls, the most common work site risk, is much higher.

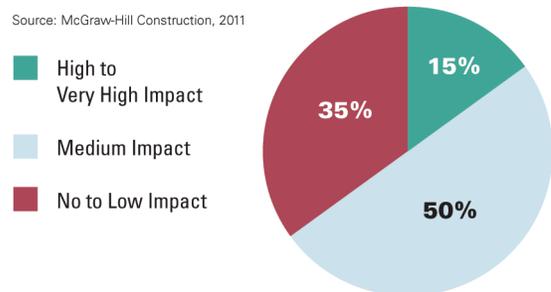
In a factory controlled setting, each worker is typically assigned to a work station supplied with all the appropriate equipment needed to provide the safest work environment possible. Offsite construction also eliminates the hazards associated with materials, equipment and an incomplete construction processes typical of construction sites that can attract curious and unwelcome “visitors” (i.e. students on a school expansion project). In addition, builders report lower rates of theft and vandalism on modular sites, since fewer materials need to be stored onsite. Also, modular buildings can be locked and secured as soon as they are put into place on the building site.

More than one third of the survey respondents (34%) who are currently using prefabrication/modularization find that they have seen site safety improve as a result. Reasons for this result may vary from site to site. But factors that contribute to increased site safety include reduced need for workers on scaffolding or ladders, as well as avoiding close work in tight spaces. However, 10% found that safety actually decreased. Prefabricated pieces are frequently large, and the approach to their installation needs to be carefully considered to avoid a negative impact on overall site safety.

Not surprisingly, the percentage of contractors reporting site safety increases (37%) and site safety decreases (12%) were significantly higher than design firms. Contractors are more likely to bear the financial and legal responsibility for site safety than design firms.

Impact of Prefabrication/Modular Construction on Improving Project Quality (According to Non-Users)

Source: McGraw-Hill Construction, 2011



5. Environmental

The main environmental benefits during the construction operation are derived from the shorter construction period, which lessens the impact on the local environments. Waste is drastically reduced because of efficient factory production, and the reduced damage or use of packaging materials onsite.

There are other local environmental benefits of the construction operation, which are identified as follows:

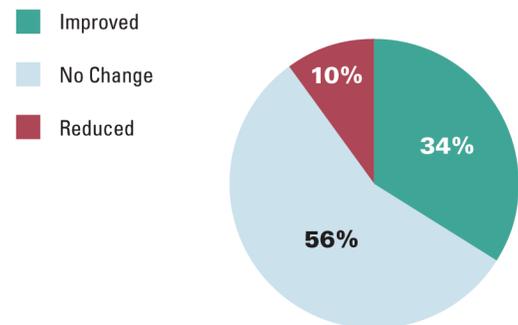
- Site installation of the modular units is a rapid and quiet operation that can be done “just in time”, with minimal requirement for site storage or additional noisy equipment.
- The delivery and installation of the modular units can be timed to observe any site working or road traffic constraints.
- The delivery of a large number of site materials is reduced.
- Less waste is created so dumping of material waste from a site is reduced to less than 30% of a conventional project
- Foundation excavation is minimized and there are fewer potentially wasteful site activities.
- Materials are used more efficiently, with considerable economy of use in production than is achievable onsite.
- Primary construction operations are less disruptive to adjacent or connected properties in terms of pollution, associated nuisance, etc.
- The constructability walls, floors and ceilings in modular units offer improved acoustical and thermal insulation between modules.

Modular buildings offer environmental benefits in reuse, as follows:

- Flexibility – When the needs change, modular buildings can be disassembled and the modules relocated or refurbished for their next use reducing the demand for raw materials and minimizing the amount of energy expended to create a building to meet the new need. In essence, the entire building can be recycled in some cases.
- Adaptability – Modular buildings are frequently designed to quickly add or remove one or more “modules” minimizing disruptions to adjacent buildings and surroundings.

Impact of Prefabrication/ Modularization on Site Safety

Source: McGraw-Hill Construction, 2011



Using offsite manufacturing processes can help the construction industry reduce waste, according to a report published by the U.K. group WRAP (Waste & Resources Action Programme). Offsite manufacture already offers the construction industry benefits in terms of time and cost predictability, health and safety and skills. However, this work shows that there is the potential to make a significant difference to the amount of waste the industry produces. Some of the biggest waste streams in traditional construction are packaging (up to 5%), timber (up to 25%) and plasterboard (up to 36%). Up to a 90% reduction can be achieved by reducing wastes such as wood pallets, shrink wrap, cardboard, plasterboard, timber, concrete, bricks and cement by increasing the use of offsite manufacture and modern methods of construction ([ModernMethodsConstruction_Report.pdf](#)).

The impact of construction on the environment is significant. The US EPA estimates more than 135 million tons of debris from construction sites end up in landfills in the U.S. each year. According to the industry, that waste can be effectively minimized through the use of prefabrication/modularization.

