



Construction Industry Institute®

Analysis Supporting Front End Planning for Renovation and Revamp Projects, Part 1

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Construction Industry Institute

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ANALYSIS SUPPORTING FRONT END PLANNING FOR
RENOVATION AND REVAMP PROJECTS, PART 1

by

Suzanne L. Howard
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The University of Alabama

A Report to
Construction Industry Institute
The University of Texas at Austin

Under the Guidance of
CII Research Team 242
Front End Planning for Renovation/Revamp Projects

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EXECUTIVE SUMMARY

Increasingly, manufacturing, commercial, and institutional owners are renovating or revamping their existing facilities in North America. Whether it is an issue of making the facility more efficient with new production technology, meeting standards and safety requirements based on new environmental regulations, or maintaining historically significant buildings, these projects present unique risks. Front End Planning (FEP) is a critical process for uncovering unknowns in existing facilities, while developing adequate scope definition and a structured approach for the project execution process. Previous research using case study analysis has supported FEP as a valuable practice for project success. The purpose of the research presented in this document is to supplement previous research efforts while focusing explicitly on renovation and revamp projects. The research presented in this report was performed in conjunction with Construction Industry Institute Research Team 242 (RT 242), "Front End Planning for Renovation/Revamp Projects."

An initial survey was issued to the Construction Industry Institute (CII) membership to gain a greater understanding of the volume of renovation and revamp (R&R) projects. The survey was used as a validation for the research in terms of whether there are a significant number of R&R projects in the general population. Forty-one CII member organizations participated in the survey, 24 owner respondents and 17 contractor respondents. Data showed that, in aggregate, 28.5 percent of total project dollars were focused on R&R projects for all three years surveyed.

One specific finding of note from the survey was that the majority of the respondent organizations manage their R&R projects differently from greenfield projects because these projects typically contain more risk in such areas as safety, unknown site conditions, interface with existing operations and so on. The unique characteristics of R&R projects, as opposed to greenfield projects, identified by the respondents included:

- Safety and security issues of workforce interfacing with existing operations
- Unforeseen site conditions more prominent
- Scope definition-estimating the amount of work more difficult
- Scheduling intensity, higher in many cases
- Shutdown issues occur on many projects
- Greater need to interface with operations/tenants, maintenance, and construction personnel
- Additional schedule constraints occur due to operational interfaces
- Different funding sources, including both local capital and non-capital funds.

Case study data for this document were gathered from a series of questionnaires and interviews from 12 projects representing over \$336 million dollars of total installed cost. The resulting case studies were written by the authors and reviewed by project representatives for accuracy and anonymity. The case study write-ups from this research as well as the cases from RT 213 “Support for Pre-Project Planning” were analyzed using a pattern-matching software program, Atlas, to sort the relevant data.

This document presents the results of the case study analysis of 25 R&R projects concerning performance metrics, critical success factors, and overarching issues. Front

end planning issues that were deemed as critical success factors or overarching lessons learned for R&R projects include:

Critical success factors:

- Stakeholder identification
- Defined front end planning process
- Scope definition including tools
- Alignment and teambuilding
- Contracting strategies and project drivers
- Investigation of existing conditions

Overarching lessons learned:

- Labor and material issues
- Leadership and experience
- Alternative execution practices

This report outlines the research conducted in more detail.

CHAPTER 1

INTRODUCTION

In recent years, a high percentage of the annual construction-related capital spending by many organizations is on renovation or revamp (R&R) work rather than on new construction. Estimates by the U. S. Department of Commerce are in the hundreds of billions of dollars annually for nonresidential R&R projects (U.S. Department of Commerce 2007). Consequently, a large volume of contractor work is in this arena as well. The Construction Industry Institute (CII) in conjunction with The University of Alabama formed the Front End Planning for Renovation/Revamp Projects Research Team, RT-242, in October of 2006 to analyze R&R projects in relation to front end planning effort and efficiency. These team members represent a broad range of the industry from process manufacturers to governmental agencies to building contractors. The experience level of the team members range from engineering project managers to a vice president of a multi-million dollar construction company. The research team is made up of 22 industry representatives, two academic researchers and two graduate students. A list of the research team is given in Appendix A.2.

While addressing renovation projects at a high level, CII research to date has not focused on R&R work directly. R&R projects present challenges that are unique compared to new construction, consequently requiring more successful planning and execution. Such projects are wrought with the risks of unknown conditions, and are often, but not always, executed while a portion of the same facility must remain in

operation. Despite these facts, the front end planning process in most organizations is structured around new construction projects rather than R&R projects. The front end planning process is characterized by a formal process that guides an organization through various planning efforts with regular gate checks, using checklists to provide defined deliverables. The process should include such steps as defining a charter, developing objectives, scope definition, stakeholder identification, and alignment. Absent the right approach, R&R projects could result in serious disputes between the owner, design professional, and contractor.

