Prefabrication & Modularization:
Impact on Productivity in the Construction Industry

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Industry Insights & Alliances
Agenda

- Study Background
- Building Type Preference & Industry Outlook
- Areas of Prefabrication/ Modularization Use
- Respondent Profile and Levels of Use
- Non-User Opinions
- User Player Insights & Preferences
- Study Highlights: Productivity and Business Benefits
- Key Takeaways
Study Background
"As you can see, we have thought carefully about ways of improving staff productivity in this company."
Research Overview

Users vs. Non-Users
(Total = 809)

Contractors
(Total = 518)

- Users: 84% (436)
- Non-Users: 16% (82)

Engineers
(Total = 190)

- Users: 90% (171)
- Non-Users: 10% (19)

Architects
(Total = 101)

- Users: 76% (77)
- Non-Users: 24% (24)
Industry Trends

- Building Information Modeling (BIM):
- Green Building:

These trends are dramatically impacting industry processes!
Industry Trend Convergence
Impact on Prefab/Modularization

Green BIM Practitioners

Never
Low 25% or less of projects
Medium 26%–50% of projects
High 51%–75% of projects
Very high More than 75% of projects

Current/Future Use of BIM Model-Driven Prefabrication


Primary Reason Behind Use of BIM Model-Driven Prefabrication
(according to Green BIM Practitioners)


Green and BIM have a direct impact on industry productivity & business benefits!
Building Type Preference for Prefabrication/Modularization & Industry Outlook
Prefabrication / Modularization Currently Being Used on Many Types of Projects

Industry Sectors In Which Over One Third of Respondents Used Prefabrication / Modularization

- Healthcare Facilities: 49%
- College Buildings & Dormitories: 42%
- Manufacturing Buildings: 42%
- Offices Low Rise (1-4): 40%
- Public Buildings: 40%
- Commercial Warehouses: 37%
- Schools K-12: 36%

Respondents reported the least use on these project types:
- Transportation Buildings (14%)
- Garages & Service Stations (14%)
- Restaurants, fast food, convenience stores (16%)

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### Broad Range of Sectors Offer Opportunities for the Future

#### Top Sectors Ranked #1 for Use of Prefabrication/Modularization in Future

<table>
<thead>
<tr>
<th>Sector</th>
<th>Use of Prefabrication/Modularization (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthcare Facilities</td>
<td>12%</td>
</tr>
<tr>
<td>Commercial Warehouses</td>
<td>10%</td>
</tr>
<tr>
<td>Hotels &amp; Motels</td>
<td>10%</td>
</tr>
<tr>
<td>Manufacturing Buildings</td>
<td>7%</td>
</tr>
<tr>
<td>Offices High Rise (5+)</td>
<td>7%</td>
</tr>
<tr>
<td>Schools K-12</td>
<td>6%</td>
</tr>
<tr>
<td>Offices Low Rise (1-4)</td>
<td>6%</td>
</tr>
<tr>
<td>Multifamily</td>
<td>6%</td>
</tr>
</tbody>
</table>
Players Preferences of Building Types for Future Opportunities

**Architects: Top 3 Future Opportunities**
- Multifamily: 11%
- Schools K-12: 11%
- Hotels & Motels: 11%

Only Category in the top 3 for more than one player: **Hotels and Motels**

**Contractors: Top 3 Future Opportunities**
- Healthcare Facilities: 16%
- Hotels & Motels: 11%
- Offices High Rise (5+): 9%

**Engineers: Top 2 Future Opportunities**
- Commercial Warehouses: 15%
- Manufacturing Buildings: 13%

“Other” selected by 17% of Engineers, who cited data centers, industrial facilities, churches
# U.S. Total Construction Starts for 2011

