
Lessons Learned in the Implementation of Best Practices for Project Security

Michael S. Rainey
Stephen R. Thomas



Construction Industry Institute

Owners

3M
Abbott
Air Products and Chemicals, Inc.
Alcoa
Amgen Inc.
Anheuser-Busch Companies, Inc.
Aramco Services Company
Biogen Idec, Inc.
BP America, Inc.
Cargill, Inc.
Chevron
CITGO Petroleum Corporation
Codelco-Chile
ConocoPhillips
Dofasco, Inc.
The Dow Chemical Company
DuPont
Eastman Chemical Company
Eli Lilly and Company
ExxonMobil Corporation
Genentech, Inc.
General Motors Corporation
GlaxoSmithKline
Intel Corporation
International Paper
Kraft Foods
Marathon Oil Corporation

Merck & Co., Inc.
National Aeronautics & Space Administration
Naval Facilities Engineering Command
NOVA Chemicals Corporation
Ontario Power Generation
Petroleo Brasileiro S/A - Petrobras
Praxair, Inc.
The Procter & Gamble Company
Progress Energy
Rohm and Haas Company
Sasol Technology
Shell Oil Company
Smithsonian Institution
Solutia Inc.
Southern Company
Sunoco, Inc.
Tennessee Valley Authority
U.S. Architect of the Capitol
U.S. Army Corps of Engineers
U.S. Bureau of Reclamation
U.S. Department of Commerce/NIST/BFRL
U.S. Department of Energy
U.S. Department of Health & Human Services
U.S. Department of State
U.S. General Services Administration
U.S. Steel
Weyerhaeuser Company

Contractors

ABB Lummus Global Inc.
Aker Kvaerner
ALSTOM Power Inc.
AMEC, Inc.
AZCO INC.
Baker Concrete Construction Inc.
BE&K, Inc.
Bechtel Group, Inc.
Black & Veatch
Burns & McDonnell
CB&I
CCC Group, Inc.
CDI Engineering Solutions
CH2M HILL
CSA Group
Day & Zimmermann International, Inc.
Dick Corporation
Dresser-Rand Company
Emerson Process Management
Fluor Corporation
Fru-Con Construction Corporation
Grinaker-LTA
Harper Industries, Inc.
Hatch

Hilti Corporation
Hyundai Engineering & Construction Co., Ltd.
J. Ray McDermott, Inc.
Jacobs
JMJ Associates Inc.
KBR
Kiewit Construction Group, Inc.
M. A. Mortenson Company
Mustang Engineering, L.P.
The Nielsen-Wurster Group Inc.
Parsons
Perot Systems Corporation
Primavera Systems, Inc.
R. J. Mycka, Inc.
S&B Engineers and Constructors, Ltd.
The Shaw Group Inc.
Technip
Victaulic Company
Walbridge Aldinger Company
Washington Group International, Inc.
WorleyParsons Limited
Yates Construction
Zachry Construction Corporation
Zurich



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Foreword

The National Institute of Standards and Technology (NIST) develops and promotes measurement, standards, and technology to enhance productivity, facilitate trade, and improve quality of life. In the aftermath of the attacks of September 11, 2001, NIST has taken a key role in enhancing the nation's homeland security. Through projects spanning a wide range of research areas, NIST is helping millions of individuals in law enforcement, the military, emergency services, information technology, the construction industry, and other areas protect the American public from terrorist threats.

NIST's Building and Fire Research Laboratory (BFRL) has as its mission to meet the measurement and standards needs of the building and fire safety communities. A key element of that mission is BFRL's commitment to homeland security. Specifically, the goal of BFRL's homeland security effort is to develop and implement the standards, technology, and practices needed for cost-effective improvements to the safety and security of buildings and building occupants, including evacuation, emergency response procedures, and threat mitigation. The strategy to meet this goal is supported by BFRL's:

- research and development (R&D) program to provide a technical foundation that supports improvements to building and fire codes, standards, and practices that reduce the impact of extreme threats to the safety of buildings, their occupants and emergency responders; and
- dissemination and technical assistance program (DTAP) to engage leaders of the construction and building community in implementing proposed changes to practices, standards, and codes. DTAP will also provide practical guidance and tools to better prepare facility owners, contractors, architects, engineers, emergency responders, and regulatory authorities to respond to future disasters.