1.1 Construction Industry Institute

The Construction Industry Institute is a consortium of more than 100 leading owner, engineering-contractor, and supplier firms from both the public and private arenas, who pool resources to study the engineering and construction industry (CII 2007). CII's mission is to "add value for members by enhancing the business effectiveness and sustainability of the capital facility life cycle through CII research, related initiatives, and industry alliances" (CII 1999c). A complete list of CII member organizations at the time of this study is provided in Appendix A.1.

1.2 Front End Planning Overview

Front End Planning (FEP) is defined as "the process of developing sufficient strategic information with which owners can address risk and decide to commit resources to maximize the chance for a successful project" (CII 1994). FEP is arguably the single most important process in the project life cycle. Figure 1.1 shows the FEP process within the project life cycle (CII 1995). The process is commonly divided into three sub-phases:

feasibility, concept, and detailed scope. At each sub-phases, “phase gates” are used to separate the phases. The numbers positioned inside the diamonds on the diagram indicate the gates. Many organizations use this FEP phase gate process to allocate funds and evaluate the progress of a project (Irons 2006 and CII 2006d).

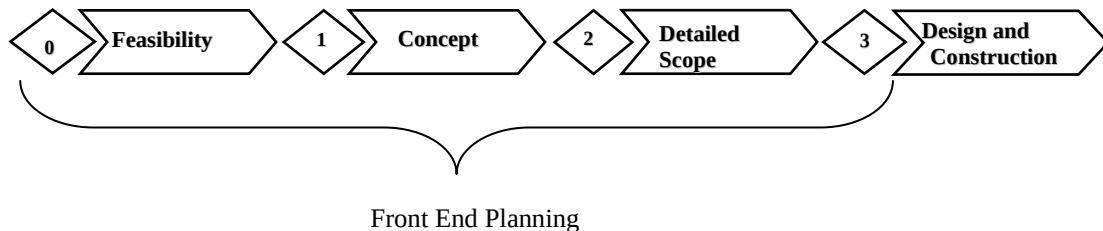


Figure 1.1 Front End Planning Process

Figure 1.1 illustrates the front end planning process in the life cycle of a project. The diamonds in the diagram represent key decision gates that must be addressed prior to moving on to following phases. Front end planning generally ends at phase gate three with project approval unless the project is terminated at an earlier gate (CII 2006).

Previous research from CII indicates that effective front end planning can reduce project cost as much as 20 percent (CII 1995). The following project elements can be heavily affected during the front end planning process:

- Alignment
- Leadership
- Experience
- Budget
- Schedule
- Scope Definition

- Site Conditions
- Modularization

Some owners view the FEP process as time taken at the beginning of a project that causes the completion date to be extended rather than a method of increasing project speed to delivery. Owner finance departments require accurate cash flow plans that are “locked in” early in the process, which can be particularly problematic on these types of projects due to the inherent characteristics of R&R projects. The project team is expected to follow unrealistic budgets, putting pressure on expenditures, and sometimes causing project scope to be used as contingency. In many cases, neither training nor experience in project delivery techniques can overcome these external project pressures, and the value of “getting the project right and then going fast” is lost. Project costs can still rise out of control even with good FEP due to lack of scope control discipline.

The front end planning process also has been called many different things, such as pre-project planning, front end loading, programming/schematic design, and scope definition. For this document, front end planning will be the term used throughout the report. Little research has been focused to quantify the relationship between the key front end planning factors and project success for R&R projects.

1.3 Scope

This research study begins with the assumption that the FEP process is valid and valuable; however, its usage, particularly in regard to revamps and renovations, is not consistent. The research investigation focused solely on renovation and revamp, R&R projects. The term R&R was defined by the authors and RT 242 as a project that is

focused on an existing facility, which includes the act, process, or work of replacing, restoring, repairing, or improving this facility with capital or non-capital funds. It may include additional structures and systems to achieve a more functional, serviceable, or desirable condition, including improvement in:

- profitability
- reliability
- efficiency
- safety
- security
- environmental performance
- or compliance with regulatory requirements.

This definition was developed and refined by the authors in conjunction with the research team over the course of four meetings. Several aliases were identified during the formulation of the definition, which will be addressed in Section 1.4 of this chapter.

The purpose of the research is to evaluate front end planning usage and methods for R&R projects, as well as to assess its relationship to “project success.” Data were gathered through questionnaires and interviews for both quantitative and qualitative analysis of the front end planning process of R&R projects and its relationship to project success. The term “project success” was defined by the owner or contractor who submitted the project for case study analysis. The authors did not determine whether a case study project was successful, leaving that instead to the submittal representative. The scope was not limited to projects completed by the organizations represented by the

members of the Research Team 242. R&R projects from previous case studies conducted by CII were also included in the analysis.

