



## Nature Of Project Complexity In Five-dimensional Project Management

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**Abstract:** *Complex projects involve an unusual degree of uncertainty and unpredictability. The project manager must make decisions in an environment in which many of the critical factors are outside the project team's direct control. This situation leads to iterative planning and design to adjust the PMP to address seemingly random events that create unforeseen changes in the project's scope. Project complexity is dynamic. Its components interact with each other in different ways, like pieces in a chess game. Although the project's ultimate scope may be uncertain in the early stages of project development, the project team must develop solutions to satisfy external stakeholders who can affect the agency's ability to achieve the complex project's objectives. The level of uncertainty may also vary with the maturity of the individual organization.*

**Key Words:** complex, projects, uncertainty, unpredicatability, environment, iterative, complexity.

The move to the 5DPM model for complex projects requires modifying traditional methods and implementing new project management tools and techniques. This guide provides a methodology that is based on the experience of seasoned complex-project managers and that draws from the study of the successful delivery of complex transportation projects.

**Resource Commitments-** Allocating resources to complex transportation projects requires a shift from traditional resource allocation models. With the traditional (noncomplex) project, the owner, designer, and builder assume duties in their customary disciplinary "stove-pipes," and contracts govern collaboration among and coordination with other stake-holders. Complex projects require truly integrated delivery, making horizontal rather than vertical integration a key element of success. In general, the owner, typically a state transportation agency, is responsible for managing the financing and funding and the contextual factors such as right-of-way acquisition; National Environmental Policy Act, National Historic Preservation Act Section 106, and Section 4(f) obligations of the U.S. Department of Transportation (DOT) Act of 1966; communication with local community groups; and so forth. The designer manages quality, compliance with codes and standards, and functionality. The

builder is responsible for handling costs and schedules. The primary responsibilities of the designer and builder form the "iron triangle" of quality, cost, and schedule. However, for complex projects, the uncertainty and dynamic interaction between the management activities of all project partners require that project management expand to a five-dimensional framework that elevates financing and context to the same level as the three traditional dimensions and changes the owner from an administrator to an active player with production responsibilities.

**Renewal Projects-** Transportation professionals recognize the uncertain condition of the nation's highway network and are actively searching for ways to deliver infrastructure projects "better, faster, and smarter." Because of the pressing need, one of the primary objectives of the SHRP 2 Renewal Program is to develop tools that help DOTs "get in, get out, and stay out." Project management is the catalyst that initiates the implementation of the various technical innovations developed through the SHRP 2 Renewal Program. The January 2010 SHRP 2 Program Brief: Renewal states it this way: "Rapid renewal scenarios may require unusual project management practices and involve different risks and performance parameters. Renewal research is developing innovative strategies for managing



large, complex projects, a risk management manual, and performance specifications that contribute to successful innovation" (SHRP 2 2010).

Randell Iwasaki, chair of the SHRP 2 Renewal Technical Coordinating Committee, furnished the following vision in the same program brief: "As the results of the SHRP 2 research are deployed, we will see more 'rapid renewal' tools developed for owners of the transportation system. The tools will lead to a fundamental change in how we approach rehabilitating our transportation system. We will be able to develop projects that are completed quickly, with minimal disruption to communities, and to produce facilities that are long lasting" (SHRP 2 2010).

**Additional Programs:** Available to Facilitate Complex Renewal Project Delivery Several established programs are available to facilitate the management of certain aspects of renewal projects. The guide, training, and other deliverables derived from the SHRP 2 R10 project are not intended to replace any other programs, but to complement them. The following descriptions are provided to assist in identifying other project management programs that may be beneficial.

**Every Day Counts:** In June 2010, FHWA added its unequivocal support to the national vision for rapidly renewing the highway system when it introduced its Every Day Counts initiative to address rapid renewal and other issues of similar importance. The Every Day Counts program is designed to accelerate the implementation of innovative practices that are immediately available, as described by FHWA Administrator Victor Mendez:

Our society and our industry face an unprecedented list of challenges. Because of our economy, we need to work more efficiently. The public wants greater accountability in how we spend their money. We need to find ways to make our roads safer. And, we have an obligation to help preserve our planet for future generations. But, it's not enough to simply address those challenges. We need to do it with a new sense of urgency. It's that quality urgency that I've tried to capture in our initiative, Every Day Counts. (Mendez 2010)

Creating an atmosphere of urgency inside technocratic public transportation agencies is itself a challenge. Hence, the FHWA Every Day Counts (EDC) program focuses on proven innovations employed successfully by state DOTs: "EDC is designed to identify and deploy innovation aimed at shortening project delivery, enhancing the safety of our roadways, and protecting the environment . . . it's imperative we pursue better, faster, and smarter ways of doing business" (Mendez 2010).

**Accelerated Construction Technology Transfer:** The Accelerated Construction Technology Transfer (ACTT) program brings national project management experts to the planning, design, and construction of major high-way projects. A three-day ACTT workshop targets technical and administrative technologies that reduce construction time, save money, improve safety, and elevate quality. ACTT workshops result in a comprehensive analysis of the major project by transportation experts to identify solutions for the specific agency's complex-project goals.

Historically, highway renewal projects resulted in major traffic congestion in large urban corridors, angering the traveling public and increasing the pressure to "get in, get out, and stay out." The ACTT program focuses on achieving these objectives.

**Major Project Delivery Process:** FHWA and state DOTs have a well-established process for planning major projects that includes risk management, National Environmental Policy Act processes, and financial planning. Transportation agency leaders and project managers must deal with many uncertainties when analyzing the allocation of highway appropriations; however, many uncertainties are quantifiable in terms of their probability of occurrence and impact of outcomes. Uncertainty is commonly termed risk. Risk analysis checks the cost-effectiveness of risk mitigation measures and forms the centerpiece of the FHWA major project delivery process.

However, for complex projects, risk evaluation must transcend traditional sensitivity



analysis because critical input variables often have high degrees of uncertainty and vary in dynamic, interrelated ways. The major project delivery program advocates the use of probabilistic-based risk analysis, most often through a method known as Monte Carlo simulation.

Monte Carlo simulation uses probability distributions based on expert opinions or historical data. The output gives complex-project managers a better understanding of the relationships between cost and time uncertainties. This understanding helps project managers to determine which variables in the project have the greatest impact on achieving project cost and schedule objectives and to form risk mitigation plans.

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