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Industrial Modularization: How to Optimize; How to Maximize

Construction Industry Institute

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**Prepared by
Construction Industry Institute
Research Team 283, Modularization**

**Research Summary 283-1
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Executive Summary

The industrial sector of the capital projects industry is clearly in need of additional guidance on when and how to exploit the benefits of modularization. While the benefits of applying a modular approach to industrial projects—when compared to those of a conventional stick-built approach—can vary in nature and be very significant, the industry has been slow to achieve high levels of modularization. Some would say that the industry has hit a ceiling in terms of the percentage of stick-built work hours being exported offsite.

CII charged Research Team (RT) 283 with responding to this situation, and the team formulated its essential question in the following way:

What changes or adaptations in traditional project work processes are required to create an optimal environment for broader and more effective use of modularization?

Focusing on the industrial sector of the capital projects industry, the team sought to compare an idealized all-modular work process with current, largely stick-built work processes, and to identify key high-value practices that are in need of change. The research methodology included a literature review, surveys, case studies, and external validation, among other features.

Findings from this research led to the development of ***five distinct solution elements***:

- a business case process
- execution plan differences
- critical success factors
- a standardization strategy
- modularization maximization enablers.

Because each of these elements is significant in its own way and should play an important role in achieving higher levels of modularization, industry leaders and project managers should be attentive to them.

1. **Business case process.** The modularization business case process should be applied at the earliest opportunity. It should start as early as the Opportunity Framing phase and be analyzed in greater depth during the Assessment phase. For the industry to truly advance, project teams would be better served by making the modular approach the default approach.
2. **Execution plan differences.** The research team identified more than 100 differences between how modular and stick-built projects should be planned and executed. Moreover, the team assigned these different planning and execution processes to their appropriate phases of implementation. Nearly half of them are applicable during the Basic Design phase.
3. **Critical success factors.** The research team identified 21 high-impact critical success factors (CSFs), noting that the industry appears to be having difficulty achieving many of them. Owner responsibilities for CSF achievement during the Assessment and Selection phases are especially significant.
4. **Standardization strategy.** The benefits of combining modularization with design standardization can exceed the additive sum, and therefore deserve special consideration. Two basic approaches exist: 1) the development of standardized modules; and 2) the development of modular standardized plants (MSPs). The business case for standardization should recognize 10 types of economic advantages and three types of economic disadvantages or tradeoffs. The research team developed an eight-step implementation process for the MSP strategy; the team also performed an MSP case study to provide further insight into strategy implementation.
5. **Modularization maximization enablers.** Lastly, industry-wide barriers continue to challenge the broad-based application of modularization. The fifth solution element consists of a listing of 10 counter-measures to these industry-level challenges.

Introduction

Modularization entails the large-scale transfer of stick-built construction effort from the jobsite to one or more local or distant fabrication shops/yards in order to exploit one or more strategic advantages. Thus, modularization may be considered a form of project business/execution strategy with unique benefits. Over the last 25 years, modularization has proven to be particularly relevant to the industrial sector of the capital projects industry.

Yet the industrial sector is in need of additional guidance on when and how it can more effectively exploit modularization. While the benefits of modularization vary in nature and can be significant, industry has generally been slow to exploit this approach and, except under extreme conditions, has not implemented higher levels of modularization. Some would say that the industry has hit a ceiling in terms of the percentage of stick-built work hours being exported to fabrication shops and yards.

CII Research Team (RT) 283 was charged with addressing this situation and developed its essential question in the following way:

What changes or adaptations in traditional project work processes are required to create an optimal environment for broader and more effective use of modularization?

As implied in the essential question, the reader should recognize that this research summary is not focused on promoting or marketing the concept of modularization, but rather on helping project teams better determine whether modularization is the right strategy for a given project—and if so, how to most successfully implement the strategy. Certainly, many different forms of benefit (such as cost or schedule savings) may result from the modular approach, and these should be examined thoroughly through the recommended business case process.

In its effort to identify key high-value project processes that are in need of change, the team sought to compare an idealized all-modular work process with current, largely stick-built work processes. In addition to finding these processes, the team sought to identify and characterize related critical success factors, and to identify and describe industry-level strategies that, together, can help the industry move toward higher levels of modularization.

The study's scope limitations included the following:

- While many findings from this effort may apply to portions of commercial and infrastructure capital projects, the scope of the study primarily covered the industrial sector of the capital projects industry, which includes process and manufacturing facility projects such as offshore facilities, petrochemical plants, power plants, and pharmaceutical plants, among other manufacturing and processing facilities.
- In contrast to the original, narrower charge from the CII Research Committee, the study scope was deliberately broadened to include front end planning-related and equipment manufacturer-related aspects of modularization.
- While plant design standardization is examined in the context of modularization, it is not addressed in any depth for conventional stick-built projects.

