



Construction Industry Institute®

Critical Success Factors for Project Commissioning and Startup

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**Prepared by
Construction Industry Institute
Research Team 312, Best Practices for Commissioning and Startup**

**Research Summary 312-1
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Executive Summary

Commissioning and startup (CSU) is the critical last phase of a capital project before the facility is placed in operation to meet commercial objectives. Unfortunately, many project teams do not effectively plan and implement the activities needed to ensure a successful CSU phase. Recognizing this significant shortcoming, the Construction Industry Institute (CII) chartered Research Team (RT) 312, Best Practices for Commissioning and Startup, to conduct a broad-reaching, data-centric study to determine critical activities for CSU success. After soliciting input from professional experts and collecting and analyzing objective data, the research team first identified 139 potential factors affecting CSU. Next, the team refined this list of potential factors down to 16 critical success factors (CSFs), characterizing them by their specific required actions and positions within the project phase sequence, and firmly demonstrating the need for generally earlier planning of CSU.

The research team also developed a set of unique indicators of CSF achievement to serve as “tell-tales” of whether CSFs have been implemented effectively. Utilizing these tell-tales, the team collected real project CSF implementation data and CSU performance data from 26 capital projects. The analysis of this data convincingly validated the principles and recommended timing of the CSFs. The team conducted additional analysis to determine why certain CSFs are less frequently implemented, and found that project teams should apply particular effort on these “laggard” CSFs.

The research team also showed how the CSFs complement, or can be integrated with, the steps of the CII Planning for Startup best practice model (described in CII Implementation Resource (IR) 121-2). In addition, the team identified five technologies that add value to the efforts of CSU teams and project stakeholders. The final RT 312 product was the user-friendly CSU Critical Success Factor Implementation Checklist, a tool for developing project execution and CSU plans, and for managing CSU

efforts all the way through to project completion. The checklist is part of IR 312-2, *Achieving Success in the Commissioning and Startup of Capital Projects*, a two-volume publication offering implementation guidance and case study summaries.

Commissioning and startup success largely determines whether a project is ultimately successful. Thus, the value proposition for rigorous, thorough CSU planning cannot be overstated. Use of the 16 critical success factors identified in this research, along with other research team findings, will help project teams ensure the achievement of full project value.

Introduction

Purpose and Objectives

Successful project commissioning and startup (CSU) are crucial for capital project investments. Yet the performance of capital project commissioning, startup, and initial operations often falls short of expectations. Such efforts are often not well-planned or effectively implemented. Team expectations pertaining to operating performance, schedule, and cost often go unmet. Because the industry needs a clearer understanding and deeper appreciation of effective approaches to commissioning and startup, RT 312 sought to study these approaches and formulate implementation guidance to help ensure success. The team also investigated new technologies and management techniques for further enhancing the performance of commissioning and startup.

The purpose of this research was to identify management approaches and new technologies that will enable successful commissioning and startup of capital projects. The team established the following six research objectives:

1. Broaden the understanding of key terms pertaining to commissioning/startup/initial operations.
2. Identify critical success factors (CSFs) that can enable stepwise advancement during the planning and execution of project commissioning, startup, and initial operations.
3. Understand the current extent of CSF achievement and identify relevant barriers to their full achievement.
4. Analyze project commissioning/startup performance relative to the extent of CSF implementation and, thereby, understand the relative contribution from CSFs to actual commissioning performance.
5. Show how the critical success factors link to the CSU model presented in IR 121-2, *Planning for Startup*.
6. Identify innovative technologies that can further leverage CSU performance.

Once implemented, the products from this research should contribute significantly to safer and more successful facility commissioning, startup, and initial operations. Facility owner/operators are the primary beneficiaries of this research, especially those in the industrial sector. Capital project team members involved in the planning and implementation of facility commissioning and startup (both contractors and owners) are also intended beneficiaries.

Scope Limitations

This study focused on commissioning, startup, and preparation for initial operations of industrial facilities, in markets such as petro-chemical, power, water/waste-water treatment, and nuclear power, among others. In addition, most findings also apply to systems-intensive building and infrastructure projects, such as pharmaceutical facilities, hospitals, and airport projects. Facility operations considerations are limited to issues and opportunities prior to and during operational ramp-up periods, and up to and including final plant performance-testing. Steady-state plant operations issues that occur after final performance testing were outside the scope of this study. Included in the scope are industry best practices for commissioning/startup/initial operations that can be performed during any project phase. Although integrating parts of this research into the IR 121-2 model was part of the research scope, comprehensively updating or revising that resource was not.

Methodology

Research Methodology

The research methodology comprised a literature review, model development, surveys of industry commissioning experts, and different forms of validation of findings, including a review by an external panel. (See Figure 1.) The focus of the process was to determine the critical success factors (CSFs) for the planning and execution of commissioning and startup. After surveying 40 commissioning experts, the team was able to identify 16 CSFs from its initial list of 139 potential factors. Table 1 lists these CSFs in the order in which they should be implemented. Once the CSFs were determined, seven subsequent CSF-related developments followed:

- CSF links to the IR 121-2, *Planning for Startup*, activity flowcharts
- four commissioning failure mini-case studies, highlighting the “missing” CSFs on the project studied
- links between CSFs and project quality and safety
- timing of CSF implementation (within the project context)
- CSF indicators of achievement
- frequency of CSF accomplishment (industry benchmarking)
- CSF/Indicator checklist tool.