1.4 Front End Planning for Renovation and Revamp Project Research Team

The terms renovation and revamp, R&R, which was defined in Section 1.2 of this chapter, will be used throughout this document, but several aliases were identified by the authors and the research team during the research. The aliases for R&R projects include:

- Retrofit
- Reconstruction
- Outage/Shutdown/Turnaround
- Maintenance project (does not include routine maintenance actions)
- Modernization
- Improvement project
- Repair project (does not include routine maintenance actions)
- Alteration
- Brownfield
- Rehabilitation
- De-bottlenecking
- Refurbishment
- Modification
- Upgrade
- Makeover
- Rebuild
- Overhaul
- Replacement
- Betterment
- Reclamation
- Regeneration
- Redevelopment
- Relocation
- Reutilization
- Restoration

1.5 Objectives

This section presents the objectives for this document as well as the objectives for the entire team.

1.5.1 RT 242 Objectives

The research objectives identified by the entire RT 242 team for this effort are as follows:

1. Enhance or supplement the CII Best Practice entitled front end planning and focus on the obstacles to successfully performing revamp and renovation projects.
2. Identify preferred methods for optimizing front end planning for revamp and renovation projects, including the use of new and existing technology for site investigations, human resources requirements, contracting approaches, and cost and schedule estimating methods.
3. Produce documents to assist project teams in developing effective front end planning for R&R projects, including risk identification, assessment, and mitigation methods.

1.5.2 Research Objectives

Within the context of the RT 242 objectives, the specific objectives of the research conducted are:

1. To explore the extent of R&R projects within CII.
2. To identify unique risks and issues related to R&R projects.

3. To highlight and describe critical success factors and overarching issues that affect performance of R&R projects.
4. To analyze the Benchmarking and Metrics database in support of FEP for R&R projects.
5. To describe unique risks and issues related to shutdown/turnaround projects.
6. To detail the development and approach of the STAR Tool for use on Shutdown / Turnaround / Outage (STO) projects.

This research report (Part I) focuses on objectives 1-3 above.

1.6 Hypothesis

The hypothesis of this research is that specific practices in the front end planning process will add value to the revamp or renovation of a capital project and subsequently ensure business success, and that a project team (and an organization) must perform these practices effectively in order to have a more successful project venture.

1.7 Overview of Document

This research investigation is organized into two research report volumes. Part I (this report) includes six chapters and documents findings from the first three RT 242 research objectives. This first chapter states the scope and objectives of the research. Chapter Two gives a background of past front end planning research. Chapter Three contains the methodology utilized for the analysis performed as part of the research. Chapter Four shows the results of a survey presented to a convenience sample of the volume of R&R projects within the industry. Chapter Five includes a summary of the case studies including both the current research presented by this research report as well as the R&R projects analyzed and presented in RT 213 “Support for Front End Planning”

research (Irons 2006 and CII 2006d). Chapter Six summarizes the research performed and provides recommendations for future research. Part II describes the results of RT 242 research objectives 4-6 and is contained in CII Research Report 242-12.

CHAPTER 2

BACKGROUND

Front end planning (FEP) has been recognized as an important part of the project life cycle. A detailed literature search focusing on front end planning for renovation and revamp projects was performed through various sources. The results of the search did not provide any valuable information for the study. The search was refined to include only front end planning within the construction industry. Several of the items identified from that search were from the Construction Industry Institute. Chapter 2 highlights previous research focused on front end planning and how it has impacted the industry.

2.1 Front End Planning Research

CII Task Force 39 was established in 1991 by CII “to find the most effective methods of project definition and cost estimating for appropriation approval.” The task force used IDEF0, Structured Analysis and Design Techniques, to outline the front end planning process (Gibson et al. 1995). Front end planning was defined by the team as “the process of developing sufficient strategic information with which owners can address risk and decide to commit resources to maximize the chance for a successful project” (CII 1994). The research effort formed a four-step process for front end planning: organize the front end planning process, identify project alternatives(s), develop a project definition package, and make decisions of whether or not a project should proceed (Gibson et al. 1995).

The research also recognized several key front end planning practices:

- develop corporate goals and guidelines
- produce a highly experienced multi-disciplinary project team with excellent communication skills
- align project team through team building
- define project objectives with stakeholder agreement
- create a formal front end planning procedures
- authorize sufficient time and resources for front end planning
- recognize roles and responsibilities
- eliminate poor business decisions and unreliable data.

2.2 Front End Planning Research

In 1994, the Front End Planning Research Team (RT 213) was established by CII to create easy-to-use front end planning tools. These tools were to be used by owner and contractor organizations to improve business, operational, and project objectives (CII 1996). From the efforts of this team, two books were produced, *Project Definition Rating Index for Industrial Projects (PDRI)* and *Alignment During Pre-Project Planning* (CII 1996; CII 1997).