This report, prepared for NIST by the Construction Industry Institute (CII), was funded as part of BFRL's homeland security R&D program. It complements previous DTAP-funded research into best practices for project security by documenting key lessons learned from implementing these practices. The security best practices were developed by CII and published in 2004 as CII technical report BMM2004-10 (available through CII) and a Grant Contractor Report, NIST GCR 04-865. This report includes a discussion of baseline measures of performance, information on a set of case study projects, a summary of significant findings producing the lessons learned, and how to use the lessons learned to improve implementation for future projects. The case study projects provided significant supporting information confirming a project team's ability to apply the security practices. Based on in-depth reviews of the case study projects, CII concluded that: (1) the security practices provide project teams access to a flexible and structured framework for the integration of security into the project delivery process (2) project teams experienced the most success when they incorporated implementation steps into existing organizational processes and procedures.

The material presented in this report complements research being conducted by the Office of Applied Economics (OAE) under BFRL's homeland security R&D program. OAE's research focuses on developing economic tools to aid facility owners and managers in the selection of cost-effective strategies that respond to natural and man-made hazards. OAE's research has produced a three-step protocol for developing a risk mitigation plan for optimizing protection of constructed facilities. This protocol helps decision makers assess the risk of their facility to damages from natural and man-made hazards; identify engineering, management, and financial strategies for abating the risk of damages; and use standardized economic evaluation methods to select the most cost-effective combination of risk mitigation strategies to protect their facility. This report covers key components of the first two steps of the three-step protocol.

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Abstract

This research was performed by the Construction Industry Institute (CII) and complements previous research into best practices for project security. The security best practices were developed by CII and published as CII technical report BMM2004-10 (available through CII) and a Grant Contractor Report, NIST GCR 04-865; however, little data still exist on the implementation of these practices. This lack of information impeded utilization of the practices due to uncertainties about cost and schedule impacts as well as impacts on established project processes. This research addresses this lack of information.

The research consisted of three tasks. The first task included a statistical analysis of a broad cross section of projects to produce baseline measures of performance used to establish a desired set of characteristics typical of exemplary projects. The second task entailed the selection of a set of exemplary projects for case-by-case analyses. The case-by-case analyses included observation of project team implementations using facilitated discussions to collect anecdotal information resulting in lessons learned. The final task of the research was a synthesis of the findings. This synthesis includes a discussion of baseline measures of performance, a summary of significant findings producing the lessons learned, and how to use the lessons learned to improve implementation for future projects.

The case study projects provided significant supporting information confirming a project team's ability to apply the security practices. The security practices provide project teams access to a flexible and structured framework for integrating security into the project delivery process. Project teams experienced the most success when they incorporated implementation steps into existing organizational processes and procedures.

Keywords

Best practices, chemical manufacturing, energy production and distribution, facility security, industrial facilities, security rating index, and transportation infrastructure

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1. INTRODUCTION

The events of 9/11 have had far reaching impacts on the country and have heightened the security awareness of industry leaders responsible for critical infrastructure facilities. The increased awareness has led to numerous security enhancing initiatives. Research funded by the Demonstration and Technical Assistance Program of the Building and Fire Research Laboratory (BFRL) at the National Institute of Standards and Technology (NIST) and published as CII technical report BMM2004-10 (available through CII) and a Grant Contractor Report, NIST GCR 04-865, identified best practices for project security. The Construction Industry Institute (CII) working with NIST developed these practices and a database for collecting data on their implementation. However, little data still exist on the implementation of these practices. This lack of information impedes utilization of the practices due to uncertainties about cost and schedule impacts as well as impacts on established project processes. This research was funded as part of BFRL's homeland security R&D program and performed by CII at The University of Texas at Austin. It complements the previous efforts by developing a comprehensive set of information based on actual project execution experiences that documents key lessons learned from implementing best practices for project security.