## Billions of Dollars

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</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Construction</strong></td>
<td>641.3</td>
<td>555.7</td>
<td>421.7</td>
<td>-7%</td>
<td>-13%</td>
<td>-24%</td>
<td>-1%</td>
<td>+5%</td>
</tr>
<tr>
<td><strong>Single Family Housing</strong></td>
<td>201.2</td>
<td>122.4</td>
<td>94.3</td>
<td>-26%</td>
<td>-39%</td>
<td>-23%</td>
<td>+6%</td>
<td>+20%</td>
</tr>
<tr>
<td><strong>Multifamily Housing</strong></td>
<td>60.6</td>
<td>38.6</td>
<td>17.5</td>
<td>-13%</td>
<td>-36%</td>
<td>-55%</td>
<td>+14%</td>
<td>+24%</td>
</tr>
<tr>
<td><strong>Commercial Bldgs.</strong></td>
<td>100.9</td>
<td>81.6</td>
<td>46.8</td>
<td>+9%</td>
<td>-19%</td>
<td>-43%</td>
<td>-15%</td>
<td>+15%</td>
</tr>
<tr>
<td><strong>Institutional Bldgs.</strong></td>
<td>117.7</td>
<td>130.6</td>
<td>111.5</td>
<td>+6%</td>
<td>+11%</td>
<td>-15%</td>
<td>-4%</td>
<td>-2%</td>
</tr>
<tr>
<td><strong>Manufacturing Bldgs.</strong></td>
<td>20.8</td>
<td>30.0</td>
<td>9.7</td>
<td>+54%</td>
<td>+44%</td>
<td>-68%</td>
<td>-12%</td>
<td>+17%</td>
</tr>
<tr>
<td><strong>Healthcare</strong></td>
<td>24.4</td>
<td>29.9</td>
<td>20.2</td>
<td>+1%</td>
<td>+23%</td>
<td>-33%</td>
<td>+13%</td>
<td>+8%</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td>53.2</td>
<td>58.1</td>
<td>48.2</td>
<td>+7%</td>
<td>+9%</td>
<td>-17%</td>
<td>-5%</td>
<td>-2%</td>
</tr>
<tr>
<td><strong>Office</strong></td>
<td>32.7</td>
<td>27.7</td>
<td>20.1</td>
<td>+7%</td>
<td>-15%</td>
<td>-28%</td>
<td>-22%</td>
<td>+11%</td>
</tr>
</tbody>
</table>
2015 Offers Significant Opportunity for Green Building in New Non-Residential

Opportunity: Office Sector

U.S. Commercial Bldgs. -- Offices

Overall Office Construction plunged downward in 2008-2010 but on upward trend 2011-2012

Green Office Construction remains strong despite downturn

Office Buildings

Millions of Square Feet

$27 billion

$15 billion

$8 billion

30% of market

50% of market

2008

2010

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Opportunity: Education Sector

**U.S. Institutional -- Educational Bldgs.**

**Overall Education Construction** continues to lose momentum in 2011, but growth in 2012

**Green Education Construction** gains market share & opportunity

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**Education Buildings**

*Millions of Square Feet*

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**Green Education Construction** gains market share & opportunity

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**Opportunity: Healthcare Sector**

**U.S. Institutional -- Healthcare Buildings**

**Overall Healthcare Construction** fell sharply in 2009, stabilized in 2010.

**Green Healthcare Construction** shows strongest growth between 2008 and 2010.

*Graph showing healthcare buildings in millions of square feet from 1986 to 2012.*

*Bar graph comparing healthcare and green healthcare construction in billions of dollars for 2008 and 2010.*
Opportunity: Other Major Sectors

Hotel

Millions of Square Feet

Multi-Family Housing

Millions of Square Feet

Manufacturing

Millions of Square Feet

Warehouse

Millions of Square Feet
Areas of Prefabrication/Modularization Use
Prefabricated/Modular Building Elements Used by Largest Percentage of Respondents

- Exterior Walls
  - Architects – 68%
  - Contractors – 62%
  - Engineers – 71%

- MEP Building Systems
  - 48%

- Building Superstructure
  - 44%

- Roof Construction
  - 34%

- Floor Construction
  - 29%

- Interior Room Modules
  - 29%

- Other
  - 9%

Nearly 50% of total respondents
Elements Ranked Highest in Use by Individual Respondents