The *PDRI for Industrial Projects* is a weighted matrix with 70 scope definition elements. These elements are issues needing to be addressed in front end planning. The PDRI categorizes these elements into three main sections with 15 sub-categories. The main objective of the PDRI is to allow a project team to measure the completeness of a

project's scope definition. The maximum score of the PDRI is 1000 points, but the lower the score the better the project scope definition (Gibson and Dumont 1996).

The research investigation also looked closely at project team alignment during front end planning. The results included identification of 10 key alignment factors, development of the Alignment Thermometer, and publication of the CII Implementation Resource 113-3, *Alignment During Pre-Project Planning: A Key to Project Success*, which lays out key processes associated with gaining and maintaining alignment (CII 2005; Griffith and Gibson 2001).

2.3 PDRI for Building Research

In 1997, CII funded a research team to develop an easy-to-use tool similar to the PDRI for Industrial Projects for building and institutional projects. The research team (RT155) "PDRI for Building Projects" developed the *PDRI for Buildings* then tested the tool on sample projects (Cho et al. 1999). The *PDRI for Buildings* has 64 scope definition elements that are broken into three main sections. The analysis of these sample projects showed a significant difference in project controls between low scoring PDRI projects (greater defined scope) and projects with higher PDRI scores (CII 1999).

2.4 Applying the PDRI in Project Risk Management

Analysis of projects using the PDRI has been limited, but in 2002, Wang explored the relationship between project performance and PDRI score. Information was gathered for analyses from 140 capital projects representing approximately \$5 billion in total

construction cost. The link between well-defined scope and enhanced project performance was established by this work (Wang 2002).

2.5 Federal Facilities Council Study

Technical Report #146, titled “Starting Smart: Key Practices for Developing Scopes of Work for Facility Projects,” was sponsored by the Federal Facilities Council Standing Committee on Organizational Performance and Management. The committee wanted to aid public organizations in defining scopes of work for Federal facilities. The report pointed out that a thorough front end planning process was the key to a well defined scope of work. The committee examined both new construction and major renovation projects. The report also identified key practices for effective scope development and acquisition strategy related to scope definition. The report gave a range of project delivery systems and contract methods (FFC 2003).

2.6 Analysis of Front End Planning Results Using CII’s Benchmarking and Metrics Database

In 2006, CII published a report analyzing front end planning practices using project data from the CII benchmarking and metrics database. The report presented research on several aspects of front end planning including front end planning cost related to total cost, and effect on good front end planning on performance metrics. Performance metrics such as cost growth, schedule growth, and change orders were analyzed with respect to PDRI scores, the Pre-Project Planning Index, percent design complete, and Alignment Index (CII 2006c).

The sample size for the front end planning phase cost related to total cost analysis included 395 owner projects, and 212 contractor projects that represented infrastructure, building, and light and heavy industrial sectors. The mean front end planning cost was 3.4 percent of the total cost for owners, and 4.3 percent of contractors for all projects greater than or equal to \$5 million. The research verified that contractors spend more than owners on front end planning as a percent of total cost for all small projects for every sector. Owners spend the most money as a percentage of total cost on large projects (greater than \$5 million dollars) in the infrastructure sector (CII 2006c).

The research compared the PDRI scores of industrial and building projects to performance metrics. Of the 237 projects with PDRI scores above 200 at the end of the detailed design phase, 186 projects performed poorer (on average) than the mean of the samples with PDRI scores below 200 (those projects with better scope definition). It was determined that the difference in cost growth factor and schedule performance for industrial projects was statistically significant when the PDRI was executed. All differences in the performance metrics for building projects were statistically significant when the PDRI was used (CII 2006c).

The percent design complete analysis found that the median percent design complete sub-sample of 27 industrial and 21 building projects outperformed the sample below the median percent design complete, on average, for cost and schedule performance. The median percent design complete of the sub sample was determined to be 20 percent. This leads to the conclusion that if the percent design complete was greater than 20 percent, the project costs would decrease by 5.6 percent versus the project estimate at end of front end planning (CII 2006c).

The researchers also analyzed 676 projects, 609 industrial and 67 building projects, to determine if the CII Pre-Project Planning Index score has an effect on the performance metrics. The Pre-Project Planning Index score has a rating scale from zero to 10. The higher the index, the greater defined the project is considered. For industrial projects, the results of the analysis show that the differences in the cost, schedule, and change order performance were statistically significant. For the building projects, the analysis was inconclusive, indicating the necessity to collect further data within the building sector (CII 2006c).

Data sub-samples of 70 projects were analyzed to compare the Alignment Index scores with the project performance metrics. The Alignment Index is based on the Alignment Thermometer, which was developed in previous research efforts (CII 1997). The thermometer consists of 10 questions with a score range between 0 and 10. It is considered that the higher the score, the better the team is aligned. The mean alignment index score for the sample set was determined to be 6.5 percent. On average, sample projects at end of detailed design, which had an alignment score greater than the median, outperformed the projects with scores below the median on all three performance metrics (CII 2006c).

