A SHRP 2 Renewal Brief

PROJECT R10

Strategies for Managing Complex Projects

MARCH 2014

Rapid renewal projects that replace, expand, or renew existing infrastructure vary both from new construction and from each other in several ways: engineering complexity, size, modality, jurisdictional control, financing approach, contract type, and delivery method. Each project calls for a distinct project management style and requires teams that comprise different skill sets to achieve successful completion. To meet the demands of rapid renewal, the practice of transportation project management is transitioning to an approach that recognizes this complexity and defines success by measures of project performance.

The objective of SHRP 2 Renewal research project R10: Project Management Strategies for Complex Projects, was to provide transportation agencies with innovative and effective project management strategies that can help accelerate sound decision making during rapid renewal projects. The research team investigated what makes projects complex and how complexity is being managed successfully. Fifteen projects in the Unites States and three international projects were investigated through in-depth case studies to identify tools that aid managers of complex projects in delivering projects successfully.

Through the case study analysis, the research team identified five dimensions of project management for complex projects, five methods for use on every complex project, and 13 tools that may be helpful on complex projects. These techniques underlie a new emphasis on the role and perspective of the project manager, which is discussed in detail in the project final report, Project Management Strategies for Complex Projects. A guide to implementing these tools was published in a separate volume titled, Guidebook: Project Management Strategies for Complex Projects; and training materials were developed to encourage adoption of the techniques. This project brief provides an overview of the new strategies and tools for managing complex projects developed by SHRP 2 Renewal Project R10.

Five Dimensions of Complexity

To meet the challenges of complex projects, both large and small, project managers ultimately must optimize the available resources (time and money) with the technical performance needs of the project (design), while operating under both known and unknown constraints (context) and accommodating the requirements of new financing partners and funding models (financing). These interrelated demands require owners to think continuously about risk and opportunity as they may arise in budgeting, scheduling, designing, allocating, and pricing. The five dimensions of complexity are further described in this section.

- Cost: Involves quantifying the scope of work in dollar terms. Cost considers project estimates, uncertainty, contingencies, project-related costs, and project cost drivers and constraints.

- Schedule: Relates to the calendar-driven aspects of the project. The schedule considers time, schedule risks, prescribed milestones, and availability of resources.
- Technical: Includes all of the typical engineering requirements. This dimension considers design requirements, scope of the project, quality of construction, the organizational structure of the owner/agency, contract language and structure, and the implementation of new technologies.
- Context: Encompasses the external influences that have an impact on project development and progress. Context factors include stakeholders, environmental issues, legal and legislative requirements, local issues, and project-specific factors.
- Finance: Relates to the need for understanding how the project is being paid for and integrating that knowledge into the scope of work. The mechanics of financing can have a direct impact on the project design, the speed with which the project can be delivered, and the ability to achieve contextual requirements.

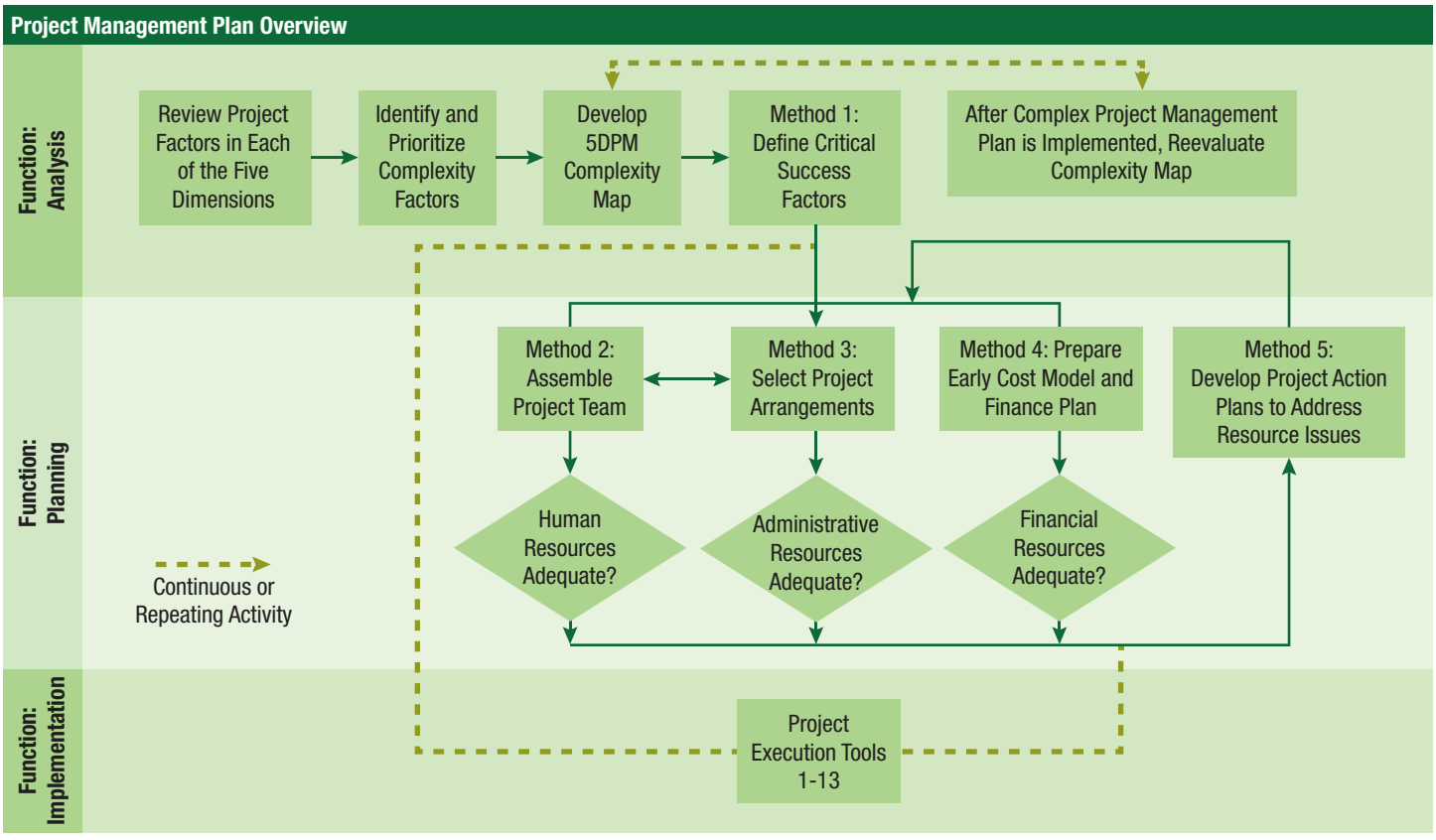
The basic premise of five-dimensional project management (5DPM) is that each dimension presents the manager of a complex project with a set of requirements to be satisfied and that optimizing the resources to ensure the project is delivered in the required period, with the available financing, and furnishing the requisite level of capacity, is the end goal of the process. Figure 1 illustrates the process flow for SDPM.