The material presented in this report also complements research being conducted by the Office of Applied Economics (OAE) under BFRL's homeland security R&D program. OAE's research focuses on developing economic tools to aid facility owners and managers in the selection of cost-effective strategies that respond to natural and man-made hazards. OAE's research has produced a three-step protocol for developing a risk mitigation plan for optimizing protection of constructed facilities (Chapman and Leng, 2004). The protocol helps decision makers assess the risk of their facility to damages from natural and man-made hazards; identify engineering, management, and financial strategies for abating the risk of damages; and use standardized economic evaluation methods to select the most cost-effective combination of risk mitigation strategies to protect their facility. This report covers key components of the first two steps of the three-step protocol.

1.1 Background

The earlier research funded by NIST and completed by CII in 2004, identified best practices for project security and a methodology for scoring the level of implementation of these practices. In a follow-on effort, CII developed a framework for integrating these practices into the project delivery process which was published in 2005 as a CII Implementation Resource BMM-3, *Implementing Project Security Practices*. Based on the input of industry experts, the implementation resource defines in detail a process for integrating the security practices into all phases of project planning and execution and suggests that this process will enable more cost effective security throughout the project lifecycle. The lack of actual project data on use of the practices and impacts on established project processes; however, hinders their acceptance.

CII also maintains a benchmarking database for capital facility projects containing approximately 1 420 projects representing over \$66 billion in total installed cost. More than 700 projects in this database fall into the sectors of chemical manufacturing, energy production and distribution, and transportation infrastructure. The projects drawn from the three sectors include new construction, additions, and modernization projects, ranging in cost from less than \$5 million to in excess of \$100 million. The richness of the CII database provides an excellent data set for the selection of project specific characteristics representative of exemplary projects. These characteristics were desired in the selection of projects for a case-by-case analysis to fill the information gap on implementation of security practices.

1.2 Purpose

The purpose of this research was to produce a comprehensive set of information based on actual project execution experiences derived from implementing the best practices for project security. Specifically, this investigation documents the level of security practice implementation during the project delivery process using a nine-step procedure defined in the CII Implementation Resource BMM-3 and described in Section 3.3 of this report. In addition to recording a project team's ability to implement the practices, this research documents lessons learned for better integrating the security practices into the project delivery process.

1.3 Scope and Approach

The scope of this research consisted of three distinct tasks, all limited to the chemical manufacturing, energy production and distribution (to include oil production and refining, natural gas processing and distribution, and power generation and distribution), and transportation infrastructure sectors. The first task included a statistical analysis of a broad-cross section of projects within the limits of these sectors. This analysis produced baseline measures of performance used to establish a desired set of characteristics typical of exemplary projects. These characteristics were drawn from industry norms on five key outcomes: cost, schedule, safety, project development and scope changes, and field rework.

The second task, using the characteristics identified from the Task 1 data analysis, entailed the selection of a set of exemplary projects for a case-by-case analysis. The task involved presentations to the project teams on the security best practices and the proposed method for their implementation. Subsequent analyses included observation of project team implementations using facilitated discussions to collect anecdotal information resulting in a series of lessons learned. The lessons learned captured include issues and difficulties with implementation efforts, perceived benefits for both completed and ongoing projects, impacts on implementation caused by the facilitation process, and implementation barriers.

All selected projects were domestic; however, each was located in differing regions within the country ranging from the East Coast and Southeast to the Midwest and Gulf Coast areas of the nation. The geographic dispersion of the projects afforded the opportunity to observe security practice implementation under varying circumstances and against a range of potential threats.

The final task of the research was the documentation of the results from Task 1 and Task 2 in this technical report. The report synthesizes the findings from both the statistical analysis and the case-by-case analysis of the selected projects. This synthesis includes a discussion of baseline measures of performance, a summary of significant findings producing the lessons learned, and how to use the lessons learned to improve implementation for future projects.

2. STATISTICAL ANALYSIS

This section provides a summary of the statistical analysis of a broad cross-section of projects drawn from the chemical manufacturing, energy production and distribution, and transportation infrastructure sectors. A brief description of the data set is presented along with performance outcomes for both owner and contractor organizations. Finally, an overview of the security practices is provided in addition to a means to measure the degree of implementation of these practices.