Finally, the authors analyzed the usage of the PDRI tool of the CII membership. In summary, 61.7 percent of CII member organizations are using the PDRI to aid in their front end planning efforts (CII 2006c).

2.7 Front End Planning Toolkit

In 2006, CII's Research Team 213 developed the *Front End Planning Toolkit* for the purpose of allowing companies to have a “one stop shop” for front end planning tools. The Front End Planning Toolkit defines the functions involved in front end planning and provides a process that can be used in the front end planning of capital projects.

At the time RT 242 was formed, CII had four existing tools focusing on front end planning. These tools included: the *Pre-Project Planning Handbook*; *Project Definition Rating Index, Industrial Projects*; *Alignment During Pre-Project Planning*; and *Project Definition Rating Index, Building Projects* (CII 1995, CII 1996; CII 1997, CII 1999). Each of these tools were developed by CII research teams at different points in time. Despite the effectiveness of these tools, RT 242 decided that it must update or archive each in order to provide a consistent message concerning the critical issues of front end planning.

The 2nd edition of *Alignment During Pre-Project Planning — A Key to Project Success* (initially published in 1997) was updated using materials from a recent CII project security study funded by the National Institute for Standards and Technology as well as the collective knowledge of the research team members. This new edition clarified the methods for using the Alignment Thermometer tool, updated references, and shed new light on alignment and its relationship with security and sustainability issues (CII 2005).

The second editions of *Project Definition Rating Index, Industrial Projects* (initially published in 1996) and *Project Definition Rating Index, Building Projects* (initially published in 1999) were updated to reflect knowledge gained from their usage

over the past several years (CII 2006a; CII 2006b). The team again drew upon materials from the CII/National Institute for Standards and Technology Security Study and the collective knowledge of the research team members. The resulting updates significantly clarify the methods for using the Project Definition Rating Index, eliminated the “yes/no” options for some element definition levels (in the Industrial Projects version), discussed tool usage by both owner and contractor organizations, and referenced security and sustainability issues. These changes made these tools much easier to implement and addressed issues that were currently of major concern to planners.

The *Pre-Project Planning Handbook* (published in 1995) was reviewed by the research team. Although much of it was still valid, the team decided that its message needed to be updated both in terms of content and format. The FEP Toolkit draws heavily on materials from the *Pre-Project Planning Handbook*, which was archived by this effort. The objective of the Toolkit is to encourage the use of FEP knowledge and promote consistency and excellence in planning to improve capital project effectiveness. By using the toolkit format, documents, templates, and tools, an organization can adapt the Toolkit for internal use. The toolkit was developed in HTML language, and can be easily adapted to an organization’s intranet or extranet site (CII 2006d).

2.8 Case Study Analysis in Support of Front End Planning Implementation

In 2006, CII RR 213-12, “Case Study Analysis in Support of Front End Planning Implementation,” outlined a series of case study evaluations used to understand implementation of FEP and project success (CII 2006c).

With few research studies evaluating individual cases, an analysis of 17 projects involving \$1.5 billion was conducted to support the idea that well performed front end planning could lead to project success. The RR 213-12 research report evaluated 13 R&R case studies.

Using the qualitative research method, pattern matching, the authors evaluated projects nominated by CII member organizations. Each project was analyzed to determine the effects of front end planning on project cost, schedule, safety, change orders, alignment with business objectives, profits and the relationship with the owner and client.

Using pattern matching techniques, the researchers used the case studies to identify planning issues on the projects that affected project success. These issues included:

- well defined front end planning procedures
- well defined scope definition
- appropriate contracting strategy
- alignment and teambuilding
- participation of owner and contractor in FEP
- leadership and experience
- labor and skill issues

- existing conditions definition.

The results of the case study analysis offered insight on several front end planning issues and techniques. For instance, five of nine case studies were successful when a well-defined front end planning process was in place. Five of eight projects that did not have a well defined process were unsuccessful. The research complemented the statistical analysis performed by previous CII research while providing managers situational evidence of both successes and failures of previous projects (CII, 2006c).

2.9 Existing Site Condition Definition and Technologies

One of the planning issues identified by RT 213 was the "existing conditions" definition. It was found in the study that eight of the 13 R&R projects that thoroughly documented existing site conditions were successful. All four cases with poorly defined existing site conditions were unsuccessful. In the current research investigation, 24 new tools or technologies have been identified to aide in the front end planning process. These technologies have been used to identify such existing site conditions as underground contaminant, equipment/process locations, leak detection, and overall material inspection (NDT 2007).

For instance, one of the most commonly used non-destructive technologies is high definition laser scanning (HDLS). HDLS is a survey tool used to identify existing location of a facility via targets. Data sets are obtained from point clouds and used to extrapolate the spatial orientation and features of the existing facility in order to provide accurate "as-built" or "as-is" information. As an added benefit, data can be captured remotely, without requiring a person to visit the objects of interest and without disrupting

ongoing activities at the site. This capability is valuable for hard-to-reach or delicate objects/sites or for sites that would otherwise be hazardous to occupy such as busy roads and not readily accessible areas such as chemical processing facilities. The results of the survey tool can be loaded into design software to produce 3D images of the facility.

