



PREFABRICATION: THE CHANGING FACE OF ENGINEERING AND CONSTRUCTION

2017 FMI/BIMForum Prefabrication Survey

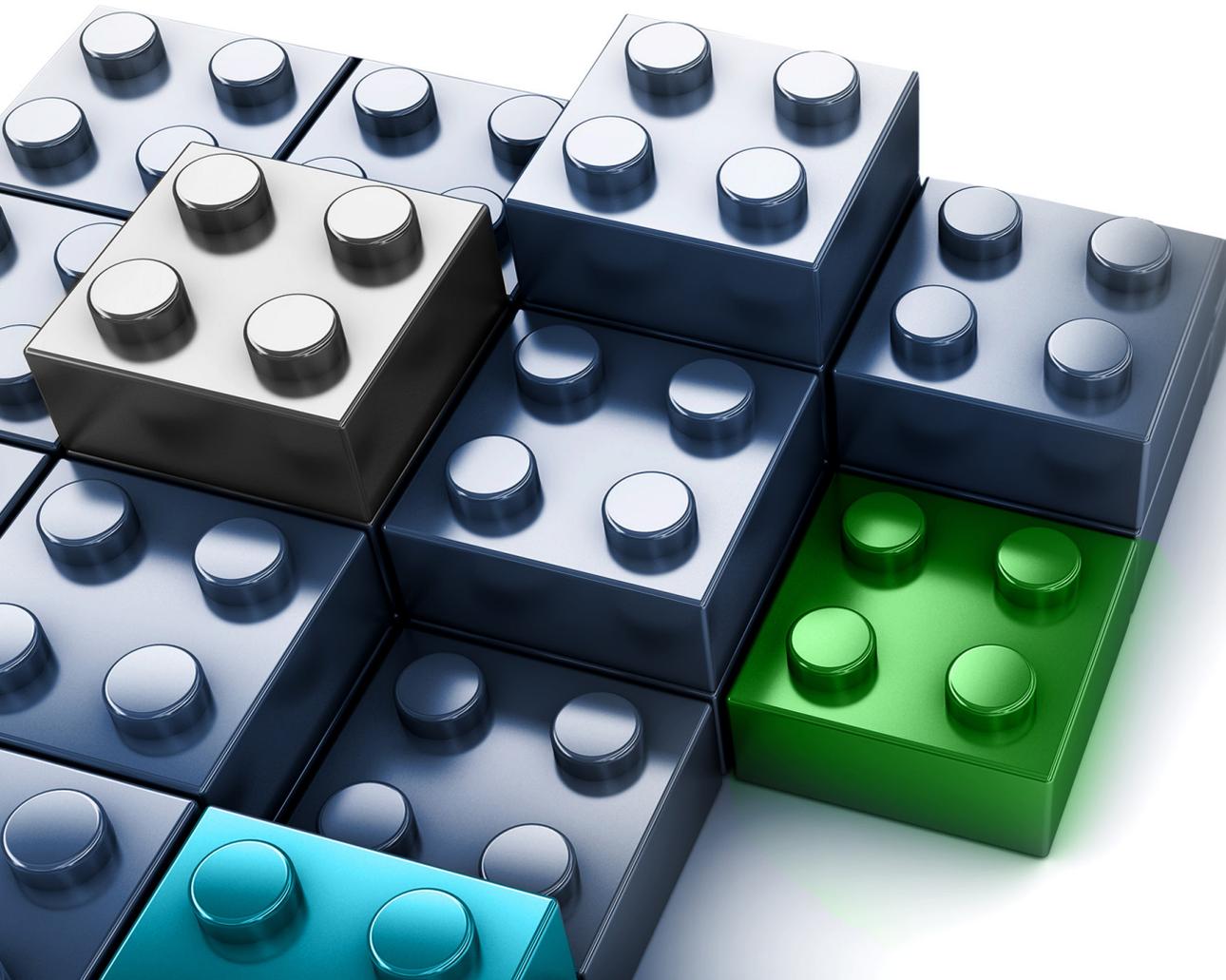


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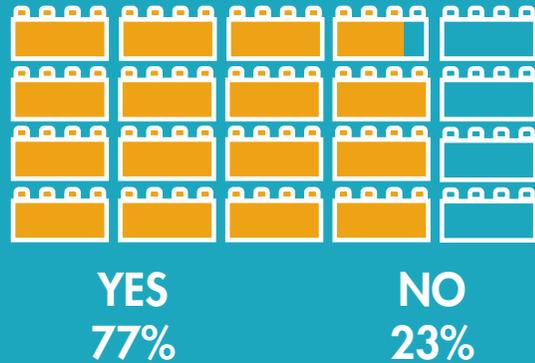
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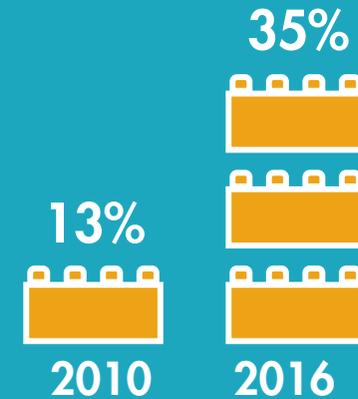
Looking Ahead

TODAY'S PREFAB ENVIRONMENT IS DIFFERENT

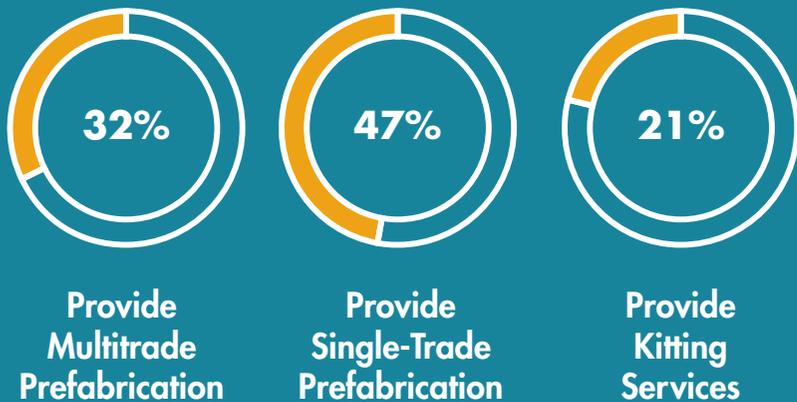
77% of respondents think today's prefab environment is different than in 2013.



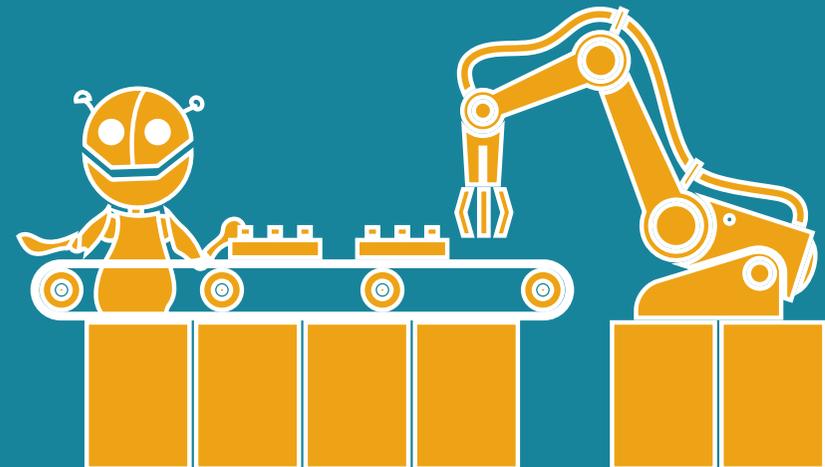
The amount of project work using prefab has **almost tripled** between 2010 and 2016.



Most contractors **perform single-trade prefabrication**.

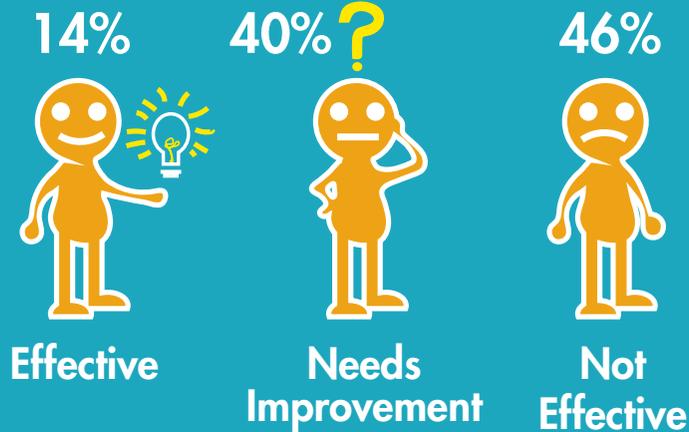


Project **inefficiencies** and **improved technologies** are driving prefabrication.

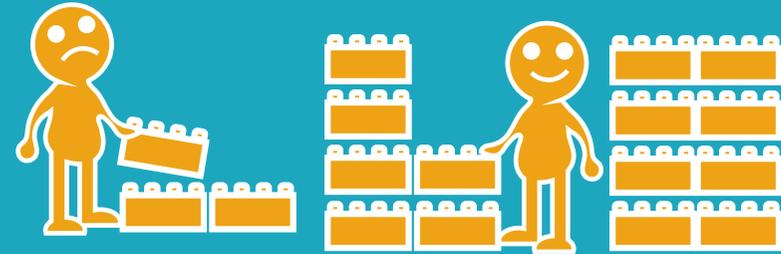


THE BIG STRUGGLE TO MAKE IT WORK

Contractors struggle to make prefabrication effective.



Contractors using prefab on more than **50%** of their projects **are more effective** compared to those who do less prefab.



Three key challenges for making prefabrication effective:



48% of respondents see less than **5%** in **savings on total annual labor hours** related to prefabrication.





Executive Summary

“The past doesn’t always match the future. That’s the nature of disruption. Patterns of change build gradually until they merge and rapidly reshape the business landscape. At that point it’s too late to respond.”

Dr. Stefan Hajkowicz, Senior Principal Scientist
CSIRO

The construction industry is back on track since the Great Recession, and total construction employment has rebounded to almost 6.7 million workers (still a far cry from its peak of 8 million workers in 2006). “Construction spending in November 2016 hit a 10-year high, with one-month and year-over-year increases in all major segments,” says Ken Simonson, chief economist at Associated General Contractors of America. “Looking ahead, contractors say they expect more work in every category in 2017 than in 2016.”

However, despite being about 16% below its 2006 employment peak, the industry is still struggling to find qualified labor. Compounding these statistics, baby boomers are reaching retirement age at a rate of 10,000 per day, while fewer, less experienced workers are moving into the engineering and construction industry. In short, labor has become a key constraint for contractors that want to take on and complete more work.

Simultaneously, the evolution of design and construction functions has taken a leap forward over the past decade, with the transition from electronic drafting to high-resolution digital modeling (also known as Building Information Modeling or BIM). Ubiquitous digital connectivity, cloud computing, 3-D printing and big data are just a few of the evolving trends responsible for the current melding of engineering, architecture, fabrication, construction and other related disciplines.

Today, all of these factors are setting the stage for revolutionary change in the engineering and construction industry and have helped prefabrication and modular construction make a comeback during an era where low cost, resource efficiency and tight schedules are priorities.

Within this industry context, FMI and the BIM Forum partnered in fall of 2016 to take a pulse of today's prefabrication developments to see what—if anything—has changed since we last surveyed the industry in 2013. Study findings

are based on almost 200 participants—a mix of both specialty trade contractors and GCs/CMs—most of whom work in the commercial sector. The companies that participated in this study collectively generate approximately \$38 billion in industry revenue each year.

Our study sheds light on big-picture industry trends that are organized around the following four themes:

1. **Today's prefabrication environment isn't the same as it was in 2013.**
2. **Most contractors struggle to make prefabrication effective.**
3. **Contractors want to double their labor investments in prefabrication over the next five years.**
4. **In today's environment, project schedules are considered a critical benefit of prefabrication.**

Our insights paint a mixed picture and show that **most contractors are struggling to make prefabrication effective and are slow to adapt to today's fast-changing world.** Our

findings also revealed a relatively small, fast-growing cottage industry of prefabrication innovators who are driving change and shaping the future of the industry.

