



Construction Industry Institute®

Front End Planning Tool: PDRI for Infrastructure Projects

Construction Industry Institute

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TransCanada Corporation	Pathfinder
U.S. Architect of the Capitol	S&B Engineers and Constructors
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U.S. Department of Commerce/NIST/ Building and Fire Research Laboratory	The Shaw Group
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**Prepared by
Construction Industry Institute
PDRI for Infrastructure Projects Research Team**

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Contents

<i>Chapter</i>	<i>Page</i>
Executive Summary	v
1. Introduction	1
2. PDRI Development Methodology	7
3. How to Use the PDRI–Infrastructure	17
4. Conclusions	23
References	27
Appendix A: Completed PDRI–Infrastructure Validation Projects	29
Appendix B: PDRI–Infrastructure Validation Projects in Progress	31
Appendix C: Example Element Descriptions	33

Executive Summary

Previous Construction Industry Institute (CII) research has found that tools for measuring project scope definition and facilitating alignment between project participants are essential to a good front end planning process. While this earlier research addressed front end planning (FEP) for industrial and building projects, it did not focus on infrastructure work directly, and little research has been performed in the area of FEP for infrastructure projects. CII formed the Project Definition Rating Index for Infrastructure Projects Research Team (RT 268) to produce an effective, simple, and easy-to-use scope definition tool for infrastructure projects. The development effort outlined in this paper is a continuation of the research/development thread conducted by CII over the past 19 years, extending it to this important industry sector. This research summary provides an overview of the research and development of the PDRI for Infrastructure Projects (PDRI–Infrastructure). It also discusses data showing the efficacy of the PDRI, based on a data sample of infrastructure projects.

The PDRI–Infrastructure is a risk management tool that consists of 68 elements presented in a weighted checklist format. The tool provides a method for measuring the completeness of project scope development on infrastructure projects. It is similar and complementary to two other popular CII front end planning tools, PDRI–Buildings and PDRI–Industrial. The tool's weighted index, based on the input of 64 experienced project planners in six workshops, allows users to measure the level of scope definition and to compare scope definition to anticipated project success. This tool should help owners and contractors better achieve business, operational, and project objectives.

The PDRI–Infrastructure tool generates a weighted project score that can reach up to 1000 points, with a lower score being better. An analysis of 22 completed infrastructure projects representing over \$6 billion of constructed cost showed that projects scoring lower than 200 (out of the 1000 total points) were significantly more successful than those that scored above 200.

The PDRI–Infrastructure tool was also used on four projects during front end planning representing over \$2.1 billion in planned expenditures. Data from these projects were provided by four organizations, and the tool proved valuable to the project teams in understanding risk and identifying scope gaps. These exercises showed the value and capability of the tool, since it helped team members identify critical planning issues.

The research findings show that the tool improves the front end planning of infrastructure projects and is ready for use. Lessons learned are presented to provide a better understanding of how to use the PDRI–Infrastructure tool for project planning. Logic flow diagrams, developed to provide time-sequenced logic to project planning activities, are also included.

Introduction

In recent years, a high percentage of the annual construction-related capital spent by public and private owner organizations has been on infrastructure work, in both foreign and domestic markets. Estimates by *Engineering News-Record* for 2008 were at \$225 billion for new construction and for repair/renovation of aging infrastructure. This represented a 10 percent increase over 2006 expenditures (ENR 2007). Although this 2008 forecast probably did not occur because of the economic downturn, it does show the scale of expenditures in this sector.

Recent failures in infrastructure projects—e.g., the bridge collapse in Minnesota, the steam line failure in New York City, and the gas pipeline explosion in California—along with the public outcry to invest in traditional and alternative energy infrastructures to reduce energy costs have all brought to light the precarious condition of the nation's infrastructure. Studies have shown a poor success rate on many large infrastructure projects (Flyvbjerg et al. 2003; NRC 2003). As the economy has slowed, government economic stimulus efforts, both foreign and domestic, are focusing on infrastructure investments to revitalize economic conditions. Consequently, a large and growing volume of construction work is focused on infrastructure projects.

While previous Construction Industry Institute (CII) research efforts have addressed front end planning (FEP) for industrial and building projects, they have not focused on infrastructure work directly, and little research has been performed in the area of FEP for infrastructure projects. The development effort outlined in this paper is a continuation of the research/development thread conducted by CII over the past 19 years, extending it to this important industry sector.

Many research studies have proven the importance of the front end planning phase of the project life cycle (CII 2006). Specifically, a complete scope definition improves project performance in the areas of cost, schedule, quality, and operational characteristics. Unfortunately, until now, the infrastructure sector has lacked non-proprietary tools to assist in performing this critical stage of the project. Because of the needs of the infrastructure sector, CII created Research Team (RT) 268. The research team set forth the following objectives:

1. Produce a user-friendly and generic tool for measuring project scope development with the following characteristics and functions:
 - is easy to use, yet detailed enough to be effective
 - helps reduce total project costs
 - improves schedule performance
 - serves as a communication and alignment tool
 - supports decision-making
 - reliably predicts project performance
 - is flexible among infrastructure facility types.
2. Validate the tool through testing on sample projects by measuring the level of project scope definition during the front end planning phases.

In meeting these objectives, RT 268 developed the Project Definition Rating Index for Infrastructure Projects (PDRI–Infrastructure). This generic, user-friendly FEP tool can help owners, designers, and constructors better achieve business, operational, and project-specific objectives.