- **Building Superstructure**: 27%
- **MEP Building Systems**: 21%
- **Exterior Walls**: 20%
- **Roof Construction**: 17%
- **Interior Room Modules**: 8%
- **Floor Construction**: 4%
- **Other**: 4%

**#1 Architects** – 30%
**#1 Engineers** – 39%
**#1 Contractors** – 34%

Prefabrication and modularization is relatively evenly distributed among the top four building components.
Job Condition Drivers

Job conditions are an important driver for prefabrication and modularization:

- **Job site accessibility**
  - Biggest influence for contractors – 62%
  - 58%

- **Number of stories**
  - 53%

- **Type of building**
  - **exterior**
  - Biggest influence for engineers – 61%
  - 52%

- **Layout of building**
  - **interior**
  - Biggest influence for architects - 52% compared to 27% for contractors
  - 35%
Respondent Profile and Levels of Use
Current Usage by Firm Size

Firm size based on:

- Firm type (A/E vs. Contractor)
- Firm annual billings (A/E) or annual revenue (Contractor)

A/E Firms Size by Billings (Total = 220)

- Small: Less than $500K
- Medium: $500K to less than $5M
- Large: Greater than $5M

Contractor Firm Size by Revenue (Total = 501)

- Small: Less than $25M
- Medium: $25M to less than $100M
- Large: Greater than $100M

Usage by Firm Size

- Small: 76%
- Medium: 87%
- Large: 94%
In two years, nearly all players will be users of prefab/modularization on some projects!
Levels of Use Increasing Over Time for Current Users

- **2009:** 37% used prefab & modular building processes on more than 50% of commercial projects
- **2013:** 45% reporting expected use on over 50% of projects—a **22% growth** over 4 years

### Percentage of Prefabrication Use for Current Users
2009 vs. 2013

<table>
<thead>
<tr>
<th>Level of Use</th>
<th>2009 (%)</th>
<th>2013 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (1% to 25% of projects)</td>
<td>39%</td>
<td>27%</td>
</tr>
<tr>
<td>Medium (26% to 50% of projects)</td>
<td>24%</td>
<td>27%</td>
</tr>
<tr>
<td>High (51% to 75% of projects)</td>
<td>15%</td>
<td>19%</td>
</tr>
<tr>
<td>Very High (&gt;75% of projects)</td>
<td>22%</td>
<td>26%</td>
</tr>
</tbody>
</table>
Among Contractors Users
Mechanical Contractors, Fabricators & Design Builders are Leading the Way!

- **Mechanical Contractors**
- **Fabricators**
- **Design-Builders**
- **Electrical Contractors**
- **General Contractors**
- **Construction Managers**

2009 vs 2013
Non-User Opinions
Expected Usage on Prefabrication/Modulatization Projects by Non-Users in 2013

87.2% of respondent non-users expect to use prefabrication/modularization by 2013!

Percentage of Future Prefabrication Use for Current Nonusers (by Industry Player)

- **Never**: 8% (Architect), 11% (Engineer), 15% (Contractor)
- **Low (1% to 25% of projects)**: 83% (Architect), 84% (Engineer), 62% (Contractor)
- **Medium to High (26% to 100%)**: 8% (Architect), 5% (Engineer), 23% (Contractor)

Contractors will have higher levels of activity.
Current Reasons by Non-Users for Not Using Prefab/Modularization

- Architect didn't design prefab into project: 46%
- Types of projects we do are not applicable for prefab: 34%
- Not familiar with process of prefab and/or manufacturers: 34%
- Owner doesn't want prefabricated modular elements: 26%
- Availability of prefab shop locally: 20%
- Concern about quality of prefab components/structure: 13%
- Availability of trained workforce to install Prefab: 11%
- Costs too much: 10%
Non-User Drivers for Future Use