To gain a deeper understanding of prefab best practices and promote a constructive dialogue within the industry, FMI will be assessing and studying several of these successful firms over the coming year. As with many new concepts, success breeds success. Prefabrication is no different and therefore all industry players must alter their mindsets and educate themselves on the benefits of modularization and prefabrication. Everyone will need to be open to new approaches to designing, manufacturing, sequencing and putting construction projects in place. **Rather than viewing prefabrication as a threat or disruption, contractors who embrace it will be best-positioned to win in the built environment of today and tomorrow.**



Key Findings

“The challenge with doing prefab is, it’s not just thinking about prefab. Instead, it’s more about thinking of how your prefab strategy fits within the overall strategy of delivering a project.”

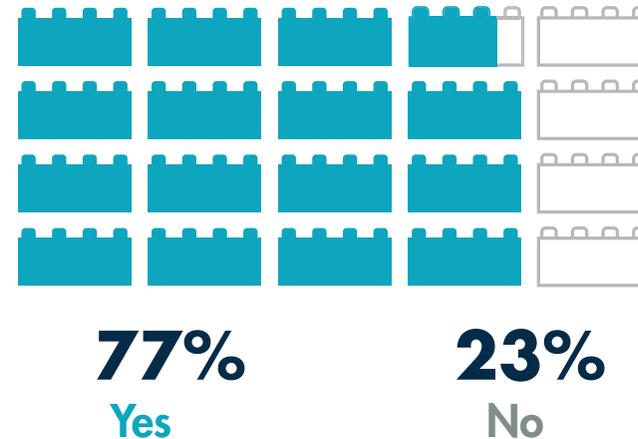
Atul Khanzode, Ph.D.
Head of Technology and Innovation
DPR Construction

In fall 2016, FMI and AGC's BIM Forum surveyed 156 contractors (both GCs/CMs and specialty contractors) in the U.S. construction industry. To delve deeper into the key topics identified in the survey, FMI subsequently conducted more than 30 follow-up interviews. The following key findings represent the main takeaways from this research; FMI will continue to investigate these topics in more detail through in-depth industry case studies in 2017.

Finding 1. The prefabrication environment has changed.

Almost 80% of our survey participants involved with prefabrication indicated that today's prefabrication environment is different compared to the conditions in 2013 (Exhibit 1). According to many of our respondents, prefabrication is more widely adopted across all stakeholder groups (e.g., owners, GCs/CMs and specialty contractors), and project participants are expanding the use and application of prefabrication beyond "traditional" projects.

Exhibit 1: Is today's prefabrication environment in construction different compared to three years ago?



Source: 2017 FMI/BIMForum Prefabrication Survey

Geoffrey Golden, president at Golden Construction, explained: "Ten years ago, we were just trying to prove that prefabrication worked (functionally)—that it was a good product. Today the conversations have shifted to, 'Just how much can we impact projects' bottom line and schedule?' We have transitioned from, 'Does it work?' to 'Yes, it works and it has become a clear competitive differentiator.'"

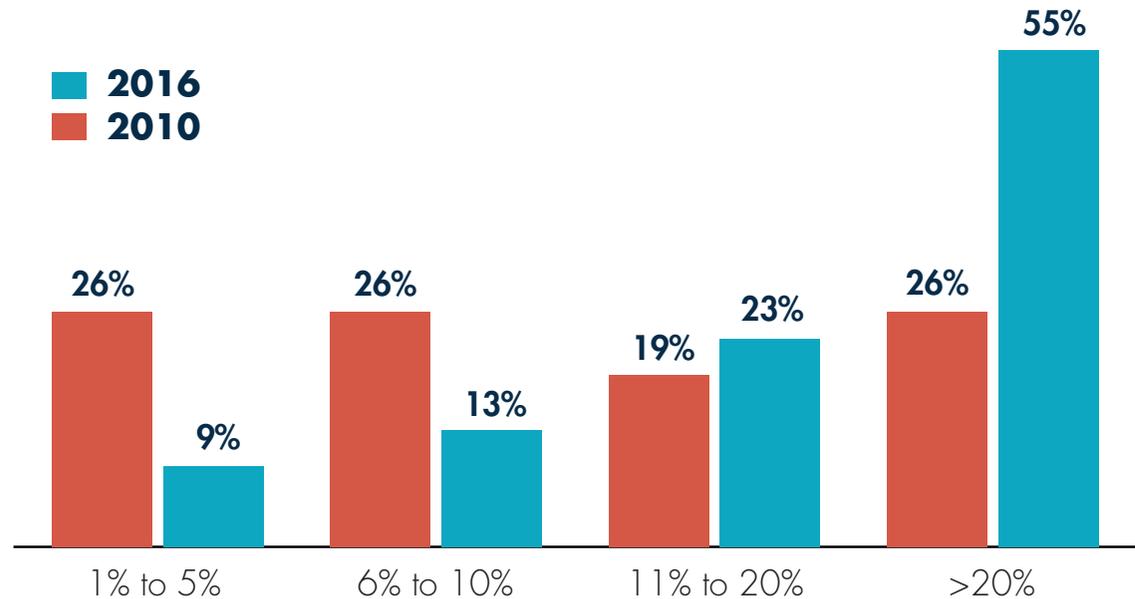
Looking back at our earlier industry studies, the numbers confirm the increased use and adoption of prefabrication. In 2010, only 26% of survey respondents were using prefabricated assemblies on more than 20% of their projects. **In late 2016, this number was more than double, with 55% of respondents using prefabricated assemblies on more than 20% of their projects** (Exhibit 2).

When looking at the project work being accomplished using prefab assemblies, the numbers are even more dramatic: **In 2010, the average use of prefab was around 13%, and in 2016, that number increased to 35%—almost three times that of 2010.**

Aaron Thompson, VP of Design & Fabrication at Corbins Electric, stated, “When you’re talking about large commercial projects, I don’t think prefabrication is going to be an option in the future. We’re seeing more and more written into the contract that off-site fabrication is mandatory, and the owners are not giving us a large laydown yard on-site. And if I’m already seeing that now, after the past three-year push, I can only imagine what’s going to happen in the next five to 10 years.”

Our data suggests that most contractors perform single-trade prefabrication (47%), while a third (32%) provide multitrade prefabrication, and 21% provide kitting services (Exhibit 3). **Not surprisingly, specialty contractors perform almost double the amount of project work (on average) using prefabricated assemblies compared to GCs/CMs: 44% versus 23%, respectively.**

Exhibit 2: What percentage of your project work is currently accomplished using prefabricated assemblies?



Source: 2017 FMI/BIMForum Prefabrication Survey

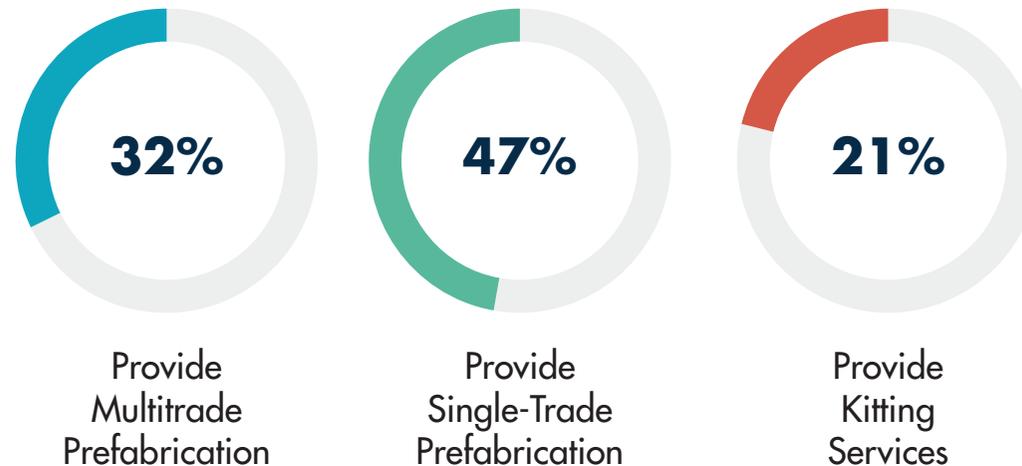
Other differences include:

- Specialty contractors provide almost double the amount of kitting services compared to GC/CMs (24% versus 13%).
- Both contractor groups perform almost the same amount of work using single-trade prefabrication (between 44%-50%), but GC/CMs provide substantially more multitrade prefabrication (coordination) compared to specialty contractors (43% versus 27%).

1a. Project inefficiencies and improved technologies are driving prefabrication.

According to our study, chronic productivity issues and new technology advancements are key factors in driving the broader use of prefabrication at a time when lower cost, resource efficiency and sustainable construction are becoming priorities. Ubiquitous digital connectivity, cloud computing and advancements in X-D modeling and 3-D printing are just a few of the evolving drivers

Exhibit 3: Which of the following do you perform?



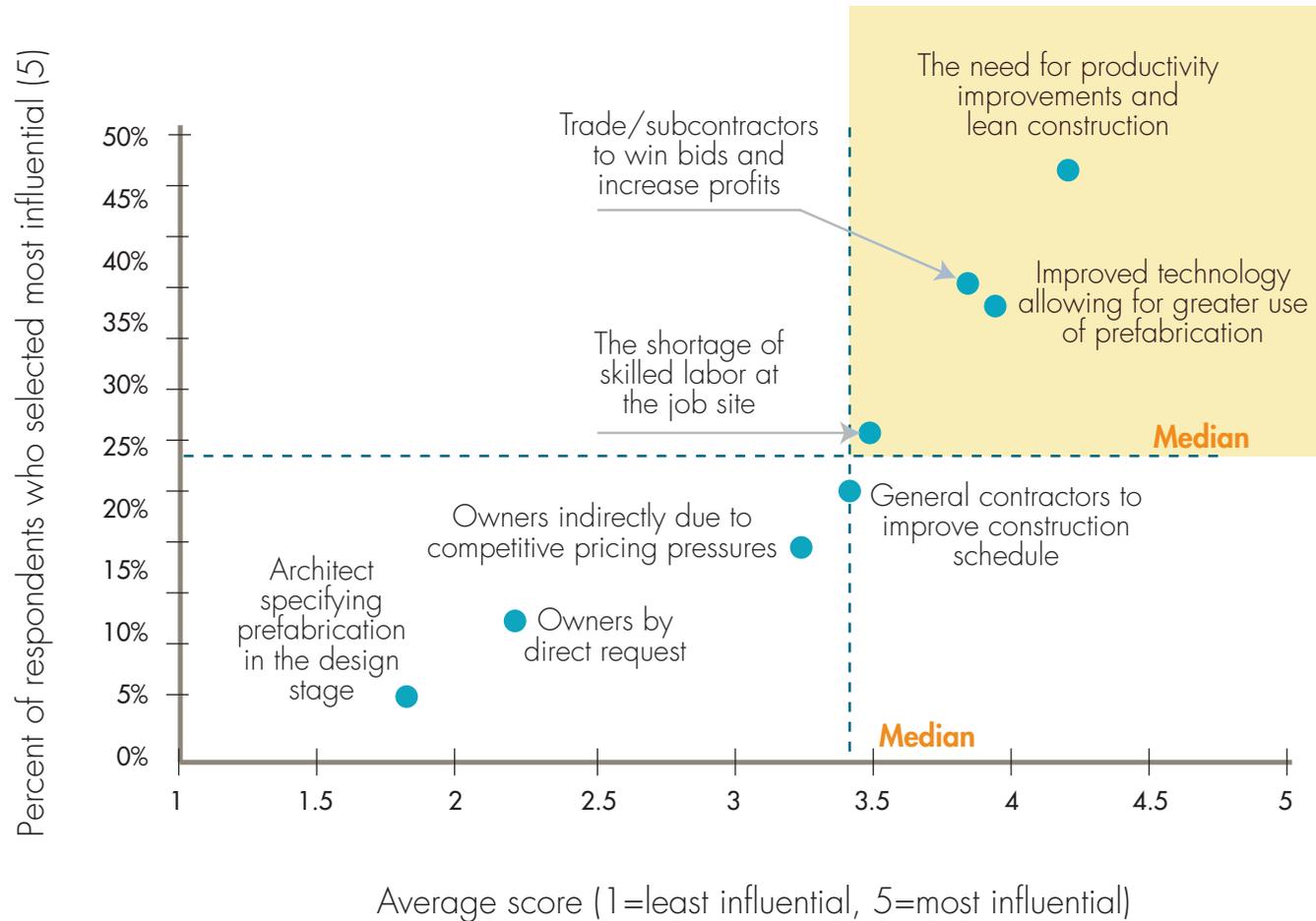
Source: 2017 FMI/BIMForum Prefabrication Survey

presenting opportunities for companies to prefabricate with greater accuracy.