Three dimensional laser scanning allows comparisons of as-built against original design. The 3D visualization helps uncover potential conflicts and design defects. The 3D walk-through model of the project area helps improve the layout for construction and maintenance. According to a Chevron Revamp Platform project, 3D scanning technology (Sanders 2001):

- Reduced shut down time by 44 percent
- Eliminated rework
- Eliminated interference during installation
- Reduced project risks
- Yielded cost saving significantly higher than associated 3D scanning deployment cost
- Generated additional savings if 3D scan is used at the Front End Planning stage.

The 24 identified tools and technologies have been demonstrated and analyzed, including high definition laser surveying, ground penetration radar, ultrasonic testing, and risk analysis software. Each individual technology is listed on a project condition investigation (PCI) card and outlined in CII Implementation Resource 242-2, *Front End Planning of Renovation and Revamp Projects* (CII 2008).

2.10 Summary

Previous research conducted by CII indicates a strong correlation between effective front end planning and improved project success measured by overall project cost, project schedule, and change order growth. The research shows that well performed front end planning can reduce project costs by as much as 20 percent, lead to less project variability, and increase the chance of projects meeting social and environmental goals. The research also shows a direct correlation between the level of front end planning effort and project success (CII 1994).

Since the effort began in 1991, many CII organizations have incorporated a front end planning process into their project life cycles. The FEP Toolkit makes the front end planning process implementation easier by incorporating all front end planning tools into a user friendly application. Several new technologies and materials have been developed to aid in defining the planning issues of the front end planning process.

It should be noted that little research has been performed on front end planning specifically for R&R projects, although many R&R projects have been studied at a high level in the past. The research performed for this document will aid in discovering which front end planning factors are critical to R&R projects.

CHAPTER 3

METHODOLOGY

Chapter Three will discuss the methodology used to gather information for both qualitative and quantitative analysis. The entire outline of the methodology for the CII Research Team 242 will be illustrated, as well as a detailed breakdown of the research presented for Part I (this research report).

3.1 Overall CII Research Team 242 Methodology

This research report details the research effort initiated by CII Research Team 242, Front End Planning for Renovation/Revamp Projects. Figure 3.1 outlines the extent of the research undertaking, with the activities given in this report highlighted.

In addition to this report, other research and tool development efforts were concurrently conducted by the RT 242. Project data were analyzed in relationship to front end planning and R&R projects, as well as to the differences between front end planning for R&R and Greenfield projects using over 600 projects from the CII Benchmarking and Metric database. The third editions of the Industrial and Building Project Definition Rating Index (PDRI) were updated to include unique aspects of R&R projects for scope definition. The Shutdown/Turnaround Alignment Review (STAR) Tool has been developed by the research team to aid the front end planning process for shutdowns, turnarounds and outages (CII 2008a; CII 2008b, CII 2008c; CII 2008d).