- **Save money**: 77%
- **Save time**: 66%
- **Owner demand**: 66%
- **Competitive advantage in the marketplace**: 65%
- **Better quality control**: 60%
- **A & E Firm Demand**: 50%

- All respondents think that saving time and money is important driver.
- Owner demand (83%) and better quality control (75%) is especially important to architects.
- Competitive advantage (76%) is particularly important to contractors.
Non-User Productivity Expectations

Project Schedule & Cost

### Project Schedule
- 68%: High/Very High impact
- 27%: Low/Medium impact
- 5%: No impact

### Project Cost
- 80%: No impact
- 16%: Low/Medium impact
- 4%: High/Very High impact
Non-User Productivity Expectations
Quality & Reducing Onsite Resources

Project Quality
- 15% No impact
- 6% Low/Medium impact
- 79% High impact

Reduced Onsite Resources
- 2% No impact
- 38% Low/Medium impact
- 60% High impact
User Player Insights & Preferences:

- Owners
- Contractors
- Engineers
- Architects
Anecdotal Owner Insights

- Helps fill skilled labor gaps
- Less disruption of existing business operations
- Significant competitive advantage from project cost savings as small as 2-5%
- Cost and Schedule are bigger drivers than ROI
- Higher quality building components
- Just-in-time delivery of prefabrication components
Users Current Business Drivers

- **Improve productivity**
  - Contractor: 92%
  - Engineer: 70%
  - Architect: 68%

- **To be competitive in our marketplace**
  - Contractor: 85%
  - Engineer: 60%
  - Architect: 52%

- **Generate greater ROI**
  - Contractor: 70%
  - Engineer: 43%
  - Architect: 40%

- **Owner/Client demand**
  - Contractor: 31%
  - Engineer: 51%
  - Architect: 35%
Users Current Reasons for Not Using

- Architect didn't design prefab into project
  - Contractor: 48%
  - Engineer: 44%
  - Architect: 14%

- Types of projects we do are not applicable for prefab
  - Contractor: 33%
  - Engineer: 24%
  - Architect: 32%

- Owner doesn't want prefabricated modular elements
  - Contractor: 21%
  - Engineer: 35%
  - Architect: 39%

- Availability of prefab shop locally
  - Contractor: 22%
  - Engineer: 28%
  - Architect: 34%
User Drivers for Future Use

- **Measurable improvement in project safety**: 30%, 50%, 65%
- **Cheaper labor costs**: 58%, 63%, 73%
- **Measurable improvement in project quality**: 70%, 66%, 71%
- **Measurable improvement in project schedule**: 90%, 79%, 85%
- **Decrease construction costs**: 83%, 82%, 86%

- **Architect**
- **Engineer**
- **Contractor**
Model-Driven Prefabrication Current Usage

- None (1% to 25% of projects):
  - Contractor: 24%
  - Engineer: 35%
  - Architect: 40%
- Low (26% to 50% of projects):
  - Contractor: 50%
  - Engineer: 39%
  - Architect: 42%
- Medium (51% to 75% of projects):
  - Contractor: 13%
  - Engineer: 12%
  - Architect: 8%
- High (>75% of projects):
  - Contractor: 7%
  - Engineer: 4%
  - Architect: 3%
- Very High (1% to 25% of projects):
  - Contractor: 6%
  - Engineer: 11%
  - Architect: 8%
Model-Driven Prefabrication Estimated Future Usage in 2013

- None: 5%, 14%, 17%
- Low (1% to 25% of projects): 40%, 39%, 40%
- Medium (26% to 50% of projects): 28%, 23%, 31%
- High (51% to 75% of projects): 14%, 13%, 5%
- Very High (> 75% of projects): 13%, 11%, 6%

Contractor | Engineer | Architect
---|---|---
Key Takeaways from Players

Future implementation will be driven based on player perceptions:

→ Owners need to better understand productivity benefits
→ Architects need Owner demand
→ Engineers & Contractors need Architects to specify
→ Some specialty contractors need to continue to take lead in use on projects:
  – Mechanical Engineers
  – Fabricators
  – Design-Builders
Study Highlights: Productivity and Business Benefits
Productivity & Business Benefits: Decreases Project Schedule