Exhibits 4 and 5 show a summary of the most influential factors driving prefabrication as listed by our study participants. Interestingly, when we asked this same question

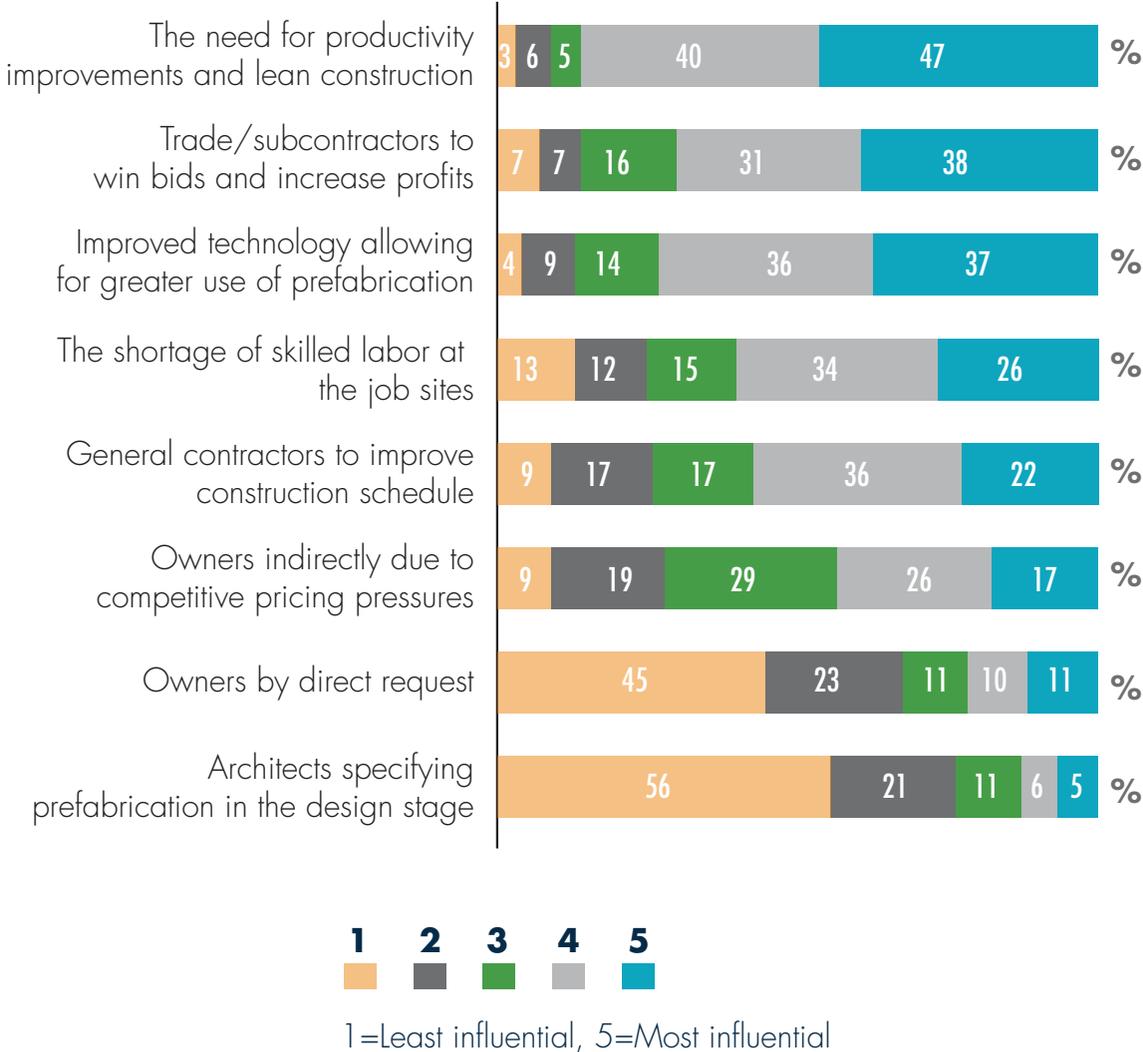
in 2013, the need for general contractors to improve project schedules was listed as the top driver (see Appendix).

Exhibit 4: What percentage of your project work is currently accomplished using prefabricated assemblies?



Source: 2017 FMI/BIMForum Prefabrication Survey

Exhibit 5: Primary factors driving the demand for prefabrication



Source: 2017 FMI/BIMForum Prefabrication Survey

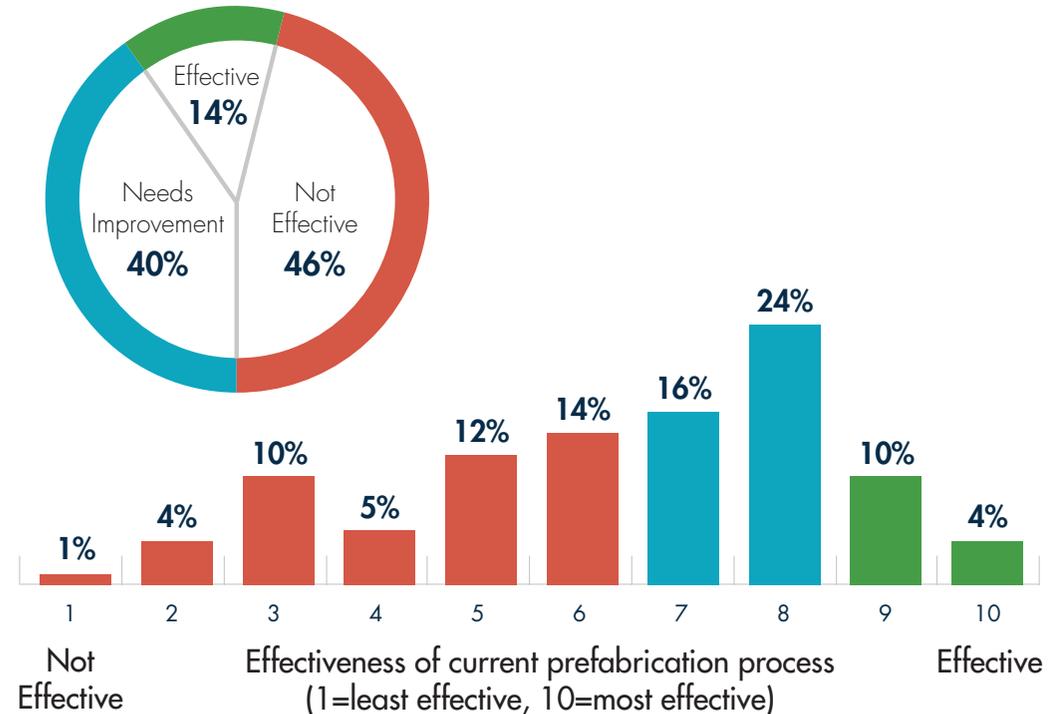
Finding 2. Most Contractors Struggle to Make Prefabrication Effective.

Here's a staggering statistic from our study: **Almost 90% of all survey respondents perceive their prefabrication process as ineffective or in need of improvement. Only 14% think their prefabrication process is effective** (Exhibit 6).

When comparing specialty contractors with GCs/CMs, specialty contractors are ahead of the curve in regard to prefabrication (see pull-out box). In many instances, these contractors have been doing prefabrication for decades and are finally seeing owners and GCs/CMs integrating prefabrication requirements in their contracts and bids.

Steve Foote, vice president and operations manager at Greiner Electric, explained, "I've been doing prefab for almost 27 years. I've seen a lot of things that worked and were worth doing, but that didn't work as well as originally desired. I refer to prefab as a 'process,' in that you have to constantly evaluate it and be willing to experiment and try different

Exhibit 6: How effective is your current prefabrication process?



Specialty Contractors
Effective: 14%
Needs Improvement: 47%
Not Effective: 39%

GCs/CMs
Effective: 14%
Needs Improvement: 28%
Not Effective: 58%

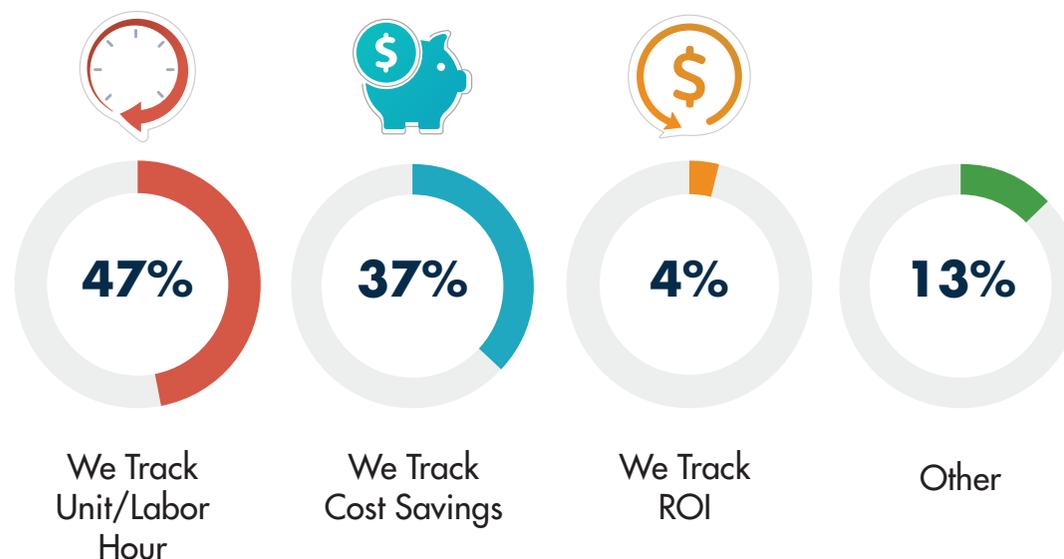
Source: 2017 FMI/BIMForum Prefabrication Survey

things. You stay after it. You HAVE to listen to the field as they are living it, work out the problems they are communicating to you, and eventually you will hit on it just right. There are very few things we've ever done that were perfect right out of the gate, but you keep after it and will get there."

In conversations with study participants and through our work with clients, we have found that the "effectiveness" issue starts with a fundamental problem: **Many contractors don't know what they don't know because they don't really understand how to measure and track prefabrication efforts effectively.**

For example, there are few things as misunderstood or as poorly managed as developing an accurate projection of costs to complete (CTC). This is particularly true when it comes to understanding how to estimate the remaining labor costs on a labor-intensive project. Specialty contractors live and die by their ability to estimate, manage and project labor costs. Consequently, producing accurate CTC estimates is a fundamental and basic project management function. However, the process is typically not very well understood by project managers, those who manage the project

Exhibit 7: How do you measure effectiveness of your prefabrication efforts?