2.1 Description of Data Set

A total of 723 projects meeting the criteria specified by NIST were used for the analysis. Data were first separated for owners and contractors and further categorized by project type, project size and project nature. The three industry groups specified above (chemical manufacturing, energy production and distribution, and transportation infrastructure sectors) were separated into three distinct project cost categories: those projects with a total installed cost of less than \$15 million, those between \$15 million and \$50 million, and those greater than \$50 million. Each project was also categorized by project nature as an addition, grass root, or modernization. Figures 2-1 to 2-4 provide distributions of the number of owner and contractor data by respondent type, project type, project size, and project nature.

Figure 2-1. Data Set by Respondent

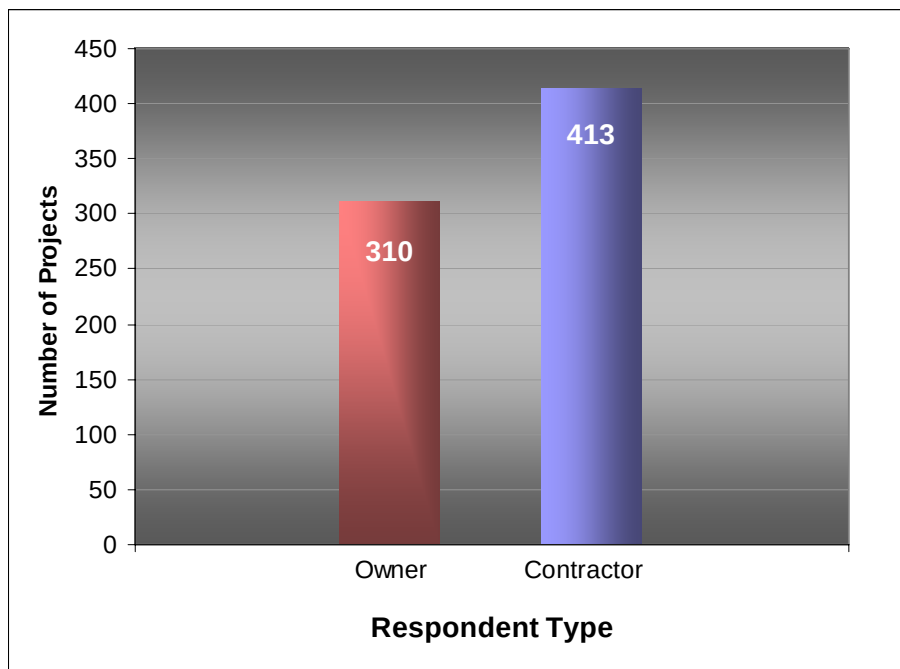


Figure 2-2. Data Set by Project Type

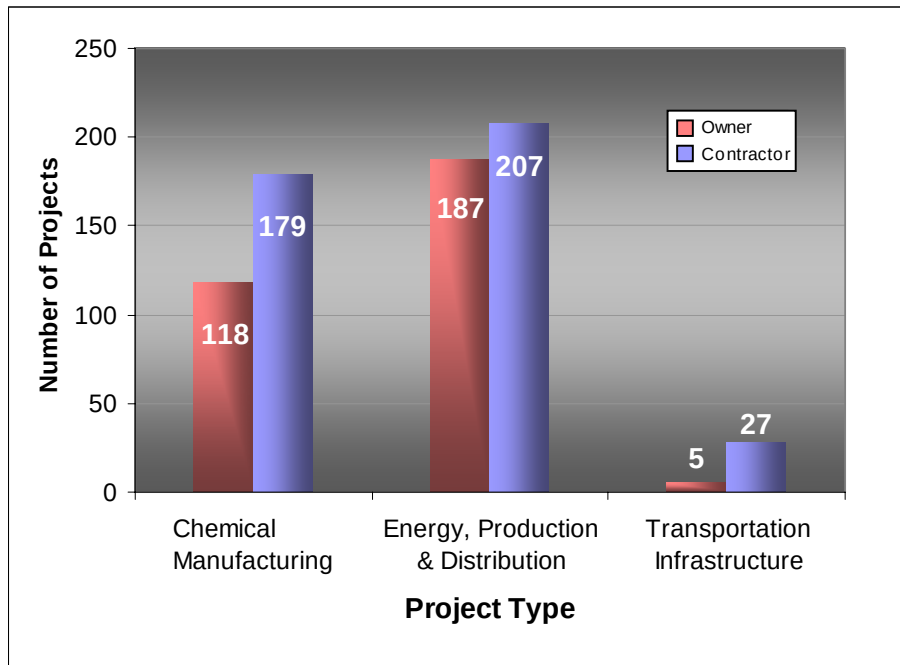


Figure 2-3. Data Set by Project Size

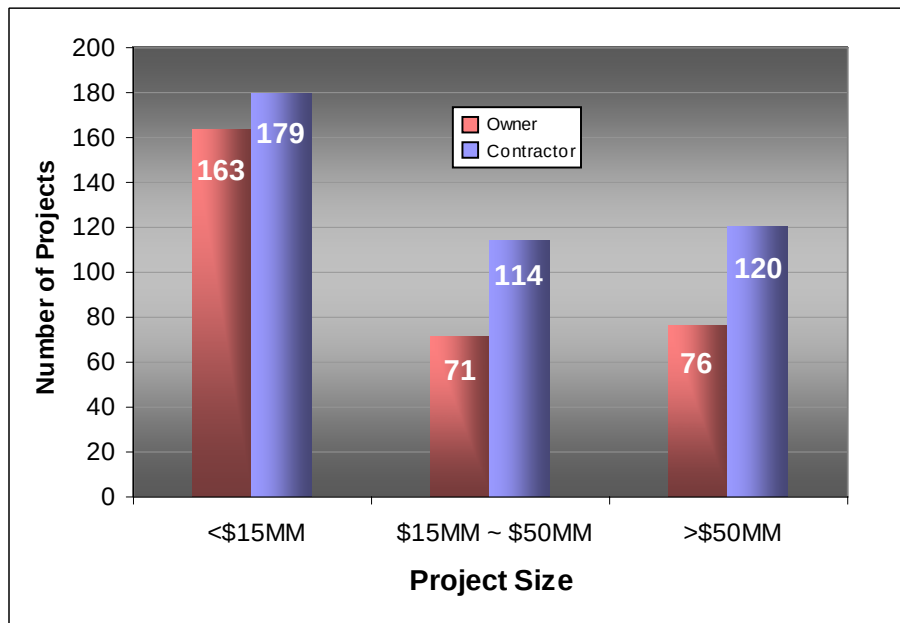
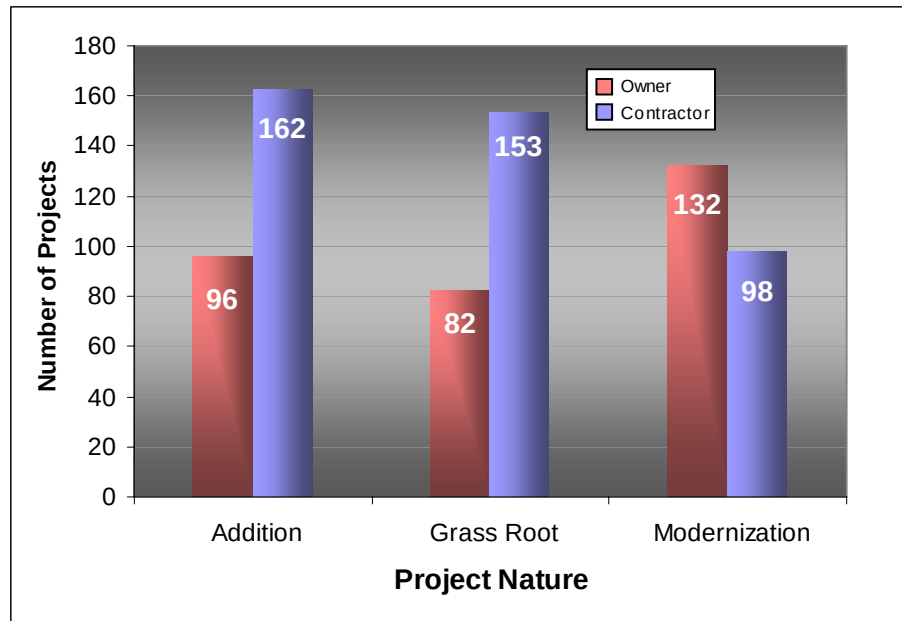


