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A New Approach to Assessing and Measuring Project Complexity

Construction Industry Institute

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A New Approach to Assessing and Measuring Project Complexity

**Prepared by
Construction Industry Institute
Research Team 305, Measuring Project Complexity and Its Impact**

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Executive Summary

The Construction Industry Institute (CII) established Research Team 305 (RT-305), Measuring Project Complexity and Its Impact, and tasked it with developing a method of measuring project complexity and determining how that complexity drives project-related decisions. CII selected this area of research because project complexity is widely believed to affect project outcomes—in fact, complexity is often cited as a key cause when a project does not achieve cost, schedule, or functional objectives. The construction industry would benefit from having a definition of complexity that is specifically tailored to the planning and execution of projects.

In addition to defining project complexity, RT-305 was chartered to study the attributes of complexity and to identify the influence of project complexity on different aspects of projects, such as cost, schedule, quality, and project performance. The work expanded, and the team developed methods to measure complexity and identify strategies that mitigate and manage the negative effects of the identified attributes of complexity. The team framed this task with the following purpose statement:

The purpose of this project is to develop a methodology and tool(s) to help organizations identify, measure, and respond to project complexity. When applied the tool will encourage organizational change in awareness, behavior, and increase the likelihood of successfully achieving project goals.

Prior to moving forward with developing measures of complexity, RT-305 developed a working definition of project complexity:

Project complexity is the degree of interrelatedness between project attributes and interfaces, and their consequential impact on predictability and functionality.

The team defined complexity in terms of the number of attributes and their interactions when managing projects, rather than ascribing complexity to specific physical attributes (e.g., types of materials, quantities of materials, number of systems, or facility technology). Describing complexity in terms of project management was necessary to ensure that the process could be generalized across industry sectors, or within an industry sector but across different types of construction projects.

To determine which complexity measures were significant in differentiating low- and high-complexity projects, RT-305 surveyed construction organizations to test 40 complexity attributes and 92 complexity indicators. Drawing on the responses from 44 projects, RT-305 identified that 37 of the original 92 indicators statistically differentiated low- from high-complexity projects. Since only three of the 37 indicators correlated directly to cost performance, and only one correlated to schedule performance, the survey results suggest that the level of complexity generally does not directly influence project outcomes. The relationship between complexity and performance appears to be indirect and dependent on the project team's ability to identify and manage indicators of complexity.

RT-305 incorporated these findings into a tool to help project teams assess and manage a project-specific set of complexity attributes: the Excel-based Project Complexity and Management (PCAM) Tool. This tool enables teams to control the drivers of project complexity and to manage and mitigate the risks they pose. The PCAM Tool can be found in Implementation Resource 305-2, *A Guide to Assessing and Managing Project Complexity*.

Introduction

“Complexity” is a term applied to projects throughout the construction industry, but most assessments of low or high complexity are based on little more than intuition or comparisons to other projects that are more familiar to an organization or its industry sector. No single, standard definition of project complexity applies to all types of projects, and the industry has no consensus understanding of project complexity: what it means or how it should be measured. Yet the fact persists that complex projects always present additional management challenges to achieving project objectives. Project complexity merits study and better understanding.

By drawing on historical experience and the current era of project performance and record-keeping, construction professionals have established that greater complexity affects a project’s delivery, management practices, and overall performance. Project complexity can especially have final measurable impacts on safety, cost, schedule, and quality. Even on a suitably staffed project with an experienced team, when one of these four areas fails to deliver on expectations, complexity and the team’s inability to manage it effectively are frequently cited as root causes.

Project complexity can have negative impacts on a project when it is handled poorly, but complexity does not always lead to flawed projects, and complexity need not be eliminated under all circumstances. To the contrary, complexity is often intentionally increased when it offers a clear potential benefit. By understanding the trade-offs, project teams can achieve benefits by effectively managing complexity.

As projects become larger, complexity typically increases. Complex projects demand greater, more sophisticated, and more proactive planning. Project teams should focus on addressing the complexity factors they are able to identify, and dedicating proper resources to manage them. The requirements for successful execution of complex

projects (e.g., planning, focusing on complexity factors, application of resources) go beyond existing management processes and techniques. While typical planning and standard-size management teams are sufficient for routine and lower-complexity projects, these teams can become overwhelmed by projects with greater complexity.

Accordingly, CII assigned RT-305 with the topic of *Measuring Project Complexity and Its Impact*, chartering it to:

“[D]evelop a methodology (including potential tool(s)) to help organizations identify, measure, and respond to project complexity to hasten organizational change in behavior and to increase the likelihood and/or predictability of achieving desired outcomes.”

To accomplish these goals, RT-305 brought together a diverse team of industry and academic professionals. The team included owners and contractors, leaders in government and industry, national and international corporations, seasoned professors and energetic graduate students. The team used its wide range of project experience and firm foundation in project management to address the central research questions:

How do we measure complexity, and how should the level of complexity drive project-related decisions?

The team addressed these central questions by formulating five primary objectives that provided the framework for the RT-305 research:

1. Define project complexity and its facets, including how complexity differs from other factors that drive project performance (e.g., risk indicators and execution difficulty).
2. Develop a methodology for determining a project's level of complexity.
3. Develop a complexity measurement approach that project teams can use.
4. Assess the relationship between project complexity and project outcomes, considering project practices and decisions (commercial, technical, and managerial).
5. Identify the best practices for addressing the identified complexity attributes.

Developing a Workable Definition of Project Complexity

Without a standard definition, complexity tends to become a catch-all category that is used whenever project results are unpredictable. (“Lack of predictability” was one attribute of project complexity identified during RT-305 research.) Complexity is also claimed whenever details of a project are poorly understood, scope is fluid, stakeholders can modify project plans and objectives, or project conditions exceed what is typically perceived to be “normal.”

A project team’s assessment of complexity should include, but not be limited to, scope and execution objectives, such as the number of interacting parts, team experience, resource availability, stakeholder considerations, and other factors that influence team decisions. To address these issues, RT-305 chose not to describe complexity primarily in terms of a project’s physical features (e.g., logistics, quantities of materials, number of systems, and technology), but rather to address complexity as it relates to project management. This approach made the team’s complexity measurement methods apply to the greatest variety of project types. A project’s physical features were captured as “complexity attributes” in the assessment method, and the team’s products could be generalized across industry sectors and, within an industry sector, across different types of projects.

After discussing the nature of complexity, RT-305 chose the following definition of complexity as the basis for its research:

Project complexity is the degree of interrelatedness between project attributes and interfaces, and their consequential impact on predictability and functionality.

This definition captures how project attributes, project scope, team organization, project location, policies and legal regulations, new technologies, and workforce skill sets interact within projects and across their business and environmental contexts. When projects have specific management techniques in place to track, control, and manage project complexity attributes, they are more likely to be predictable and successful.