Source: 2017 FMI/BIMForum Prefabrication Survey

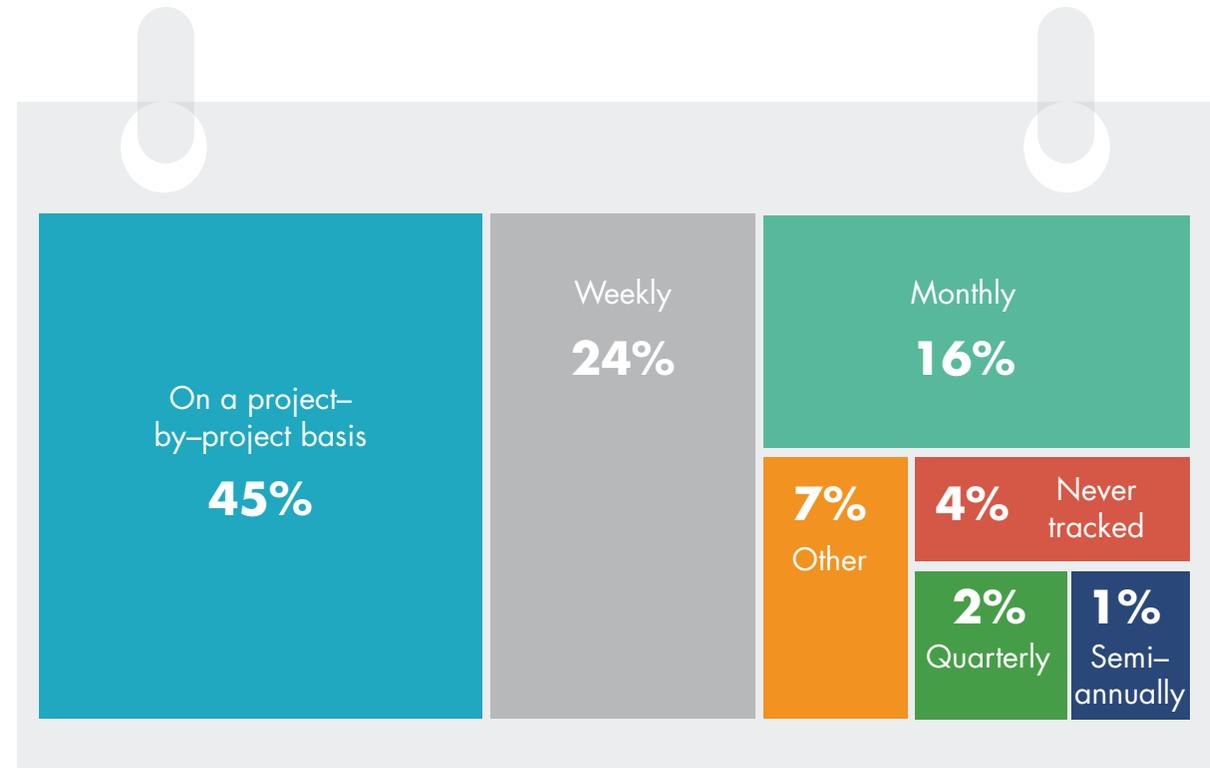
managers, and, in many cases, the people who manage the people who manage the project managers. Add a new business model like prefabrication to the mix, and tracking labor, supplies, time and/or cost accurately becomes nearly impossible—a reality that can ultimately lead to cost overruns and project delays.

Exhibit 7 shows that most contractors track prefabrication efforts by measuring unit per labor hour or cost savings (see Appendix for a detailed breakdown between GCs/CMs and specialty contractors). Almost 50% of survey participants track prefabrication effectiveness on a project-by-project basis while just

one-quarter track these efforts on a weekly basis (Exhibit 8). This again might explain some of the process challenges contractors are running into, based on slow reaction time to problems (i.e., once the project is over) and an inability to make necessary course adjustments.

As one survey participant stated, “We are trapped by our ‘project-by-project’ mentality. Defining the activities and coming up with measurements that are appropriate for tracking production is something we struggle with because we think about it per job.”

Exhibit 8: How frequently do you track effectiveness of your prefabrication efforts?



Source: 2017 FMI/BIMForum Prefabrication Survey

2a. Three Key Challenges for Making Prefabrication Effective.

In interviews with study participants, we identified three main obstacles that are holding back many contractors from improving—or even kicking off—their prefabrication efforts. The challenges include:

The Big Culture Obstacle. One of the biggest barriers to change and transformation as it relates to prefabrication is not technology, it's culture. **Getting people to embrace new ways of thinking and doing work differently is one of the most challenging aspects of organizational change.** Introducing an innovative concept like prefabrication requires curious, tenacious people who are willing to learn new things and take risks. It is also particularly important to develop a culture in which employees are not afraid to make mistakes and where everyone is open to learning from each other's mistakes.

As one interviewee stated, “It's important for the field guys to know that they can communicate the issues they're running into and that there's a willingness to hear and evaluate

that feedback. Ultimately, they're the ones who have to install everything.”

Timing for fresh and innovative thinking couldn't be better. Many younger employees, particularly millennials, are excellent team players and care about their company's success—not just their own jobs (see FMI's Industry Survey “[Millennials in Construction: Learning to Engage a New Workforce](#)”). Virtual design, BIM and prefabrication all require high degrees of collaboration within and among project teams. Having these young people focused on a common purpose, effective processes, excellent communication and strong teams could help transform companies (and our industry) over time.

Atul Khanzode, Ph.D., head of technology and innovation at DPR Construction, explained, “One of the things that we've realized is that we need to leverage the ‘democratization of technology’ to work with the young people that join our organization, and to influence and inspire them to try new things. These innovative ideas are not just coming from one particular place; they can come from anywhere in the organization.”

“Making prefabrication successful requires a cultural mindset. CEOs, project managers, estimators, superintendents—everyone has to buy into it. It needs to be throughout the entire company, top to bottom. That is the only way it will work effectively.”

Aaron Thompson, VP, Design & Fabrication, Corbins Electric

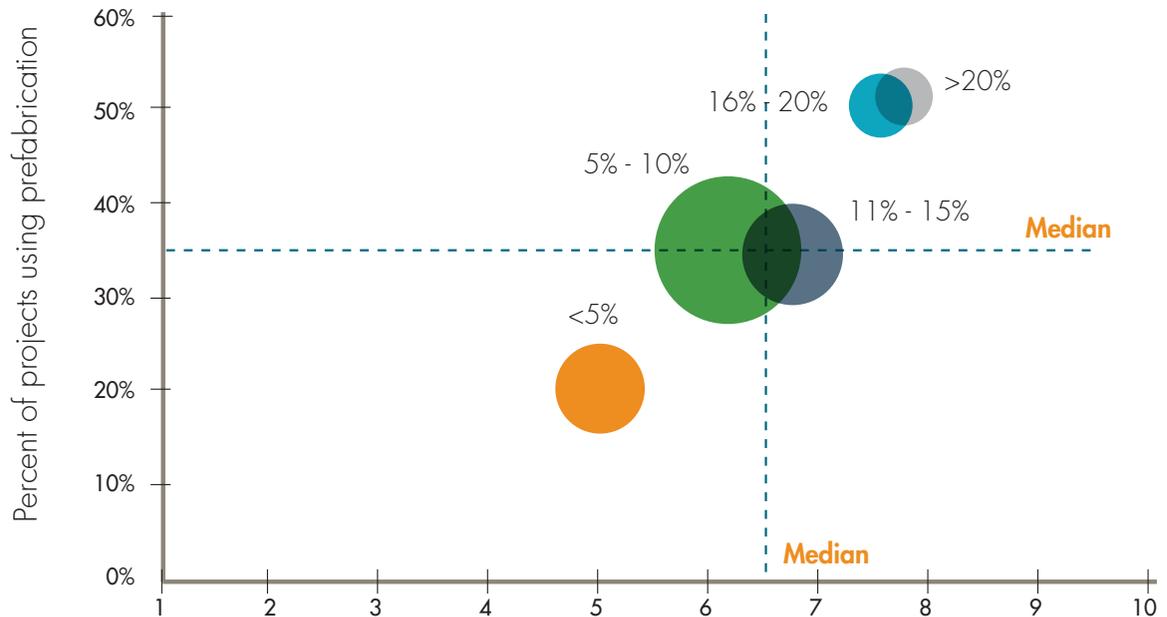
Resistance to Making a Full Commitment.

The old saying, “Practice makes perfect,” is particularly true for prefabrication. Our study shows that **almost 80% of participants use prefabrication on less than 50% of projects and are considerably less effective compared to those who prefabricate on more than 50% of their projects (Exhibits 9 and 10).**

In our work with contractors, we often come across situations whereby a project manager or superintendent might be experimenting with prefab on a project-by-project basis. But prefabrication is not something you can just dabble in and expect to see big returns from. It is an entirely different business philosophy that must be a fundamental part of the corporate strategy. Otherwise, it just ends up being a very expensive mistake.

As with all important strategic initiatives, the “business of prefabrication” starts at the top, with committed leaders who communicate a clear strategy and strong vision around what the company is trying to achieve (e.g., start with the question: Why are we doing prefab?). Successful compa-

Exhibit 9: What percentage of total annual field labor cost do you expect to save through prefabrication?

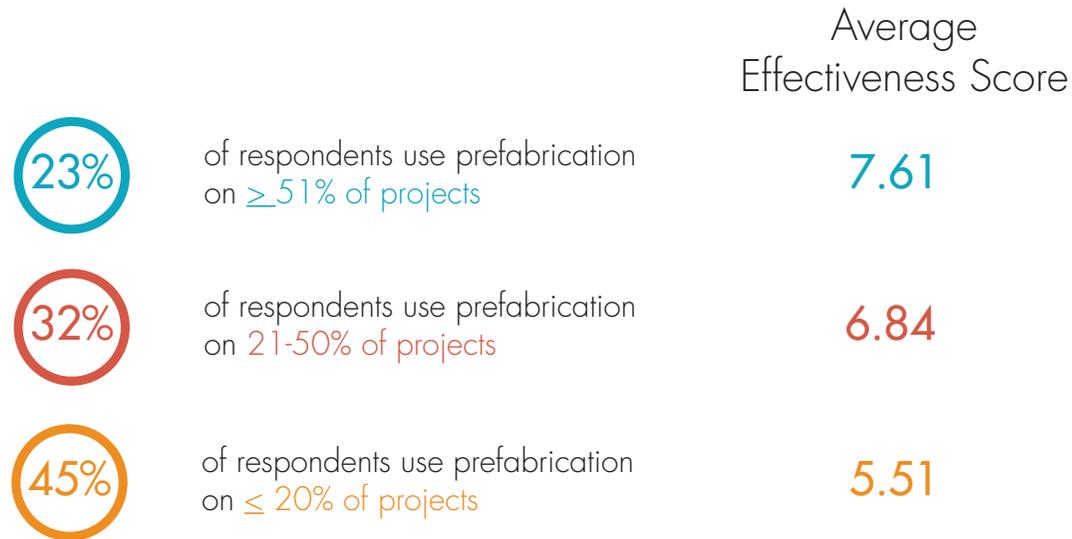


Effectiveness of prefabrication process (1=least effective, 10=most effective)

Note: Bubble size represents the number of respondents

Source: 2017 FMI/BIMForum Prefabrication Survey

Exhibit 10: Percentage of projects using prefabrication and effectiveness



Source: 2017 FMI/BIMForum Prefabrication Survey

nies typically select a champion at the executive level to head up the prefabrication initiative and align everyone with the company's prefab vision and strategy. This approach often requires close collaboration and coordination across different business groups, such as estimating, VD, BIM, fabrication and the field crews, and ultimately helps build a better business.

Several of our study participants confirmed that making prefabrication a corporate initiative resulted in successful ventures. Some of the comments include:

- “You have to be committed to it, because you fail more at prefab than you're going to succeed. It takes a long time to get somewhat good at it.”
- “We have a prefab committee that makes sure all of the project teams are actually doing their fair share of prefabrication. Every project that we do must meet a predetermined prefab labor goal for that project as a percentage.”
- “We have a prefabrication manager who came from a manufacturing background. This has been a huge advantage for us.”

Before jumping into the world of prefabrication, companies must learn industry best practices and study a broad range of questions, including:

- **What types of customers or work require prefabrication?**
 - How fast will demand grow for this type of work?
 - Does this fit into your company strategy and vision?
- **What is different about using prefabrication? And what are the implications for your organization?**
 - For example: What are best practices for inventory controls, tracking work progress, packaging, shipping and delivery, etc.?
- **How do you implement prefabricated assemblies effectively in the field?**
 - What new skill sets and competencies are needed? How do you prepare your workforce to adapt to all of these changes? What are the cultural implications?

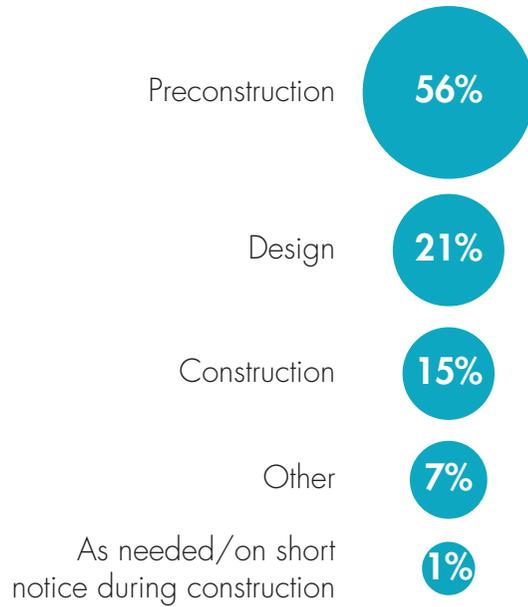
Needed: A New Sequencing and Control mindset. With prefabrication, timing is critical. **Only a fifth (21%) of study participants plan for prefabricated assemblies during the design stage** (Exhibit 11). Three-quarters of respondents plan for prefabricated assemblies too late in the process—during preconstruction (56%) or construction (15%)—which can adversely impact both schedule and budget.