Figure 2-4. Data Set by Project Nature



Subject to the selection criteria discussed above, all projects in the CII database were eligible for inclusion in this analysis. In some cases though, item responses were excluded from the detailed analyses that follow because they were deemed to be statistical outliers based on the decision rule described in Appendix A. The number of projects represented in the tables was further reduced by item nonresponse and confidentiality rules which are also explained in Appendix A. Thus, while the data in Figures 2-1 through 2-4 above represent all the projects included in the analytic data set, the data included in Tables 2-1 and 2-2 represent only those data values that are more typical values throughout the entire distribution of projects.

All data are presented as aggregates to ensure that no individual project could be identified in any of the charts or tables. When the risk of identifying a project in any subcategory was increased due to the small number of projects in that subcategory, the data for that subcategory are suppressed to ensure confidentiality. This was particularly true for analyses of transportation infrastructure projects and change performance metrics across most project types. For these cases, data are not shown within Tables 2-1 and 2-2 due to the CII Confidentiality Policy and are identified with the code “C.T.” (confidentiality test).

Tables 2-1 and 2-2 summarize the key project outcomes for owner and contractor projects respectively. In each summary, mean values are provided to establish industry norms for five categories: cost, schedule, safety, changes, and field rework. To assist in the analysis of the table data, the best performance in each category is shaded. Appendix B contains metric definitions and formulas for each measure used within the table in addition to project phase definitions.

2.2 Project Outcomes - Owners

Within the key outcomes of cost and schedule, owner respondent projects achieved an overall project cost growth of -4.9 percent with a mean schedule growth of 4.9 percent. With respect to safety, owner projects reported a recordable incidence rate of 1.437 and a remarkable lost workday case incidence rate of 0. While the lost workday case rate is hard to comprehend on a sample this size, verification of the data reveals that any lost workday incidents are statistical outliers which were stripped from the sample by the data analysis rules documented in Appendix A.

In general, energy production and distribution projects experienced somewhat better overall project cost performance compared to chemical manufacturing projects as shown in the shaded cells of Table 2-1; however, the chemical manufacturing projects reported stronger schedule performance than their energy counterparts. Insufficient data are available to report for transportation infrastructure projects.

Within cost categories, larger projects greater than \$50 million reported better project and construction cost growth. This particular outcome is consistent with CII previous experience due to larger projects typically reporting a greater use of performance enhancing best practices. Overall schedule growth though, was better in the mid-sized \$15 million to \$50 million category with the less than \$15 million projects excelling at construction schedule growth.

With respect to project nature, as expected grass roots projects reported the best project cost and project schedule growth in comparison to addition and modernization projects. Although grass root projects tend to be larger in size, they generally experience less complexities and interferences common in the execution of addition and modernization projects.