66% of Users Report that Project Schedule is Decreased

66%: Schedule Decreased By

- Decreased
- Stayed the Same
- Increased

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Productivity Impact on Project Schedule

**Contractor**
- Increased by 1 week or more: 6%
- Stayed the same: 22%
- Decreased by 1 week: 15%
- Decreased by 2 weeks: 12%
- Decreased by 3 weeks: 37%
- Decreased by 4 weeks or more: 8%

**Engineer**
- Increased by 1 week or more: 4%
- Stayed the same: 31%
- Decreased by 1 week: 12%
- Decreased by 2 weeks: 7%
- Decreased by 3 weeks: 31%
- Decreased by 4 weeks or more: 8%

**Architect**
- Increased by 1 week or more: 3%
- Stayed the same: 31%
- Decreased by 1 week: 9%
- Decreased by 2 weeks: 10%
- Decreased by 3 weeks: 5%
- Decreased by 4 weeks or more: 40%
Productivity & Business Benefits: Decreases Project Budget

65% of Users Report that Project Budget is Decreased

- 65%: Budget Decreased By
- 24% Decreased by 1 to 5%
- 19% Decreased by 6-10%
- 17% Decreased by 10-20%
- 5% Decreased by more than 20%

<table>
<thead>
<tr>
<th>Decreased</th>
<th>Stayed the same</th>
<th>Increased</th>
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Productivity & Business Benefits: Lower Purchase/Installation Price for Materials

Nearly 50% users find that prefabricated/modular construction decreases the purchase & installation price for materials.
Productivity
Purchase Price Materials/Installation

- Less by 10% or more
  - Contractor: 12%
  - Engineer: 16%
  - Architect: 9%

- Less by 6-10%
  - Contractor: 19%
  - Engineer: 13%
  - Architect: 18%

- Less by 1 to 5%
  - Contractor: 17%
  - Engineer: 16%
  - Architect: 18%

- About the same
  - Contractor: 35%
  - Engineer: 35%
  - Architect: 44%

- Greater by 1 to 5%
  - Contractor: 9%
  - Engineer: 8%
  - Architect: 4%

- Greater by 6-10%
  - Contractor: 5%
  - Engineer: 10%
  - Architect: 6%

- Greater by more than 10%
  - Contractor: 4%
  - Engineer: 2%
  - Architect: -
Opinion on Green Benefits
Amount of Materials Used on Project

**Contractor**

- Increase by 1% or more: 2% 37%
- Stayed the same: 32%
- Decreased by <5%: 2% 40%
- Decreased by 5 to 15%: 7%
- Decreased by >15%: 22%

**Engineer**

- Increase by 1% or more: 19%
- Stayed the same: 30%
- Decreased by <5%: 4%
- Decreased by 5 to 15%: 14%
- Decreased by >15%: 8%

**Architect**

- Increase by 1% or more: 9%
- Stayed the same: 48%
- Decreased by <5%: 1%
- Decreased by 5 to 15%: 14%
- Decreased by >15%: 38%
Productivity & Business Benefits: Site Safety

Over One-Third of Users Report that Site Safety is Increased

- 56% Improved
- 34% Stayed the same
- 10% Reduced
Productivity
Site Safety

<table>
<thead>
<tr>
<th></th>
<th>Reduced</th>
<th>Stayed the same</th>
<th>Improved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>77%</td>
<td>62%</td>
<td>57%</td>
</tr>
<tr>
<td>Architect</td>
<td>3%</td>
<td>21%</td>
<td>32%</td>
</tr>
<tr>
<td>Engineer</td>
<td>6%</td>
<td>32%</td>
<td>37%</td>
</tr>
<tr>
<td>Contractor</td>
<td>12%</td>
<td>51%</td>
<td>57%</td>
</tr>
</tbody>
</table>
Productivity & Business Benefits: Green Benefits Contribute to Cost Savings