As for lead time, **the majority (63%) of survey respondents indicated having one month or less for putting together prefabricated assemblies** (Exhibit 12). Only one-third of participants have a lead time of one to three months for prefabricated assemblies—a pattern similar to what we found in the previous studies (2010 and 2013).

“There is a steep learning curve for prefabrication. It is huge. If you fail at prefab, it’s expensive. You have to have that mindset of, ‘OK, that was all right, but if we had done it like this or used these parts, or done it this way instead, it would have worked out a lot better.”

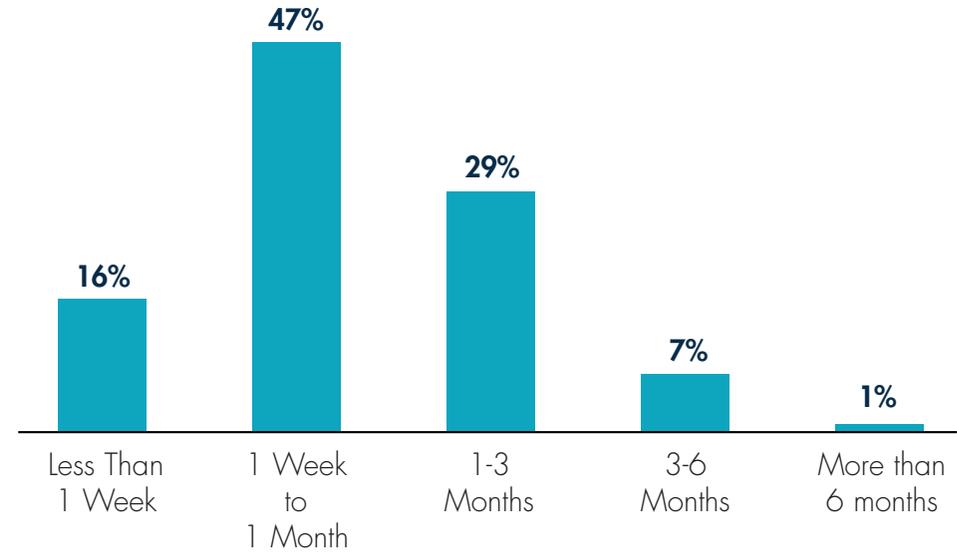
Steve Foote, Vice President and Operations Manager
Greiner Electric

Exhibit 11: During which project phase do you plan for prefabricated assemblies?



Source: 2017 FMI/BIMForum Prefabrication Survey

Exhibit 12: On average, what is your lead time for prefabricated assemblies?



Source: 2017 FMI/BIMForum Prefabrication Survey

“Probably the biggest influence would be the owners getting their design nailed down better before the project starts. We start so many projects where the design is not complete and we have to make allowances accordingly.”

Prefab Study Participant

Planning and sequencing are areas where many contractors struggle to make things work effectively. In our conversations with participants, people listed outdated project delivery models, issues with design quality and ongoing risk transfer as some of the key challenges to making prefabrication work. In one of FMI’s recent industry studies, [“Managing and Mitigating Risk in Today’s Construction Environment.”](#) many industry stakeholders confirmed that owners are putting more pressure on project costs and schedules while modifying contract terms to place greater risk on all contractor levels (CMs, GCs and specialty trade contractors).

In another FMI study focused on U.S. electrical contractors, one executive explained, “Design drawings have gone from 90% complete five years ago to 50% complete in today’s business environment. Incomplete designs have become the contractor’s responsibility. As such, subcontractors have to plan for incomplete designs and provide greater engineering.”

All of these factors dramatically influence planning, timing and sequencing of prefabrication efforts and can make or break the business model altogether. Today, successful prefabrication contractors align with progressive project teams and owners who are reinventing project delivery methods, collaboration and project sequencing entirely.

Guy Skillett, director of construction at Rhumbix, explained, “Construction companies are accustomed to planning, sequencing and executing their work using traditional scheduling methodologies. When you move to prefabrication, processes for production planning and control change substantially. Prefabrication relies on managing just-in-time delivery and inventory. With traditional construction planning methods, you’re pushing your planning out into the future. The problem with that is

it’s making huge assumptions about where the project, your materials and everything else will be in the future. Unless you’re paying very close attention to your schedule, updating it appropriately and monitoring at the right level of detail, these forward-looking forecasts may not necessarily be reliable.”

As this ideological and structural shift in the construction industry continues to evolve, we will likely witness a move from traditional design-bid-build contracts toward design-build and new forms of integrated project delivery. The transition from traditional design and engineering functions to systems design and simulation, manufacturing and assembly will also likely accelerate over the next five to 10 years as the industry undergoes one of its greatest transformations.

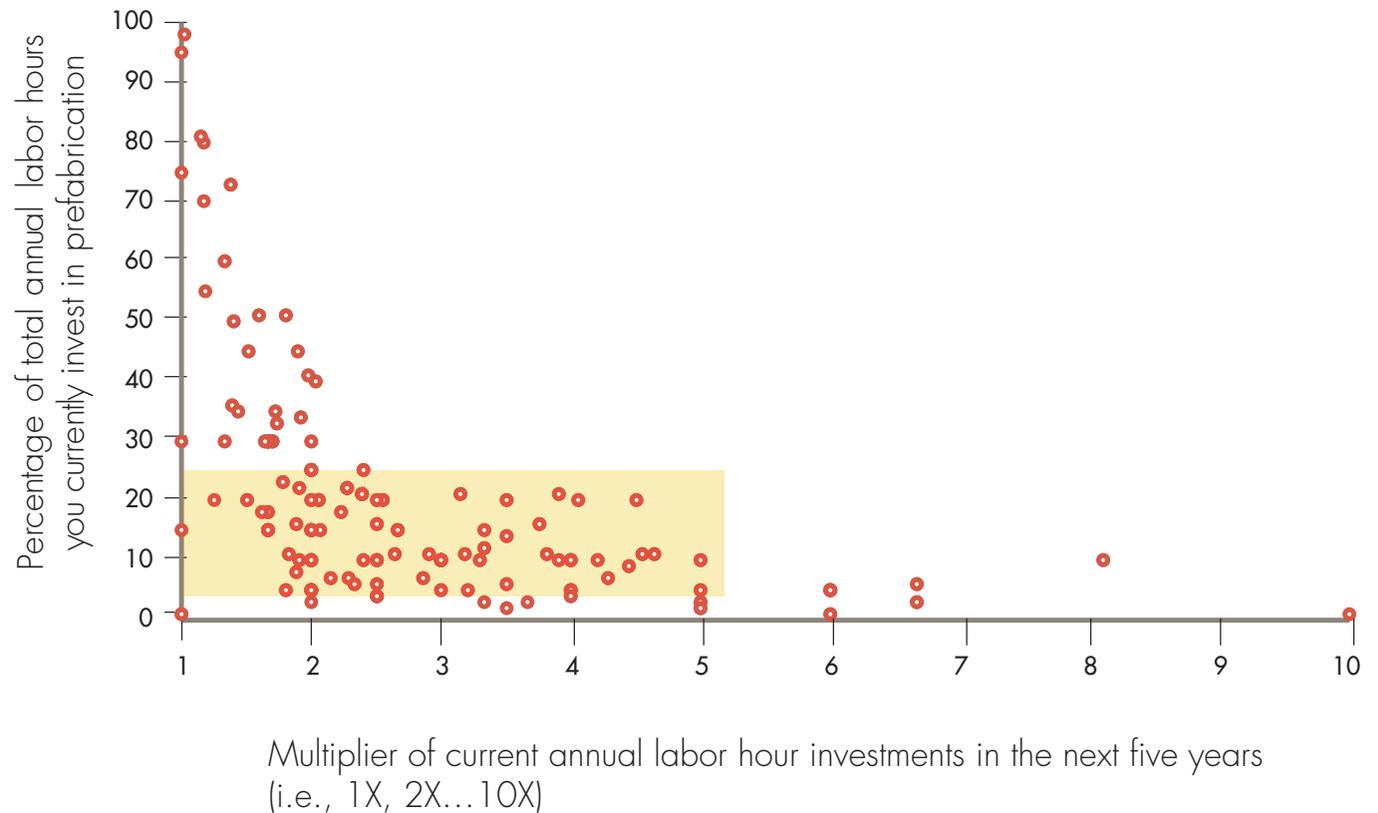
Finding 3. Contractors Want to Double Their Labor Investments in Prefabrication Over the Next Five Years.

In our previous studies (both in 2010 and 2013), contractors of all types were investing around 12% of their labor hours in prefabrication. In 2016, that number almost doubled to 20%.

Survey participants would like to see their investments in prefab labor hours increase from 20% (2016 average) to almost 40% on average within five years. Specialty trade contractors expect to invest more labor hours compared to GCs/CMs: 43% versus 31%, respectively.

Exhibit 13 shows that participants currently investing 5% to 25% of total annual labor hours in prefabrication (highlighted area) anticipate a significant increase in those investments over the next five years. This might be a further sign of contractors planning and preparing for a worsening skilled labor shortage in the future, and therefore investing more time and labor in prefabrication methods to gain effectiveness over time.

Exhibit 13: What percentage of total annual labor hours do you invest in prefabrication?



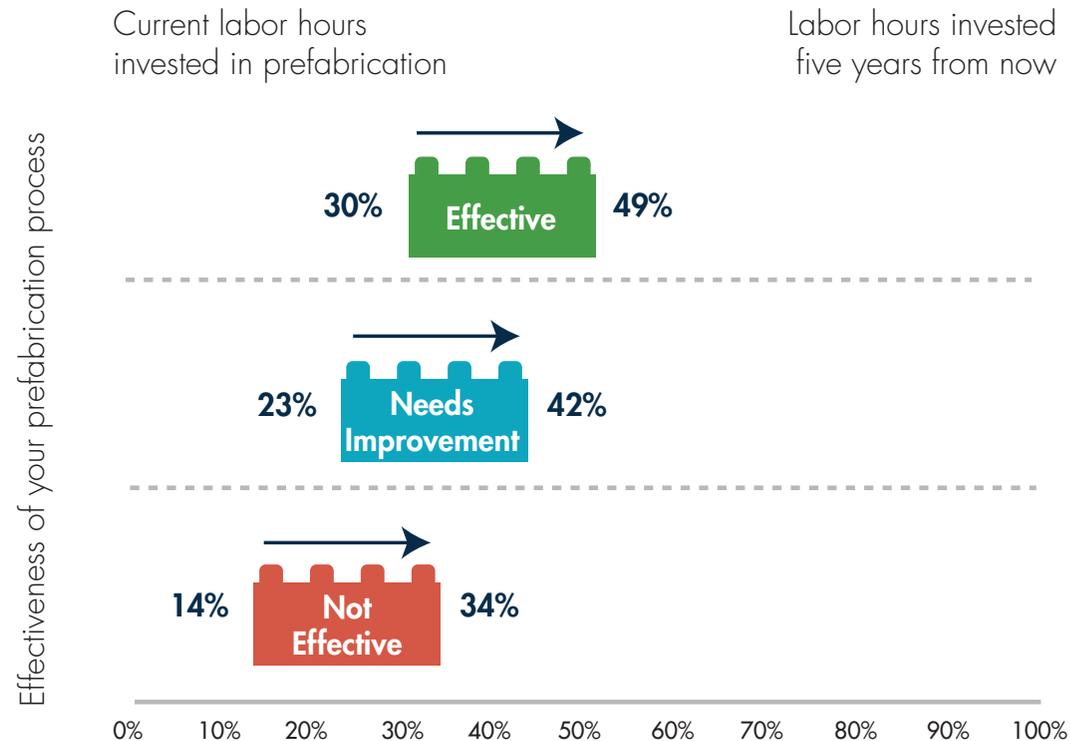
Source: 2017 FMI/BIMForum Prefabrication Survey

This trend is also confirmed in Exhibit 14, which compares prefabrication effectiveness with associated labor hour investments. Based on our data, there are two interesting conclusions:

- Those that indicated their prefabrication process was effective believe they will invest nearly 50% of labor hours in prefabrication five years from now. This is a shift from 30% (2016) to 49% (in 2021).
- Those that indicated their process was not effective believe they will attain a 30% level of labor investments five years from now—right where today’s effective prefab contractors are. This would mean a shift in labor hour investments from 14% to 34%, more than double today’s amount.