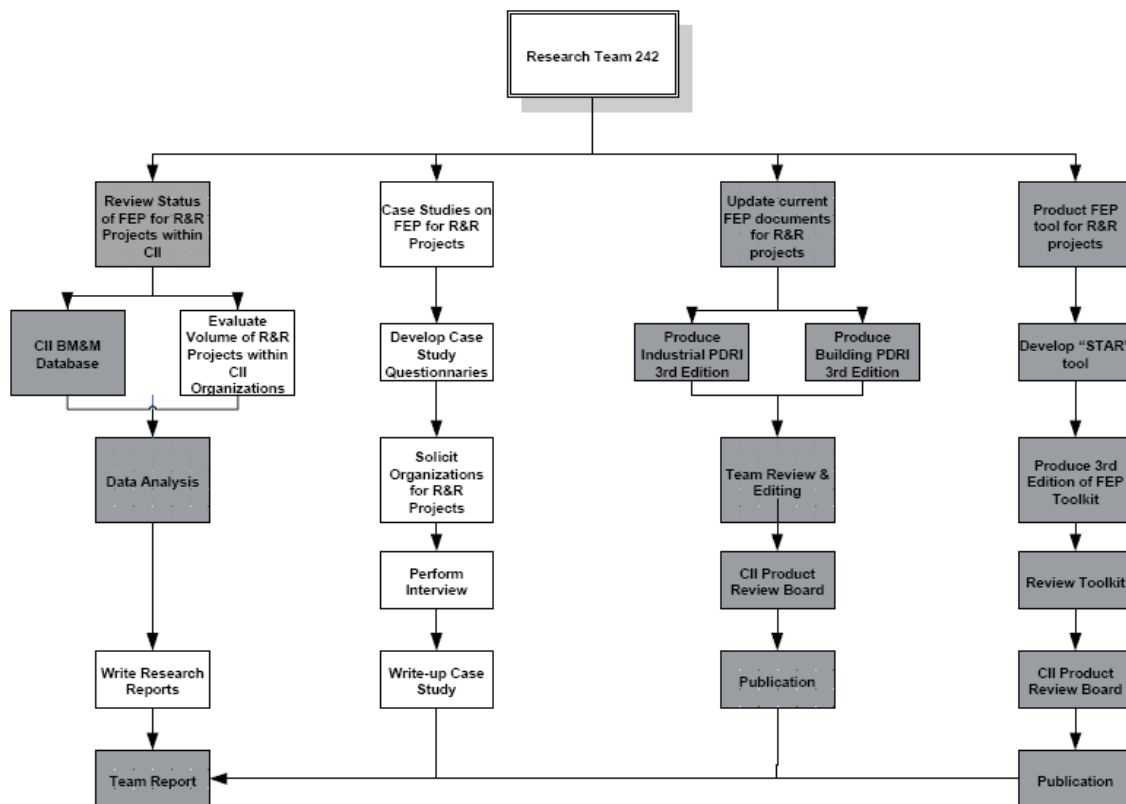


Figure 3.1: CII RT 242 Research Diagram

The research team has also been charged with informing organizations of the newest technology or tools to aid in the front end planning process. Twenty-four tools and technologies were reviewed and analyzed, including high definition laser surveying, ground penetration radar, ultrasonic testing, and risk analysis software. Each individual technology was listed on a project condition investigation (PCI) card, which was then divided into project conditions with a “transit map” that presents an organization with several tools to assist in front end planning. The third edition PDRIs have been

incorporated into version 2.0 of the Front End Planning Toolkit along with the new STAR tool and the 24 PCI cards.

3.2 Research Report Part One Methodology

The research methodology diagram for this research report (see Figure 3.2) focuses on the volume of R&R projects and analysis of documented cases to support front end planning for R&R projects.

Background

In order to understand the importance of front end planning in respect to all project as well as R&R, a review was conducted and is presented in Chapter 2. During the background review, it was concluded that little information on front end planning specifically relates to R&R projects.

Phase I Survey

The authors and the research team needed to gauge whether it was important to study R&R projects related to front end planning. A survey was issued to the 101 member organizations of CII in 2006 concerning the volume of R&R projects, the amount of revenue or budgeted amount generated from R&R projects, and the managerial style of their companies' front end planning process. A sample of the survey material package, which was developed by the authors with the assistance of the research team, is included in Appendix B.1. The entire sample and analysis is presented in Chapter 4.

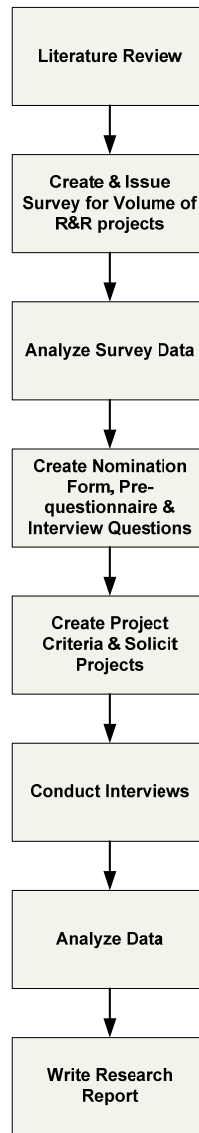


Figure 3.2: Research Methodology Diagram

Case Study Analysis

Case study analysis was the next step in learning what key factors in front end planning affected R&R projects. The nomination form, questionnaires, and interview questions were developed based on specific front end planning process, previous research on front end planning, and the experience of the research team. A sample of the nomination package is included in Appendix B.2.

The projects analyzed in the study were submitted by both owner and contractor organizations. They represented several sectors including pharmaceutical, petrochemical, institutional, remediation, power, and industrial. The projects were solicited from the CII member companies, which comprise both owner and contractor organizations. The case study projects had to meet a list of qualifications to be nominated for the research. Projects were selected based on the following criteria: (1) One project which was successful and the other that was unsuccessful based on an organization's criteria; (2) the final cost of the project was open; (3) the project ideally had been completed and in operation for at least six months; (4) the project ideally needed to have been completed in North America, but nominations were taken from projects worldwide; (5) the facility was a building or industrial facility; (6) the project could either be from the private or public sector; and (7) the project **must** be an R&R project.

All information gathered from the organizations was kept strictly confidential to allow the representatives to be candid. Anonymity is given to all participants and their nominated projects, including contractor or client information, and project locations. The case studies were given alias with "OR" representing owner companies and "CR" representing contractor organizations. All organizations were also numbered in random order after the nomination process. Within the pair of projects, the "unsuccessful" project is listed first followed by the "successful" project. For example if the project was nominated by the second owner and was "successful," it would have the alias code OR2.2 and if the third contractor company nominated a pair of projects, the "unsuccessful" one would have the alias CR3.1. In the cases where only one project was submitted, it was coded as the first project whether it was "unsuccessful" or "successful."