The Project Definition Rating Index (PDRI) for Infrastructure Projects is a powerful and easy-to-use tool that offers a method for measuring project scope definition for completeness. It identifies and describes in detail each critical element in a scope definition package. Using it, project teams can also quickly identify project risk factors related to the

desired outcomes for cost, schedule, and operating performance. Once these are identified, the tool also helps users capture mitigation action items. It is intended to evaluate the completeness of scope definition at any point prior to detailed design and construction. Note that there are two other versions of the PDRI, one for building projects and one for industrial projects (CII Implementation Resources 155-2 and 113-2, respectively).

An infrastructure project is defined as a capital project that provides transportation, transmission, distribution, collection, or other capabilities in support of commerce or the interaction of goods, service, or people. Infrastructure projects generally affect multiple jurisdictions, stakeholder groups, and/or a wide area and have a primary purpose that is integral to the effective operation of a system. These collective capabilities provide a service and are made up of nodes and vectors laid out on a grid or as a system (e.g., pipelines connected with a water treatment plant). Vector examples include the following:

- people and freight
 - highways
 - railroads
 - access ramps
 - toll booths
 - tunnels
 - airport runways
 - security fencing
- energy
 - electricity transmission/distribution
 - fiber optic networks
 - electrical substations/switch gears
 - towers
 - wide area networks

- fluids
 - pipelines
 - aqueducts
 - pumping and compressor stations
 - locks and weirs
 - reservoirs
 - meters and regulator stations
 - pig launchers and receivers
 - canals
 - water control structures
 - levees
- nodes/centralized facilities
 - dams
 - power generation facilities
 - steam or chilled water production
 - marine, rail, or air terminals
 - water/wastewater/solid waste processing
 - refineries.

In the context of systems, an infrastructure project in this definition provides the needed services and connections (vectors) that enable industrial facilities and buildings to function effectively. If any of these vectors are disrupted, the entire system will fail to function effectively unless redundancy is provided. The diagram in Figure 1 illustrates this concept, showing the connection of industrial facilities and buildings (i.e., nodes) by infrastructure such as pipelines, electrical distribution, canals, rail, and highways (i.e., vectors). Note that these projects are generally “horizontal” in nature as opposed to the more “vertical” nature of industrial or building projects.

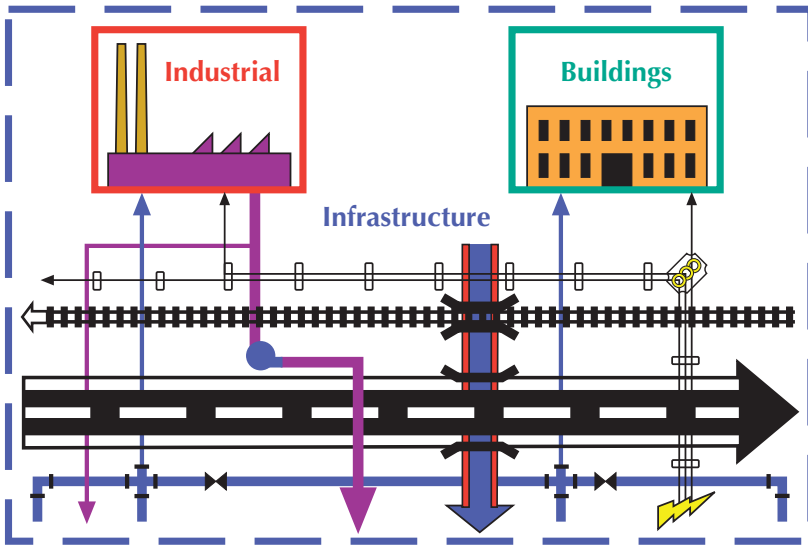


Figure 1. Infrastructure Interrelationship Diagram

The research project pursued by RT 268 was initiated to fill a gap left by previous CII research. The product of previous CII research, Implementation Resource (IR) 113-2, *PDRI: Project Definition Rating Index – Industrial Projects*, is now widely used as a planning tool in the industrial sector. In that research, a PDRI–Industrial score of 200 points or less was shown to increase the likelihood of a successful project. A similar effort led to the development of a PDRI for building projects, IR 155-2, which has also been widely adopted.

The PDRI–Infrastructure tool (IR 268-2) was developed to help project teams develop a complete project definition package. Readers are encouraged to use the tool to improve the predictability of project performance.

The central premise of the PDRI for Infrastructure Projects Research Team effort is that project teams must work collaboratively (i.e., achieve alignment) on the right projects and perform the right work (i.e., define scope) during front end planning.

PDRI Development Methodology

The initial work to develop the PDRI–Infrastructure was based on the PDRI–Industrial and the PDRI–Buildings; the research team also used the Advance Planning Risk Analysis (APRA) tool currently in use by Texas Department of Transportation (Caldas et al. 2006). In addition, a detailed literature review helped identify issues that were unique to infrastructure projects.

Draft Tool Development

The CII research team met multiple times over the course of nine months to draft the PDRI for infrastructure. The final version of the PDRI–Infrastructure consists of 68 elements, which are grouped into 13 categories that are further grouped into three main sections. Table 1 presents the complete list of the three sections, 13 categories, and 68 elements. The 68 elements in the PDRI–Infrastructure are arranged in a score sheet format and are supported by detailed descriptions and checklists. An excerpt of part of the checklist can be seen in Figure 2, which shows the elements that make up the Project Strategy category. As shown in Figure 3, each element is further detailed with a description. The format of the score sheet and descriptions for the PDRI–Infrastructure has the same look as that of both the PDRI–Industrial and PDRI–Buildings. An example of an entire category and its associated elements is given in Appendix C.

The PDRI is a tool designed to help assess the degree of scope definition on a project based on the collective professional judgment of the project team. Before detailed design and construction, project representatives make a comprehensive checklist of scope definition elements to be evaluated. These elements are then evaluated on the basis of their level of completeness. After all elements have been assessed, an index is calculated that gives the relative level of definition for the project (CII 2010).