These findings could indicate that contractors with less effective processes are realizing they need to invest seriously in both process and people to achieve the true benefits of prefabrication. The industry as a whole also finds itself in various prefabrication adoption stages, led by a “cottage industry of innovators” that is paving the way.

Exhibit 14: On average, what is your lead time for prefabricated assemblies?



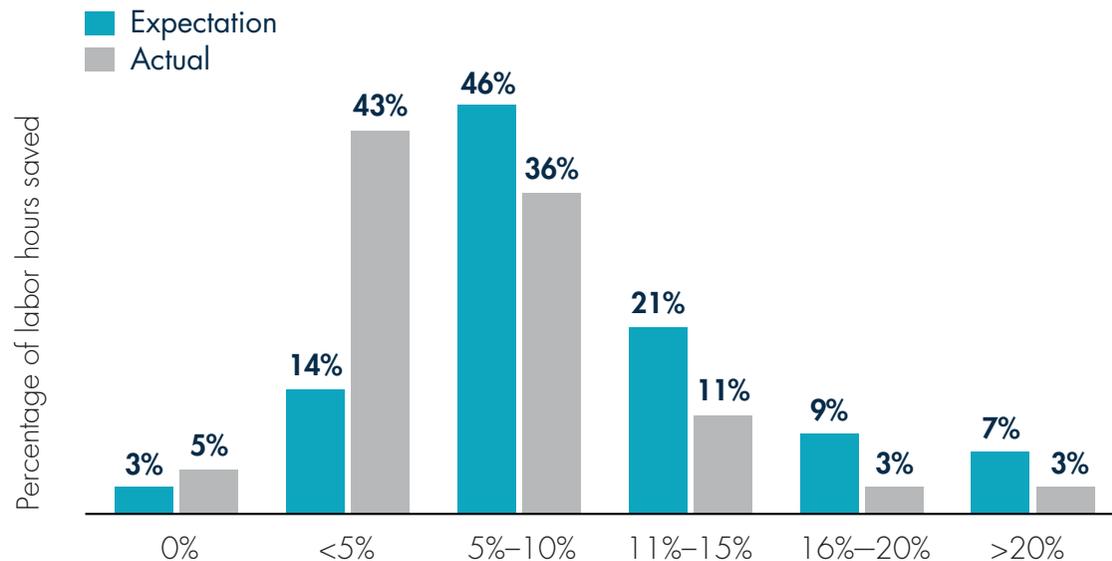
Source: 2017 FMI/BIMForum Prefabrication Survey

3a. Many Survey Participants Achieve Minimal Savings in Total Annual Labor Hours Related to Prefabrication Efforts.

Almost half (48%) of our survey respondents see less than 5% in savings on total annual labor hours related to prefabrication (Exhibit 15). Our findings show that expected total annual field labor cost savings through prefabrication can be linked to prefabrication effectiveness. In other words, contractors that have effective processes in place expect to save more on field labor costs versus those that are less effective (Exhibit 16).

Exhibit 15: What percentage of total annual field labor cost do you expect to save through prefabrication?

What percentage of total annual labor hours did your company save last year that is attributable to your prefabrication efforts?

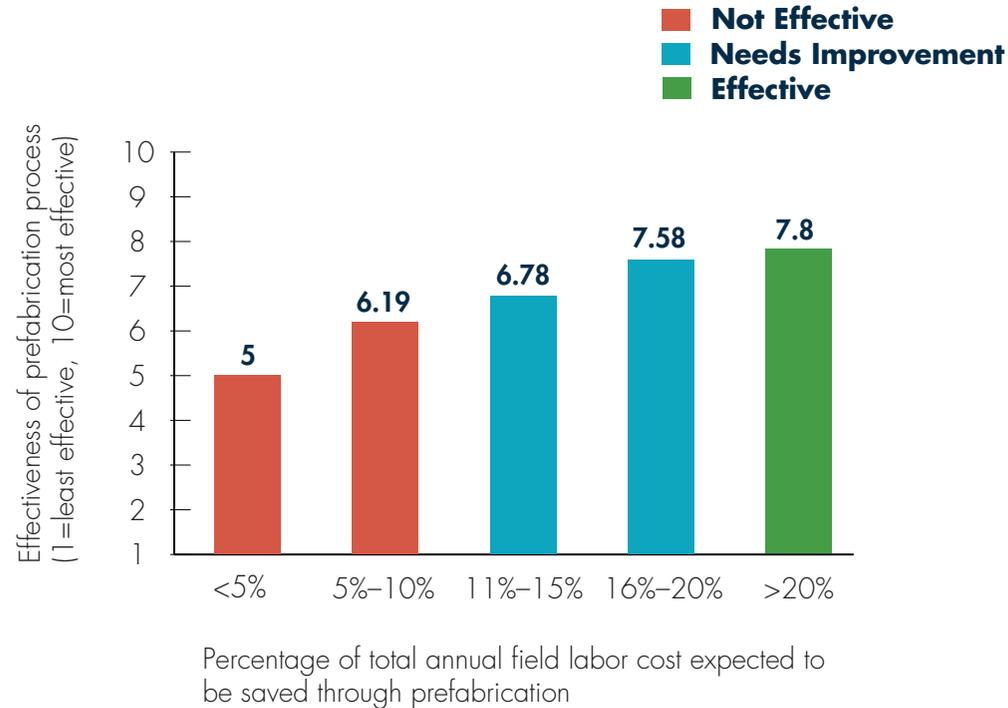


Source: 2017 FMI/BIMForum Prefabrication Survey

That said, these numbers must be interpreted with caution since labor cost savings related to prefabrication have varied definitions. Here are some key factors to consider:

- In most cases, prefabrication shops are more productive on a pure labor hour per unit measurement. However, when the time associated with material handling (unloading, staging, packaging, shipping and delivery) is added, total labor savings are diminished.
- Contractors track prefab labor differently. Depending on how they categorize “activities” (e.g., material handling/staging, installation/assembly, packaging, shipping, delivery, etc.), results may vary. Questions to ask include:
 - Do you know what categories of activity are and are not efficient?
 - Can you improve or eliminate waste?
 - Are you maximizing coordination and sequencing across all stakeholder teams?

Exhibit 16: What percentage of total annual field labor cost do you expect to save through prefabrication?



Source: 2017 FMI/BIMForum Prefabrication Survey

- Shop labor is typically less expensive per hour than field labor. Even if a project requires the same number of hours, if the former is less expensive, then there is still incentive to use prefabrication.
- Prefab shops usually leverage a few experienced people to supervise the work of many less skilled workers. In addition to saving labor hours or dollars, this can also help address the shortage of highly skilled talent (i.e., there are more less skilled people to help fill these positions).

Payback time frames on prefabrication investments are shrinking. In 2010 and 2013, most survey respondents expected a payback period of three years. **In 2016, the majority of our survey respondents expected a payback period of one or two years.**

Again, calculating return on investment on prefabrication efforts is challenging for many contractors. There are lots of different, nontraditional variables to consider when developing an estimate. Questions to ask include:

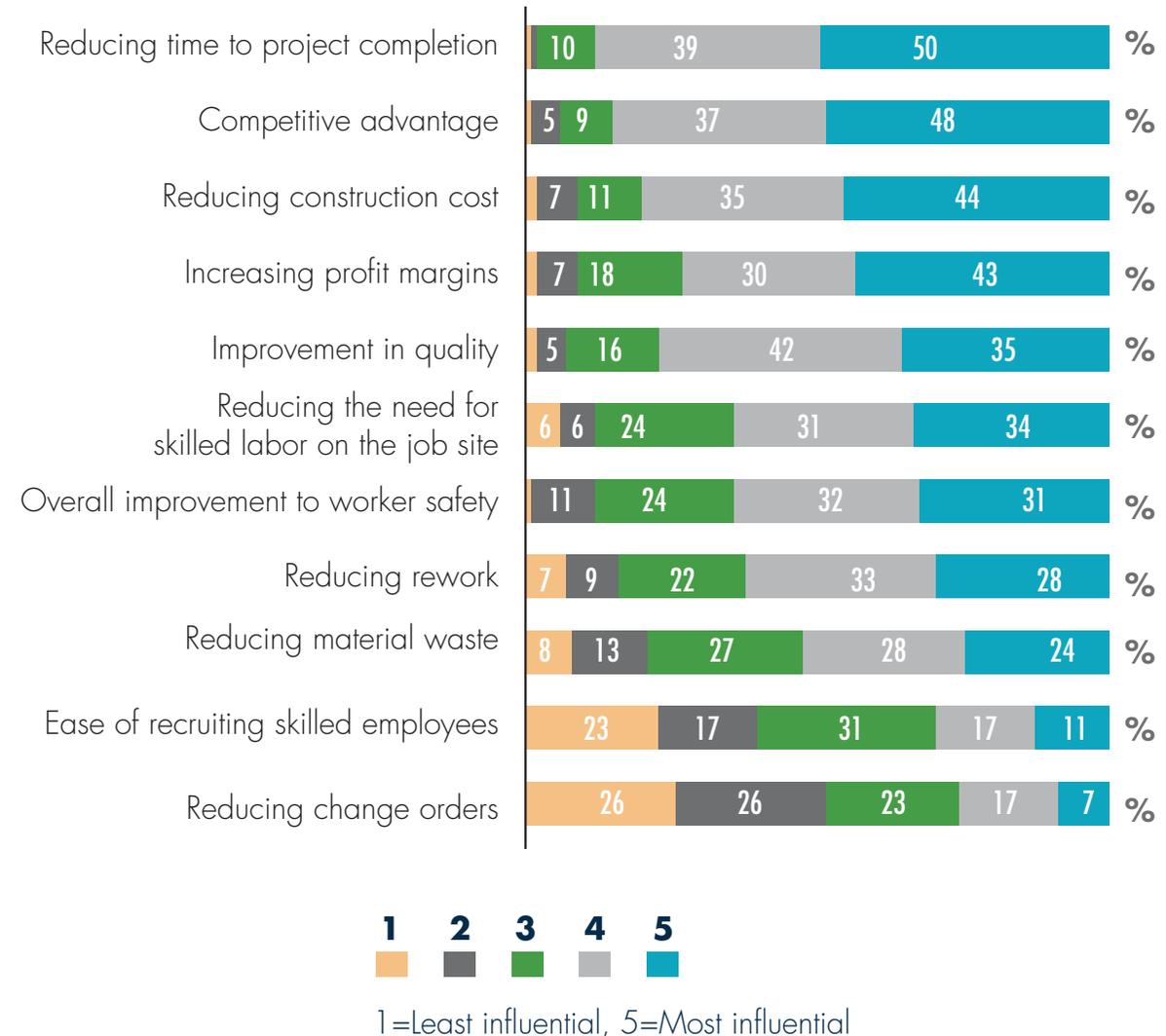
- What are your additional costs (other than obvious direct costs like labor, materials, etc.)? For example, what is the cost of your shop/facilities, utilities, additional equipment/tools and trucks?
- How do you charge for downtime or excess capacity?
- How do you track cost of packaging materials? What is the cost of delivery and on-site staging and transportation?
- How do you quantify some of the associated benefits, such as:
 - Reduced on-site time
 - Tapping a larger workforce by using lower-skilled workers (i.e., greater supply)
 - Competitive differentiator in winning new work
 - Higher margins
 - Better safety and risk control (very important for owners!)
 - Higher consistency in quality output

These are just a few considerations that can generate a host of new, often unexpected issues. For example, Thompson explained, “In the past, projects that took about four weeks to install now only take us three to four days, and then our guys run out of work. So we’re really having to think strategically about how we schedule our prefab work because it gets done so much faster, and now I have a bunch of guys standing around. It’s a good problem to have, but we’re having to re-evaluate how we schedule and sequence our work more carefully.”