→ 77% report that site waste is reduced

→ 62% report that they have reduced the materials used

Reduction of Site Waste

<table>
<thead>
<tr>
<th>Decreased by</th>
<th>32%</th>
<th>31%</th>
<th>13%</th>
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</thead>
<tbody>
<tr>
<td>&lt;5%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 to 15%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;15%</td>
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</table>

Reduction of Material Use

<table>
<thead>
<tr>
<th>Decreased by</th>
<th>35%</th>
<th>21%</th>
<th>6%</th>
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<tbody>
<tr>
<td>&lt;5%</td>
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<td></td>
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<tr>
<td>&gt;15%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Opinion on Green Benefits
Amount of Construction Site Waste

- Decreased by >15%
  - Contractor: 13%
  - Engineer: 12%
  - Architect: 17%

- Decreased by 5 to 15%
  - Contractor: 36%
  - Engineer: 22%
  - Architect: 26%

- Decreased by <5%
  - Contractor: 33%
  - Engineer: 33%
  - Architect: 25%

- Stayed the same
  - Contractor: 16%
  - Engineer: 32%
  - Architect: 31%

- Increased by 1% or More
  - Contractor: 0%
  - Engineer: 2%
  - Architect: 1%
# Study Summary Highlights

Prefabrication/Modularization Is Improving Productivity

<table>
<thead>
<tr>
<th>Benefit</th>
<th>% of firms reporting benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreases in Project Schedule:</td>
<td>66%</td>
</tr>
<tr>
<td>Decreases in Project Cost:</td>
<td>65%</td>
</tr>
<tr>
<td>Lower Materials Purchase Price:</td>
<td>47%</td>
</tr>
<tr>
<td>Improved Site Safety:</td>
<td>34%</td>
</tr>
<tr>
<td>Decreased Waste:</td>
<td>77%</td>
</tr>
<tr>
<td>Decreased Use of Materials:</td>
<td>62%</td>
</tr>
</tbody>
</table>

- **Level of Benefit**
  - 35% report decreases of 4 weeks or more
  - 22% report decreases of over 10%
  - 30% report decreases of 6% or more
  - Site Safety also noted by Owners
    - 44% report decreases of 5% or more
    - 27% report decreases of 5% or more
Key Takeaways
What We Learned From the Data

All Players – Prefabrication/Modularization are:

- Improving productivity and competitiveness in market place and are key business drivers
- Decreasing construction costs and improving project schedule which are top rated benefits
- Reducing site waste and decreasing materials which is an important recognized green benefit
What We Learned From the Data

→ Contractors:
  – Architect needs to spec prefab/modularization to drive usage
  – Subcontractors, especially Mechanical, Fabricators, & Design-Build are driving prefab/modularization adoption
  – Model-driven prefab is having an important and growing impact on contractor projects

→ Architects:
  – Owner demand and availability of quality prefab components are key drivers to usage
  – Green benefits of prefab/modularization are particularly important to architects

→ Engineers:
  – Owner demand is key driver
  – Architect needs to spec prefab/modularization to drive usage
Market Opportunities Identified from the Data

- Healthcare Is the Strongest Market—both in current and future activity
  - Starts valued at $53.1 billion over next two years

- Hotels seen as a growth area
  - Relatively lower starts value

- For engineers, warehouses and manufacturing buildings largest use areas
  - With starts increasing in these sectors, strong future activity for prefabrication/modularization
**Recommendations**

- **Educate owners** on the productivity and business benefits of prefabrication & modularization
  - Encourage them to demand use on their projects

- **Develop BIM objects** for your products to make it easier for architects to specify in designs
  - BIM is a key industry trend impacting construction processes

- **Understand and promote the green benefits** of prefabrication & modularization
  - Green is a key industry trend impacting construction processes
Thank You!

MHC Resource Websites:

- construction.com
- analytics.construction.com
- greensource.construction.com
- construction.com/market_research
- bim.construction.com
- archrecord.com
- enr.com