The SDPM approach starts by inventorying the project requirements and constraints and associating each with a given dimension. By identifying the constraints imposed on the project at a very early stage, the project manager can then gain input, support, and resources from the affected stakeholders so that the final project is satisfactory to all parties. Once completed, the inventory can be used as a risk register to generate the means and methods to deliver project requirements within the cost, schedule, technical, contextual, and financial constraints identified in the inventory.

Five Project Planning and Analysis Methods for Every Complex Project

The five project planning and analysis methods are used to identify project execution tools that can be used to help achieve the critical project success factors. These methods should involve executive-level personnel, as well as project-level personnel and should be implemented at the very earliest stages of the project lifecycle to effectively manage overarching degrees of complexity that are not attributable to one specific dimension of complexity.

Figure 1. Overview of complex project management and 5DPM process flow



In general, Method 1 involves identification of critical success factors, which are then used to allocate human (Method 2), administrative (Method 3), and financial (Method 4) resources. Any potential remaining barriers to success or resource constraints are addressed through targeted or general project action plans in Method 5. Tools such as a scale for scoring project complexity and complexity maps, as in Figure 2, help define and rank the critical project success factors.

Method 1—Define Project Success by Each Dimension: To overcome the uncertainty and irregularity that are characteristic of the dynamics of complex projects, the team needs a simplifying method to guide decisions and analyses. Complexity maps and flow charts are used to support the analysis.

Method 2—Assemble Project Team: The outcomes of Method 2 identify team responsibilities and authority. The process uses a gap analysis in which project needs such as skills, knowledge, responsibility, and authority are identified and compared to in-house resources and capabilities.

Method 3—Select Project Arrangements: The outcomes of Method 3 are the procurement plan, delivery methods, and other project arrangements (for example, interagency agreements, utilities, railroads, authority transfers, funding) that are required to achieve project success, as well as selection of project execution tools that support project success.

Method 4—Prepare Early Cost Model and Finance Plan: The outcomes of Method 4 are a cost model for the project, a list of secure identified funding sources, positive or negative differences in fund balance, and a funding plan, as well as selection of project execution tools that support project success.

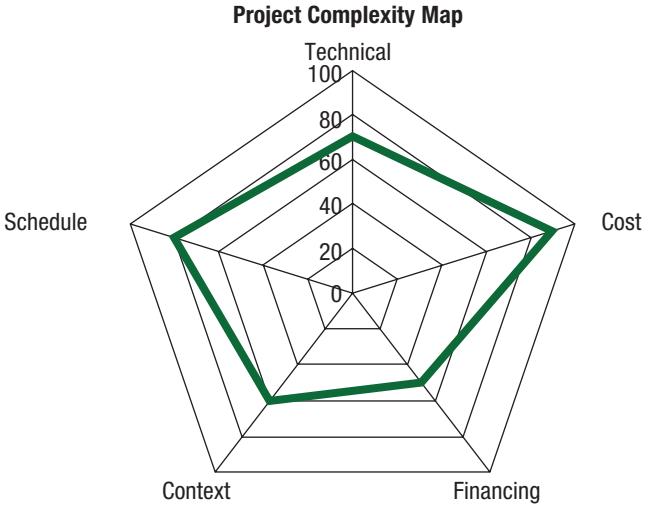
Method 5—Develop Project Action Plans: The outcomes of Method 5 are a clear understanding of the influence of external stakeholders and a plan to direct this influence positively to achieve project success, as well as targeted project action plans to overcome constraints and reduce delays. The goal of Method 5 is to develop innovative solutions, which can be administrative, contractual, technical, or methodological.