To ensure alignment and to establish a foundation for subsequent developments, the team needed an initial clarification of terminology.

Two key terms include the following:

- **Module:** a portion of plant fully fabricated, assembled, and tested away from the final site placement, in so far as is practical
- **Percent modularization:** a portion of original site-based work hours (excluding site preparation and demolition) exported to fabrication shops.

This publication is organized as follows:

- a research methodology overview
 - data collection
 - case studies
 - validation
- an overview of five different solution elements
 - business case process
 - execution plan differences
 - critical success factors
 - standardization strategy
 - modularization maximization enablers
- brief descriptions of each of the five solution elements
- conclusions and recommendations.

Readers seeking deeper explanations of the five solution elements are directed to Research Report (RR) 283-11, *Industrial Modularization: How to Optimize; How to Maximize*.

Methodology

To illustrate how each of the five solution elements (enumerated and shown in blue) fits into the overall process, Figure 1 provides a graphic overview of the methodology of this research. The process of industrial modularization is well established, and its values and benefits have generally been recognized since it was originally introduced. The literature review conducted in this study investigated the uses of modularization and the benefits it can offer, in terms of increased productivity, lower capital costs, greater quality, reduced waste, and better environmental performance. Beyond its investigation into benefits, the team also documented learnings pertaining to modularization impediments/barriers, comparative pros and cons of modularization, and industry approaches to overcoming the impediments to modularization. The detailed findings of this review may be found in the literature review segment of RR 283-11, *Industrial Modularization: How to Optimize; How to Maximize*.

The broad experience of the research team itself provided the foundation for the development of all five solution elements. The team was composed of extremely well-qualified modularization experts, as evidenced by the team characteristics:

- 17 industry representatives: six owners and 11 contractors
- 450+ years of industry experience
- 170+ modular projects in 13 different countries within the last five years.

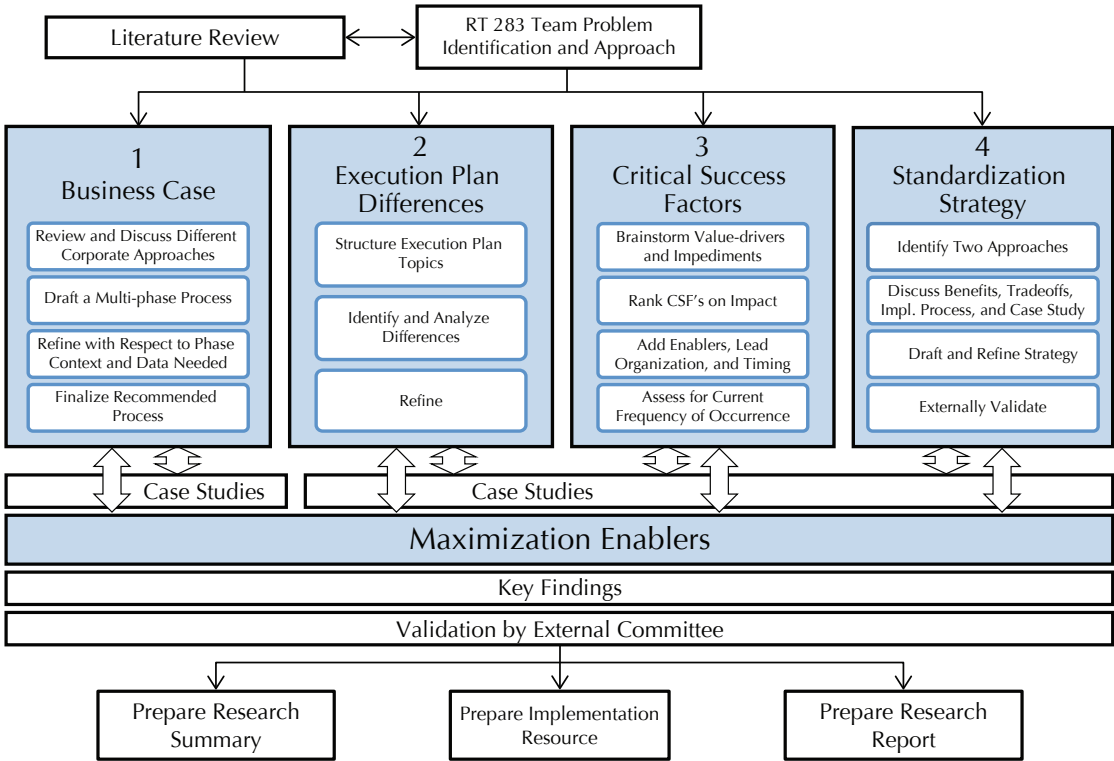


Figure 1. RT 283 Research Methodology