Table 2-1. Summary of Project Outcomes - Owners

Metric ¹		All Owners (N = 310)		Project Type						Project Size						Project Nature					
				Chemical Mfg. (N = 118)		Energy, Production & Distribution (N = 187)		Transportation Infrastructure (N = 5)		<\$15MM (N =163)		\$15MM - \$50MM (N = 71)		>\$50MM (N = 76)		Addition (N = 96)		Grass Root (N = 82)		Modernization (N = 132)	
				Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N
Cost	Project Cost Growth	-0.049	292	-0.030	111	-0.060	177	C.T.	C.T.	-0.041	152	-0.048	68	-0.066	72	-0.044	94	-0.064	76	-0.041	120
	Construction Cost Growth ²	-0.031	266	-0.023	100	-0.037	161	C.T.	C.T.	-0.031	137	-0.019	61	-0.044	68	-0.005	77	-0.070	71	-0.022	116
	Startup Cost Growth ²	-0.083	130	-0.085	66	-0.081	63	C.T.	C.T.	-0.134	59	-0.042	34	-0.038	37	-0.153	39	-0.021	43	-0.082	47
	Procurement Phase Cost Factor ²	0.315	272	0.284	104	0.338	166	C.T.	C.T.	0.286	140	0.329	67	0.365	65	0.296	84	0.364	69	0.298	117
	Construction Phase Cost Factor ²	0.483	287	0.477	107	0.474	175	C.T.	C.T.	0.512	150	0.447	67	0.456	70	0.493	87	0.448	73	0.497	125
	Startup Phase Cost Factor ²	0.035	163	0.035	82	0.035	80	C.T.	C.T.	0.031	78	0.036	42	0.042	43	0.027	51	0.052	50	0.030	61
Schedule	Overall Project Duration (ppp-startup) (weeks)	129	299	101	110	145	184	C.T.	C.T.	99	161	129	63	194	75	115	93	151	77	127	127
	Design~Startup Duration (weeks) ²	94	297	75	109	105	183	C.T.	C.T.	72	160	94	63	141	74	83	92	112	76	91	127
	Construction Phase Duration (weeks) ²	55	287	44	104	61	178	C.T.	C.T.	37	151	54	62	94	74	52	87	70	73	49	125
	Startup Phase Duration (weeks) ²	6	222	7	92	5	129	C.T.	C.T.	4	115	6	54	9	53	5	70	8	59	4	92
	Project Schedule Growth	0.049	263	0.041	101	0.049	158	C.T.	C.T.	0.057	137	0.028	56	0.050	70	0.050	81	0.031	73	0.061	107
	Construction Phase Schedule Growth ²	0.054	257	0.047	97	0.060	155	C.T.	C.T.	0.044	131	0.052	58	0.076	68	0.044	79	0.050	70	0.068	106
Safety	Startup Phase Schedule Growth ²	-0.051	202	-0.006	77	-0.079	124	C.T.	C.T.	-0.022	97	-0.087	50	-0.068	55	-0.036	59	-0.095	56	-0.029	86
	Recordable Incidence Rate	1.437	198	1.348	96	1.566	99	C.T.	C.T.	1.176	112	1.616	46	1.961	40	1.318	67	1.971	49	1.245	80
Change	Lost Workday Case Incidence Rate	0.000	168	0.000	81	0.000	84	C.T.	C.T.	0.000	102	0.000	40	0.000	26	0.000	54	0.000	33	0.000	80
	Development Change Cost Factor	0.047	20	0.051*	18*	C.T.	C.T.	C.T.	C.T.	0.048*	19*	C.T.	C.T.	C.T.	C.T.	0.046*	10*	C.T.	C.T.	C.T.	C.T.
	Scope Change Cost Dactor	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.
	Development Change Schedule Factor	0.138*	11*	0.138*	11*	C.T.	C.T.	C.T.	C.T.	0.148*	10*	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.
	Scope Change ScheduleFactor	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.
Rework	Rework Cost Factor	0.028	123	0.024	46	0.031	75	C.T.	C.T.	0.030	66	0.037	34	0.012	23	0.027	36	0.027	28	0.030	59
	Rework Schedule Factor	0.005	48	0.010*	15*	0.003	33	C.T.	C.T.	0.003	33	0.010*	13*	C.T.	C.T.	0.010*	11*	C.T.	C.T.	0.003	31

¹Metric definitions are provided in Appendix B

²Phase definitions are provided in Appendix B

* = Statistical warning indicator (less than 20 projects)

C.T. = Data not shown per CII Confidentiality Policy (less than 10 projects or submitted by less than 3 companies) as provided in Appendix A