Execution Tools for Complex Projects

The research identified the following 13 tools that apply to one or several dimensions of complexity that will be realized during the project. Selecting which project execution tools to use should begin when defining the critical project success factors (Method 1) and continue throughout the process of using all five of the project development methods.

1. Attach Incentives to Critical Project Outcomes: The use of targeted incentives or disincentives can apply to financing, design, public relations, or construction contracts, as well as employment contracts and are highly recommended on complex projects. This tool should be used as early as possible in the planning process and should always be considered as part of the procurement plan. Development of performance metrics and incentive language may take place multiple times on a project, especially when partners join the team at different stages.
2. Develop Dispute Resolution Plan: The use of dispute resolution plans can help in managing complexity and potential setbacks in cost, schedule, technical/quality, context/stakeholder issues, and financing, and is highly recommended on complex projects. Dispute resolution methods should be established for each major project partner or stakeholder as soon as they are identified and invited (or contracted) to participate in the project.
3. Perform Comprehensive Risk Analysis: Comprehensive risk analysis can help manage direct risks from complexity in cost, schedule, scope/quality control, and indirect costs. Analysis of schedule and scope risks that arise from the potential impact of context/stakeholder issues and risks associated with project financing is highly recommended on complex projects.
4. Identify Critical Permit Issues: Identification of critical permit issues can control the cost, schedule, and scope impacts arising from context/stakeholder issues. Financing may be dependent on minimizing schedule and cost growth related to permit issues. Identification of critical permit issues is highly recommended on complex projects
5. Evaluate Applications of Off-Site Fabrication: Off-site fabrication must be considered, not only for

Figure 2. Example of resulting radar complexity map given scores for the five dimensions



schedule control purposes, but also quality control, minimal public disruption (such as noise and loss of access), and environmental impact control. Considering that complexity on projects may come from context issues, off-site fabrication can be a good solution for external issues in minimizing road closures, disruption to local business, traffic delays, detour lengths, and public inconvenience.

6. Determine Required Level of Involvement in Rights-of-Way/Utilities: Interaction with a right-of-way holder (such as a railroad) or a utility that cannot be avoided will result in schedule delays if not managed properly. Some flexibility in staffing, incentives, early coordination, etc., can minimize potential schedule impacts.
7. Determine Work Package/Sequence: Determination of work packages and sequences is recommended on complex projects when schedule and technical constraints make close coordination of work sequencing a requirement.
8. Design to Budget: Designing to a budget is recommended on complex projects when financing is constrained, cost control is possible without an impact on schedule, and there is flexibility in technical alternatives.
9. Co-Locate Team: Particularly on multi-jurisdictional (e.g., bi-state) projects, placing a dedicated, empowered , representative project team in a common location is important . Depending on the project delivery system used, the co-location strategy can be incorporated for design-build partners or the contracting team in later stages.
10. Establish Flexible Design Criteria: Use of flexible design criteria is recommended on complex projects when technical complexity and constraints in other dimensions makes use of standard designs and specifications impractical.
11. Evaluate Flexible Financing: Use of flexible financing is recommended on complex projects when few viable technical alternatives exist, contextual constraints are significant, and cost/schedule parameters require that the project move forward (e.g., the problems will only get worse if the project is put on hold).
12. Develop Finance Expenditure Model: Use of a finance expenditure model is recommended on complex projects when project technical scope is large and fixed, project cost is closely equal to available funding, and few alternatives exist that would not substantially delay the project.
13. Establish Public Involvement Plan: If context uncertainty or complexity creates a potential impact on cost and schedul e factors, a public involvement plan should be considered to manage external communication and public expectations. In addition, if innovative financing is used, a public involvement plan can be useful in educating the public as to the new methods employed on the project.

Products

The products of SHRP 2 Renewal Project Rl0 including the guide, workshops, and webinar materials complement established project management programs such as Every Day Counts, Accelerated Construction Technology Transfer, Highways for Life/Accelerated Bridge Construction, and the Major Project Delivery Process.

The guide uses examples from case studies of 18 complex projects to illustrate the concepts it describes. Training materials based on information in the guide can be used to help deliver 11/2-day workshops and to provide self-paced training in webinar format. The research report and the Guide Book are available at http ://www.trb.org/Main/Blurbs/167481.aspx . The training materials will be available on the same web page later in 2014.