According to Current Users 76% of current users report that prefabrication/modularization decreases the amount of their construction site waste, with 41% reporting decreases of 5% or more. Not only are these gains environmentally beneficial, but they also are financially beneficial, with less waste translating to cost savings and higher ROI .

6. Efficiency & Productivity

Construction workers typically are exposed to high levels of noise, dust and airborne particles, adverse weather conditions, and other factors that can cause fatigue and injuries and thereby reduce efficiency and productivity. Manufacturing building components offsite provides for more controlled conditions and allows for improved quality and precision in the fabrication of the component. Modular technology makes it possible to optimize construction material purchases and usage while minimizing onsite waste and offering a higher quality product to the buyer. Bulk materials are delivered to the manufacturing facility where they are stored in a protected environment safe from theft and exposure to the environmental conditions of a job site.

One study that examined the relationship between changes in material technology and construction productivity based on 100 construction-related tasks found the following:

- Labor productivity for the same activity increased by 30 percent where lighter materials were used; and
- Labor productivity also improved when construction activities were performed using materials that were easier to install or were prefabricated (Goodrum et al., 2009).

Modular construction by nature is material and resource efficient. One of the great economies of modular construction is the ability to assemble repetitive units in controlled conditions. Another is to minimize material waste associated with conventional construction due to weather intrusion and construction site theft. Whole modular units—largely finished prior to arriving at the construction site—can significantly limit construction waste generated at the site and contribute directly to construction site waste management.

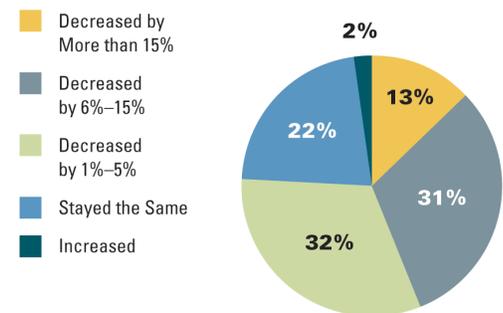
Modular construction capitalizes on the ability to move product in controlled manufacturing conditions, and on tight inventory control and project schedules. It is inherently waste conscious and can have minimum site impact if delivered carefully and strategically with respect to site constraints.

Other contributors to a more efficient and productive project include:

- Improved supervision of labor, easier access to tools, and fewer material deliveries
- Fewer job-site environmental impacts because of reductions in material waste, air and water pollution, dust and noise, and overall energy costs
- Compressed project schedules due to accelerated construction
- Fewer conflicts in work crew scheduling and better sequencing of crafts persons
- Reduced requirements for onsite materials storage, and fewer losses or misplacements of materials
- Increased worker safety through reduced exposures to inclement weather, temperature extremes, and ongoing or hazardous operations and better working conditions

Impact of Prefabrication/Modularization on Amount of Construction Site Waste

Source: McGraw-Hill Construction, 2011

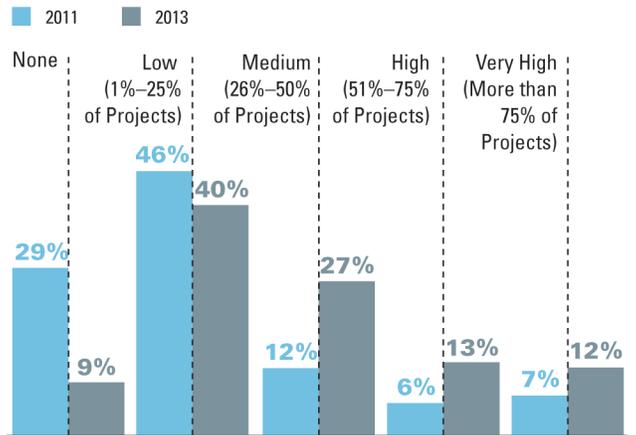


BIM

The increasing use of BIM also contributes to the potential for increased use of prefabrication and modularization. In a recent study about the use of BIM on green projects, McGraw-Hill Construction found that the use of BIM model-driven prefabrication on more than one quarter of their projects is expected to increase from 37% to 73% among practitioners who use BIM for green work. Even those who are currently not using green BIM expect an increase from 22% to 57%. BIM helps enable prefabrication of tightly integrated MEP systems, allowing designers to maximize space for other uses in high-tech buildings like hospitals.

Use of Model-Driven (BIM) Prefabrication (by Percentage of Respondents)

Source: McGraw-Hill Construction, 2011



Modular & Sustainability

After reviewing the key attributes of modular construction, it's evident that its techniques have been are inherently green in 7 major areas:

1. Less Materials Waste
2. Less Material Exposure to Inclement Weather
3. Less Site Disturbance
4. Safer Construction
5. Flexibility
6. Adaptability
7. Built to Code With Shorter Build Times

Why Modular?

Accelerate construction timelines, save money & reduce environmental impact.

References & Resources:

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- Current Practices and Future Potential in Modern Methods of Construction – published by Waste & Resources Action Programme, The Old Academy, 21 Horse Fair, Banbury, Oxon OX16 0AH



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