Finding 4. Participants Consider Reduced Project Schedules as a Critical Benefit of Prefabrication.

Benefits derived from prefabrication are manifold, and before making big investments, it is critical to think through the real benefits that you are trying to achieve through this new business approach. We often come across contractors who prefabricate “just” to save money. In reality, most contractors don’t save money, but instead they realize many other benefits such as reduced project schedules, better safety ratings, reduced risk and increased chances of winning jobs, to name a few.

Exhibit 17: Rank the benefits of prefabrication most important to project success



Source: 2017 FMI/BIMForum Prefabrication Survey

When we surveyed the industry in 2013, top benefits of prefabrication were “reduced time to project completion” and “reduced construction cost.” The time issue is still one of the top factors in today’s construction environment, but, interestingly, “competitive advantage” now ranks second—a clear sign that owners are starting to see the value of prefabrication (Exhibit 17). Furthermore, given today’s lack of experienced field personnel—combined with ever-increasing project complexity—prefabrication will likely become a game changer in the realm of safety and risk management in the future—two major areas of concern for owners.

As with many new concepts, success breeds success. Prefabrication is no different and therefore it is essential that industry players alter their mindset and get educated on the benefits of modularization and prefabrication. Everyone will need to be open to new approaches to designing, manufacturing, sequencing and putting construction projects in place. Collaboration and partnering skills will be paramount, for example:

- **Owners** will need to be more educated and convinced of the benefits of this approach and will play a critical role in selecting the right teams.
- **Architects** will need to embrace the possibilities and the constraints of modular construction.
- **Engineers** will need to become familiar with the possibilities and manufacturing processes associated with various prefabricated components.
- **Manufacturers** will need to become involved in project discussions at the outset, and contractors and the specialty trades should use prefabrication and modularization to reduce project schedules, improve safety and reduce waste.

Because FMI works industrywide with architects, engineers, contractors and the specialty trades, we are in a unique position to see the positive impacts of prefabrication on the construction value chain. When **planned** and managed correctly, prefabrication and modularization will improve productivity dramatically in the coming decades. The risks and rewards of prefabrication must be shared among all parties that contribute to value creation. **This will call for better coordination and alignment among owners, designers, manufacturers and contractors, and ultimately lead to a more productive and safer industry.**



Business Implications

We always saw prefabrication as a three-step process: Create, Innovate and Revolutionize. Create so it functionally works. Innovate so it holistically works. Revolutionize to improve the industry. It took us three years of hard work through our ‘creating stage’ before we started truly affecting the whole project. We currently reside in our ‘innovate stage,’ focused on making prefabrication affect the bottom line. We continue to see more and more success on our projects and look forward to transitioning into a ‘revolutionize stage,’ impacting the industry and ultimately fulfilling our purpose to ‘Build People, Revolutionize the Industry.’

Geoffrey Golden, President
Golden Construction

Prefabrication is not new, yet our findings show that the industry is still struggling to adopt this manufacturing technique at a broad level. With the rapid emergence of innovative technologies, such as augmented reality, 3-D scanning and printing, XD-BIM, drones, etc., it is easy to get caught up in all the technology buzz and forget about what it really takes to innovate and change.

As discussed earlier, **one of the biggest barriers to change and transformation as it relates to prefabrication is not technology; it’s people and culture.** Table 1 provides some high-level recommendations to consider at the strategic, operational and tactical levels when developing a prefabrication business strategy. These are general suggestions that can serve as a good foundation for creating a customized approach to prepare your company for the future.

STRATEGIC LEVEL

VISION

Start by identifying a compelling prefab vision and communicate that vision clearly to the company.

Ask yourself: Why are we doing prefab, and how does it fit within the broader company vision?

Establish clear objectives for your prefabrication efforts and investments:

- What do you expect to accomplish?
- What will be measured?
- What are you willing to spend?
- How long do you expect a return on investment to take?

OPERATIONAL LEVEL

Develop processes for building “innovation communities” that truly inspire and encourage people to test new ideas.

Promote a collaborative and transparent work culture and build strong bridges between the field and office.

Attract and retain key employees for moving your prefab vision and strategy forward.

TACTICAL LEVEL

Develop specific interview questions for hiring new candidates to make sure they are a good cultural match.

Leaders need to promote buy-in (in the prefab vision) from top to bottom, across all business units, and remain open-minded and flexible.

Employees need to understand what their career can look like long term in the context of a prefabrication business model.

CULTURE OF INNOVATION

Spend your time, energy and resources on your organization’s people and culture. Helping them learn and grow in their thinking, experiences and competencies will pay dividends when you need an innovative shift.

Don’t expect the leader(s) to come up with all the innovative ideas. Every role in your business has a different perspective on how things could be done better. Provide an inclusive way for all voices to be heard—and then listen.

Build a culture that encourages frequent conversations around continuous improvement and better ways of doing things. Create a safe place to talk about failures, learn from those mistakes and teach others in the future.

Develop a framework for idea sharing—both internally and externally.

- Solicit and respond to input from the field.
- Listen for fresh ideas and recommendations on how to improve.

Develop and implement performance management processes that factor in ongoing training, coaching, development and associated performance metrics that are linked to your prefab strategy.

Maintain a strong focus on quality—from assembly through installation.

- Create and track project controls for prefabricated portions of work.
- Consider packaging, shipping/trucking and delivery time/costs.
- Predetermine how you will track inventory, work in progress and finished goods.
- Plan for on-site unloading, conveyance and storage.

Create space for nontraditional employees to join your team. External experiences and perspectives often bring some of the most influential shifts in our industry.

Develop formal learning plans that leverage new technologies, methodologies and outcomes. Leverage millennials in “reverse mentoring” as well as senior leaders in mentorship roles for younger employees.

Identify new skills and competencies required, and develop individualized career plans and adjust on a continuous basis.

STRATEGIC LEVEL

TALENT STRATEGY AND CHANGE MINDSET

Develop a talent strategy that aligns with your corporate prefab vision and strategy.

Communicate regularly on the organization's philosophy around embracing change and explain why that change is necessary.

Pay attention to and give credit for embracing and driving change.

Develop a "manufacturing" mindset and culture:

- Minimize rework and waste
- Maximize throughput
- Track equipment utilization
- Look to improve or eliminate bottlenecks

OPERATIONAL LEVEL

Define performance evaluation and promotion criteria that reinforce the organization's value of a change readiness mindset and change implementation success.

Develop processes for improving collaboration and implement programs to solicit suggestions and feedback from the field, prefab shop and office.

Build a focused and strategic prefab talent development program that is closely aligned with other core operational functions (e.g., estimating, project management, project controls, accounting, etc.) and that aligns with the overall corporate strategic goals.

Develop a communication platform where all employees can provide ideas and suggestions around strategic business issues as well as concerns they may have about less effective characteristics of the corporate culture.

TACTICAL LEVEL

Develop recruitment materials and selection processes that reflect the organization's value of a change readiness mindset and a focus on prefabrication.

Incorporate innovation within talent development programs. Leverage innovation to connect older and younger employees.

Have strong leaders and experienced tradespeople lead the prefab shop, facilities and people.

Anticipate potential feedback and be open to making changes based on input from millennials as well as other constituencies.

Redesign the hiring process to place an emphasis on cultural fit as well as role fit.





Looking Ahead

“ Your enterprise’s business model is already under attack from digital disrupters. It’s time to bite the bullet. ”

Geoffrey Moore, American organizational theorist,
management consultant and author

The year was 1913 when Ford rolled out its first moving assembly line. With this innovation in place, the automaker was able to reduce the number of man-hours spent on final assembly from more than 12 hours to less than three hours. This level of mass production led to significant and immediate changes: Within four years, Model T production rose to 585,388 (from 82,388 in 1912) and the price dropped to \$360 (from \$600).

This year, nearly all Ford vehicles will be built off nine core “platforms” that not only boost manufacturing productivity but also give drivers the fuel efficiency, features and technology that they’ve come to expect in their automobiles.

Although manufacturing cars is very different compared to designing and building structures, we are seeing similar advanced manufacturing capabilities and groundbreaking technologies gaining momentum in today’s engineering and construction industry, disrupting long-established value chains. This “silent movement” is happening in pockets across the country, in different market sectors and across a range of project types and sizes. And while this may not be a sweeping trans-

formational disruption across the entire E&C space just yet, there is no doubt that transformation is happening.

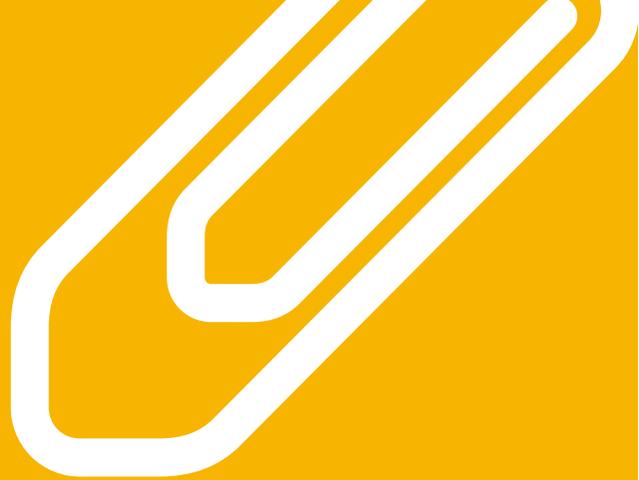
While our study findings indicate that the E&C industry as a whole is still struggling to progress and adapt to these fast-changing dynamics, some firms are taking steps to successfully transform their businesses. For example, a handful of new startup firms are entering the playing field, bringing expertise from high-tech companies such as Google, Nokia and Apple to the table, and challenging long-held industry paradigms around productivity, speed and quality.

These movements underscore the fundamental tectonic shift that is taking place, geared toward systems thinking and streamlining. As design and construction functions are becoming increasingly complex and require ever-more specialization, the disciplines’ segregated silos are crumbling, creating space for integrated, cross-disciplinary thinking. There hasn’t been a better time for owners, contractors, designers and engineers to align with one another across all market sectors and geographies to reinvent collaboration and create innovative partnerships.

As we look to the next five to 10 years, FMI expects the industry to undergo significant changes. **Even though there is a lot of talk about technology and robotics, for example, we strongly believe that your people will prevail as the foundation of your success.** After all, it’s more than just the culture that you create; it’s also about the skills that your employees bring to the table. That’s why investing in those employees is a critical aspect of meeting the needs and requirements of today’s ever-evolving business environment.

It’s important to note that systemic and sustainable innovation requires patience and will likely involve multiple failures, which are a hallmark of a true breakthrough change. It won’t all be pretty and it won’t be smooth, but it will be full of new challenges and opportunity. The firms that remain agile, technically proficient and versatile—and that have extraordinary capabilities in processing vast amounts of information and data—will come out the winners.

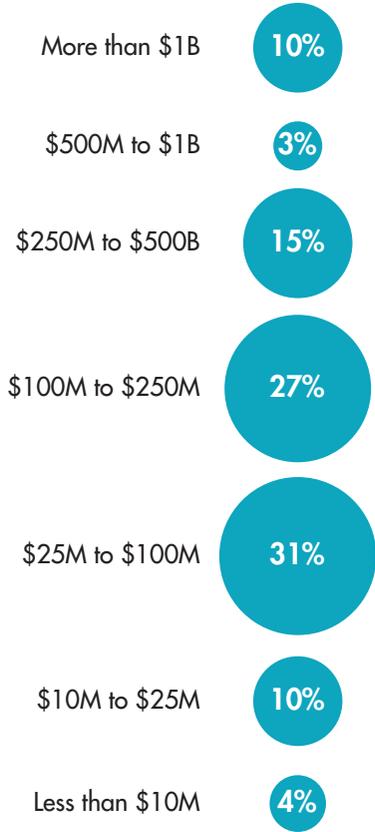
FMI will continue to investigate and research these important trends and promote a constructive dialogue among all industry stakeholders as we move down this new and exciting path.