■ = Better performance

Table 2-2. Summary of Project Outcomes - Contractors

Metric ¹		All Contractors (N = 413)		Project Type						Project Size						Project Nature					
				Chemical Mfg. (N = 179)		Energy, Production & Distribution (N = 207)		Transportation Infrastructure (N = 27)		<\$15MM (N =179)		\$15MM - \$50MM (N = 114)		>\$50MM (N = 120)		Addition (N = 162)		Grass Root (N = 153)		Modernization (N = 98)	
				Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N
Cost	Project Budget Factor	0.968	378	0.972	165	0.958	187	1.019	26	0.968	165	0.962	103	0.974	110	0.975	149	0.965	138	0.962	91
	Project Cost Growth	0.044	379	0.051	163	0.030	191	0.101	25	0.052	159	0.036	104	0.040	116	0.041	148	0.055	143	0.032	88
	Construction Cost Growth ²	0.047	277	0.067	110	0.024	145	0.109	22	0.007	94	0.076	88	0.061	95	0.041	97	0.063	112	0.032	68
Schedule	Project Schedule Factor	0.976	354	0.974	153	0.976	178	0.982	23	0.975	147	0.968	97	0.984	110	0.971	132	0.980	139	0.977	83
	Construction Phase Duration (weeks) ²	66	301	63	127	62	153	111	21	41	91	64	95	88	115	66	95	76	130	48	76
	Project Schedule Growth	0.028	357	0.036	156	0.019	182	0.048*	19*	0.043	144	0.015	101	0.021	112	0.030	134	0.026	142	0.028	81
Safety	Construction Phase Schedule Growth ²	0.023	271	0.029	115	0.022	138	-0.001*	18*	0.036	79	0.013	83	0.022	109	0.020	83	0.026	124	0.023	64
	Recordable Incidence Rate	1.553	239	1.560	101	1.310	125	3.842*	13*	0.965	73	2.094	75	1.580	91	1.557	84	1.647	98	1.386	57
	Lost Workday Case Incidence Rate	0.091	232	0.089	98	0.083	126	C.T.	C.T.	0.018	74	0.115	67	0.133	91	0.109	78	0.102	100	0.044	54
Change	Development Change Cost Factor	0.076	57	0.020*	13*	0.094	43	C.T.	C.T.	0.083	49	C.T.	C.T.	C.T.	C.T.	0.109	31	C.T.	C.T.	0.040*	19*
	Scope Change Cost Dactor	0.028*	19*	C.T.	C.T.	0.034*	15*	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.
	Development Change Schedule Factor	0.120	38	C.T.	C.T.	0.126	31	C.T.	C.T.	0.131	32	C.T.	C.T.	C.T.	C.T.	0.146	24	C.T.	C.T.	C.T.	C.T.
Rework	Scope Change ScheduleFactor	0.041*	12*	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.	C.T.
	Rework Cost Factor	0.021	125	0.023	69	0.020	53	C.T.	C.T.	0.016	35	0.022	44	0.024	46	0.024	50	0.020	56	0.019*	19*
	Rework Schedule Factor	0.008	57	0.007	29	0.010	26	C.T.	C.T.	0.006*	16*	0.010*	18*	0.008	23	0.005*	12*	0.009	36	C.T.	C.T.

¹Metric definitions are provided in Appendix B
²Phase definitions are provided in Appendix B
* = Statistical warning indicator (less than 20 projects)
C.T. = Data not shown per CII Confidentiality Policy (less than 10 projects or submitted by less than 3 companies) as provided in Appendix A
■ = Better performance

2.3 Project Outcomes - Contractors

In general, contractor respondents reported greater cost growth in comparison to owners; however, this is likely reflective of the competitive nature of the bidding process resulting in lean budget estimates and differences in the treatment of changes between owners and contractors. The overall project cost growth of 4.4 percent is 9.3 percentage points higher than the owner counterparts. In contrast, contractors experienced a project schedule growth of only 2.8 percent; over two percentage points better than owners. This likely is reflective of a lesser role in the drawn out planning and start-up phases. Contractors also reported slightly higher safety recordable rates and much higher lost workday case incidence rates, although, these rates are still very good in comparison to Bureau of Labor Statistics (BLS) published norms.

By project type, the energy production and distribution sector performed best for most cost, schedule, and safety metrics. It is interesting to note that the larger cost category of projects for contractors underperformed the others in every measurable key outcome, although this finding likely lacks statistical significance. This differs from the owner data where larger projects experienced better project cost growth. Also of interest for the contractors is the better performance of the modernization projects on cost and safety metrics, although in most cases the differences lack any practical significance.