Other steps in the research process included the following: formalization of CSU phases and milestones, along with the development of key terms; identification and characterization of innovative commissioning technologies; identification of barriers to implementation of the less frequently achieved CSFs; and, very importantly, analysis of project commissioning performance relative to levels of CSF implementation on sample projects. The appendix illustrates the relationship between CSU phases and milestones. Research Report (RR) 312-11, *Identification and Implementation of Critical Success Factors in the Commissioning and Startup of Capital Projects*, provides a more detailed discussion of the research methodology and literature review.

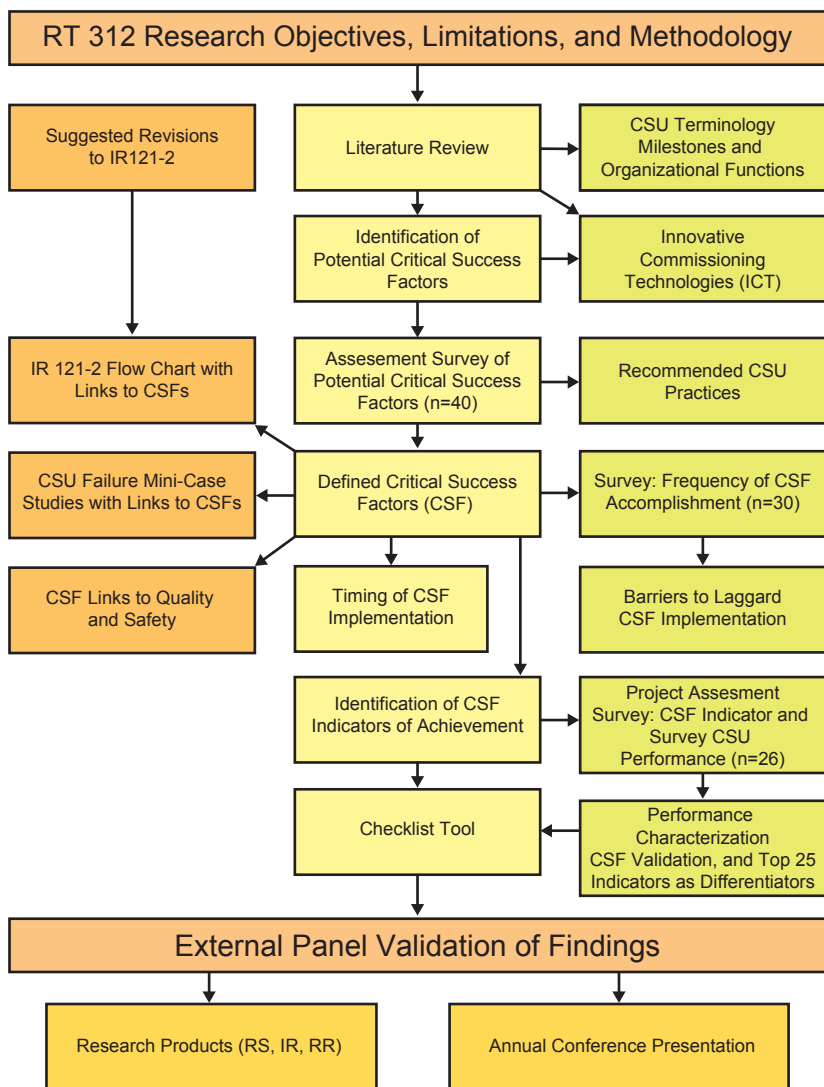


Figure 1. Overview of Research Methodology

Table 1. CSU Critical Success Factors

1	CSU Value Recognition
2	Critical Interfaces on Brownfield Projects
3	Adequate Funding for CSU
4	Alignment among Owner PM, Operations, CSU, Engineering, and Construction
5	CSU Leadership Continuity
6	System Milestone Acceptance Criteria and Deliverables
7	CSU Systems Engineering during FEED
8	Recognition of CSU Sequence Drivers
9	Detailed CSU Execution Plan
10	Systems-focus in Detailed Design
11	CSU Check-sheets, Procedures, and Tools
12	CSU Team Capability
13	Integrated Construction/CSU Schedule
14	Accurate As-built Information
15	Transition to Systems-based Management
16	Collaborative Approach to Construction-CSU Turnover

Research Team (RT) Member Background

The extensive CSU expertise of the RT 312 members enabled them to contribute significantly to the development of the CSU model presented here. With an average of 25 years of experience each, these 18 domain experts collectively possessed 453 years of industry experience. Over the course of their careers, these industry veterans participated in or led the CSU efforts on a total of 572 projects, with an average of 32 projects each. Among them, one is a corporate practices standards manager, two are asset managers, two are project managers, seven are commissioning managers, one is a design manager, three are construction managers, and two are fabricator/supplier managers.

Validation Approach and Panel

The research team took two approaches to validating the research findings:

- The 16 CSU critical success factors were validated by determining any relationships between commissioning/startup performance and levels of CSF implementation on sample projects.
- All study findings were provided to an external review panel of nine commissioning experts for feedback. Where appropriate, panel feedback comments resulted in modifications to the research findings.