Appendix

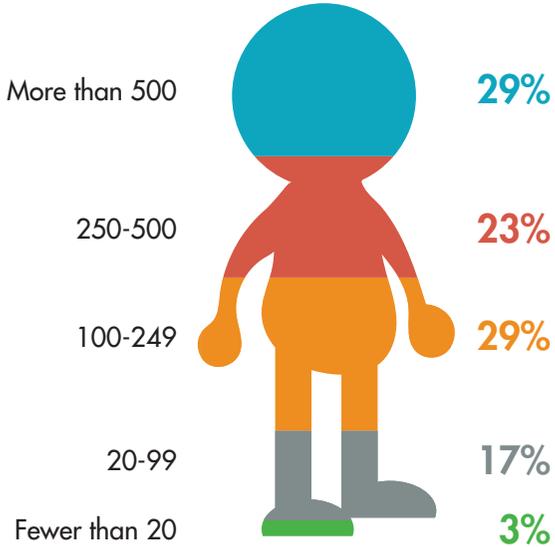
Survey Demographics

What is your organization's annual revenue?



Source: 2017 FMI/BIMForum Prefabrication Survey

How many full-time employees are currently employed at your firm?



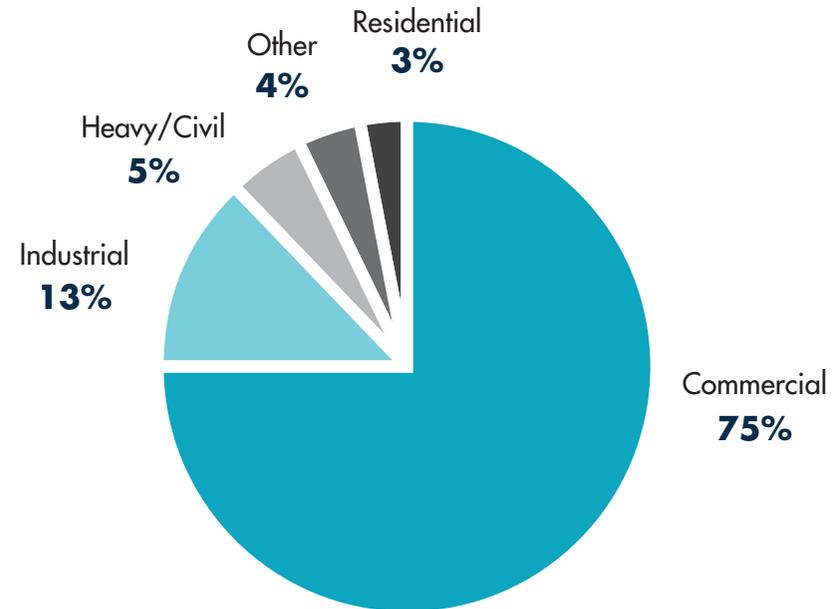
Source: 2017 FMI/BIMForum Prefabrication Survey

Which of the following best describes your organization?



Source: 2017 FMI/BIMForum Prefabrication Survey

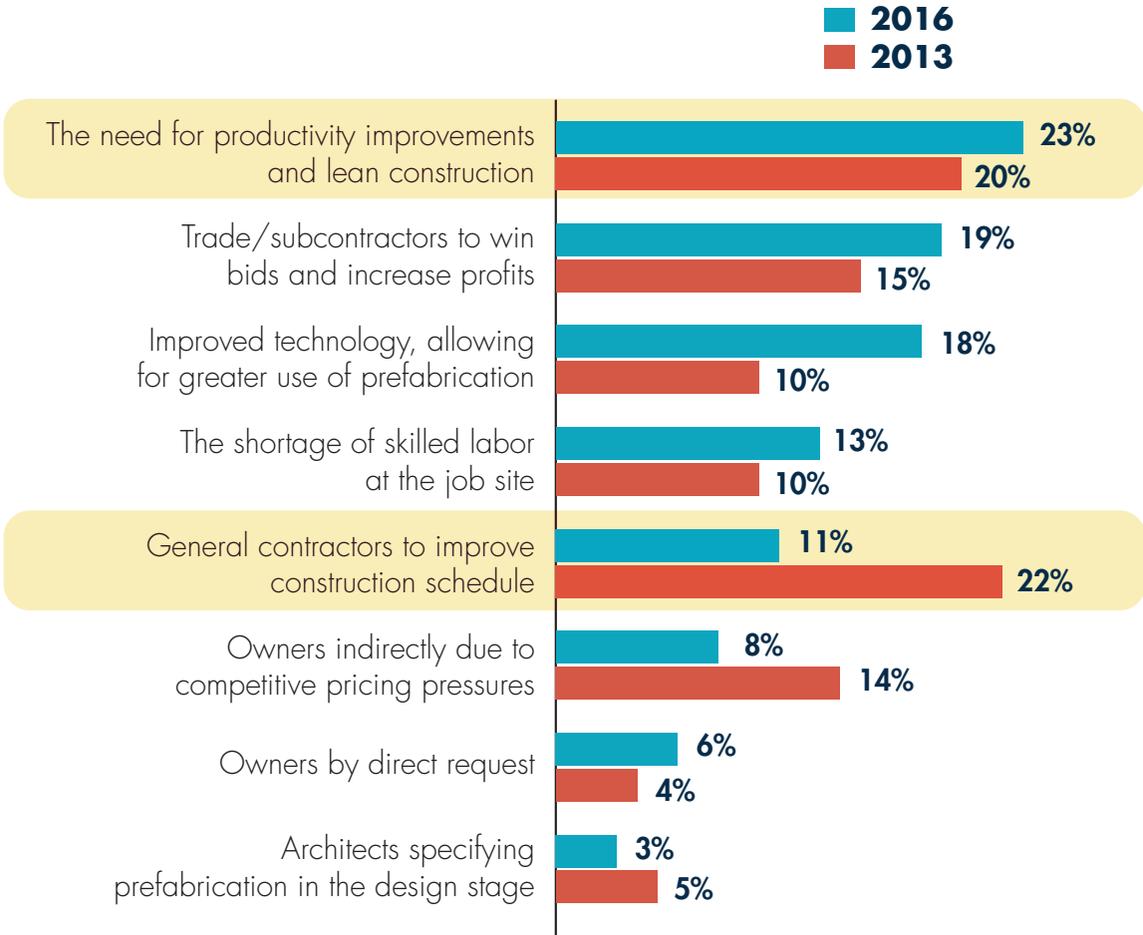
Which of the following construction segments represents the majority of your business?



Source: 2017 FMI/BIMForum Prefabrication Survey

Factors Driving Prefabrication Demand

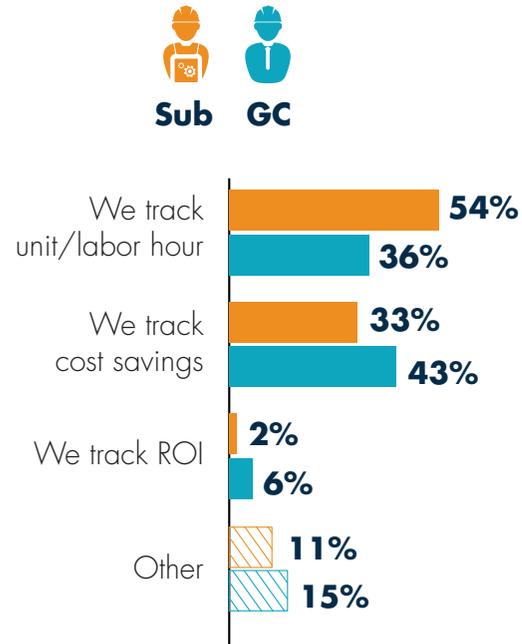
What stakeholders or factors are the primary drivers of prefabrication?



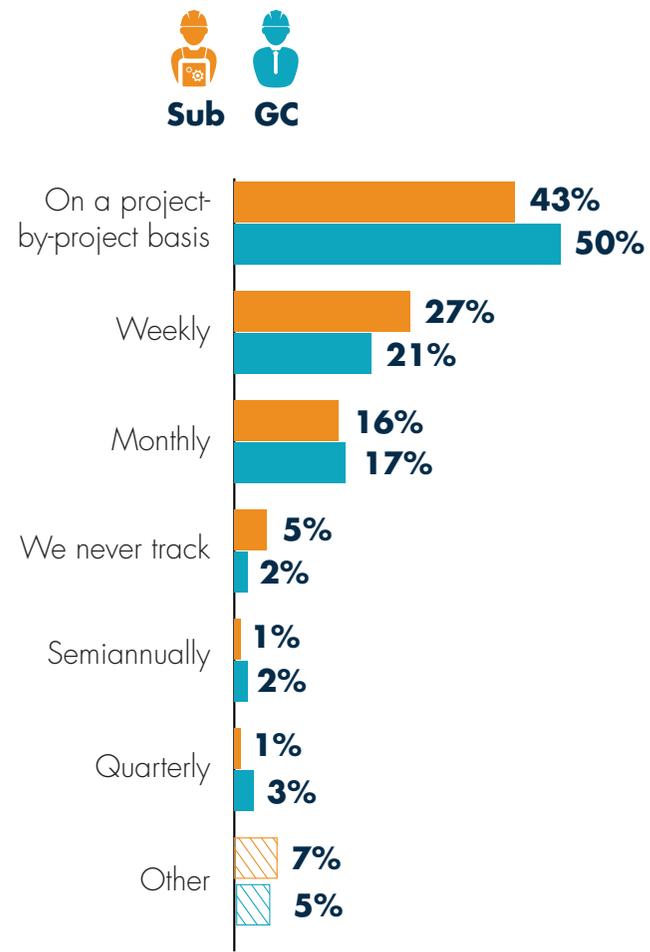
Source: 2017 FMI/BIMForum Prefabrication Survey

Tracking Prefabrication Effectiveness

How do you measure effectiveness of your prefabrication efforts?

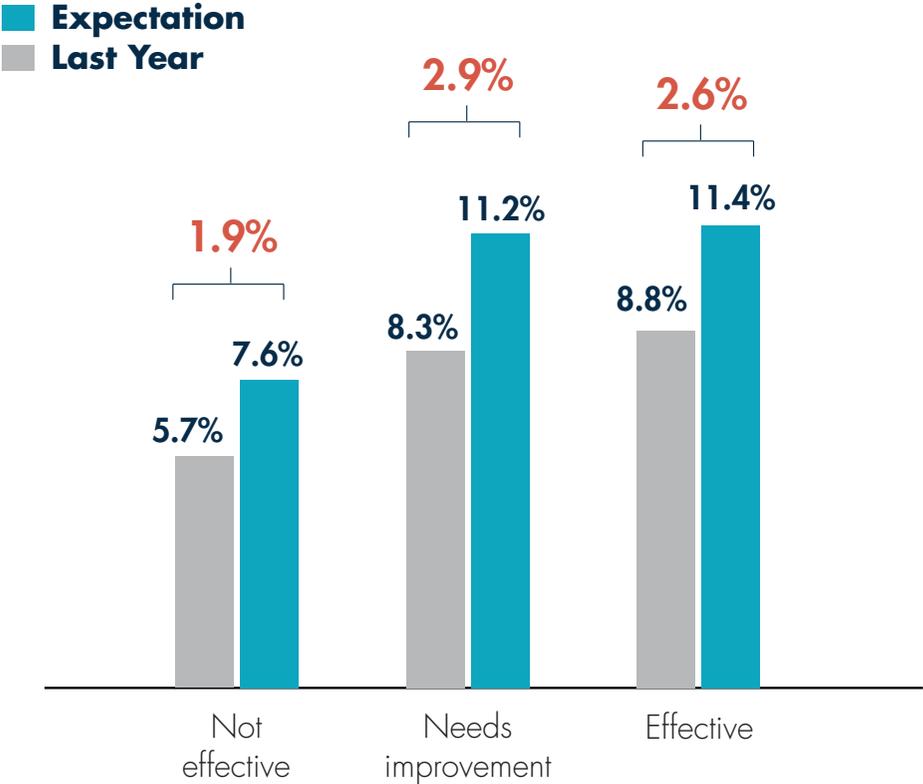


How frequently do you track effectiveness of your prefabrication efforts?



Source: 2017 FMI/BIMForum Prefabrication Survey

Expectations Around Annual Field Labor Cost Savings



Source: 2017 FMI/BIMForum Prefabrication Survey



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About FMI

For over 60 years, FMI has been the leading management consulting and investment banking firm dedicated exclusively to engineering and construction, infrastructure and the built environment.

FMI serves all sectors of the industry as a trusted advisor. More than six decades of context, connections and insights lead to transformational outcomes for clients and the industry.

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