In order to gain information for a nominated project, the organization's representative had to fill in a pre-questionnaire form and participate in an interview with the authors. All questionnaires and interview questions were developed by the authors with assistance from the research team membership. The initial questions on the pre-questionnaire asked general information about the company and the project, while the second part requested project performance records, technical information, managerial style, safety, and the effort of front end planning for the project. The set of interview questions were generated and distributed to all participants before the interview was conducted. These questions were used to uncover project details in order to find the key factors during front end planning that helped or hurt the project. The representative was also asked whether he/she felt the project was "successful" or "unsuccessful" within these questions. The pre-questionnaire and interview questions samples are in Appendix B.3 and B.4.

The interviews normally took 90 minutes to conduct, involving from one to three representatives for each project. Once the interview was completed, a case study was written and reviewed by all participants of the interview for accuracy and anonymity.

During the literature review, it was recognized that RT 213 "Case Study Analysis in Support of Front End Planning Implementation" had gathered 13 projects meeting the criteria for this research effort. The original information gathered for research effort RT 213 was obtained and combined with the RT 242 research to form a larger sub-sample to analyze. The projects from RT 213 are represented with the alias "C" for contractor and "O" for owner organizations. The projects obtained from RT 213 have similar project

characteristics as the ones from RT 242. The summaries of these projects have previously been published (CII 2006c).

During the pre-questionnaire and interview phases of the case study data collection effort, several initial findings for key factors related to front end planning for R&R projects were recognized. At this point, it was decided that for increased accuracy, pattern matching software would be purchased to qualitatively compare the case studies for common key factors of front end planning affecting project outcomes (Cleverbridge 2007).

Pattern matching is recognized as the dominant mode of analysis for case study research (Cleverbridge 2007). In determining the software to use, several brands were demonstrated and articles and studies were assessed. It was concluded that Atlas was the most appropriate for case study research in this effort (Garson 2007 and Hawes 2007). The program is Windows®-based, allowing the user to upload the case study MSWord® file, then set key words such as “alignment” as codes within the program. The program generates a list of all the coded words and phrases through running a query. The software produced the frequency of specific coded words across all the case studies. A sample of the data generated by the program can be found in Appendix D.1.

The two main front end planning categories found through the analysis were critical success factors and overarching issues. Critical success factors are well-defined tasks that should be performed during front end planning to increase the success rate of a project. These are the key factors that were discovered during the initial phases of the case studies. Overarching issues are lessons learned from a project that are generally less concrete and sometimes out of the control of the project participants.

The data collected through this methodology has some limitations. First, the sample was a “convenience” sample and cannot be generalized for the entire industry. A convenience sample is a sample where the researcher makes a limited attempt to insure that the sample is an accurate representation of some larger group or population (Simon 2002). All nominated projects were collected from the RT 213 and RT 242 research teams, which are CII member organizations (Irons 2006). The data are both qualitative and quantitative in nature. Qualitative analysis using pattern matching can be subjective due to the individual writing the case study and inputting the coding for the software. The term success for these case studies was based on different organizations definition, and all factors may not have been identified. Despite several limitations to the research, it is a valuable resource to the industry.

Once the information and data were analyzed using the various methods, findings were synthesized into this report.

CHAPTER 4

INITIAL SURVEY: VOLUME OF R&R PROJECTS

Chapter 4 discusses the Phase I survey, which was used to gain a greater understanding of the volume of renovation and revamp projects (R&R) within the Construction Industry Institute membership. The survey was also used as an initial validation for the research in terms of whether there are a significant number of R&R projects in the general population.

4.1 The Survey

A Phase I survey was developed by the authors with the assistance of the RT 242 research team. The survey was to encompass the volume of budgeted dollars and revenue earned for any R&R projects either non-capital or capital for any facility. While developing the survey, RT 242 considered both the owner and contractor side of R&R projects as well as domestic and international.

The survey was divided into three sections: 1) the first section requested total domestic budget for all projects and the domestic R&R budget in 2005 and 2006 with a projected budget for 2007 from owner respondents; 2) the second section requested the domestic revenue for all projects and the domestic R&R revenue for 2005 and 2006 with projected revenue for 2007 from contractor respondents; and 3) the third section requested information from the organization on how or if the organization handles front end planning differently for R&R projects and if there are special characteristics of R&R projects. An example of the survey is located in Appendix B.

4.2 R&R Definition

Before the survey could be provided to an audience, one major component had to be developed, the definition of R&R. The respondents needed to have a clear understanding of R&R to report budget and revenue information on the subject. After consulting dictionaries, reviewing procedures of organizations, and long sessions of discussion, a consensus definition was developed by the team. As previously stated, the definition of R&R is "a project that is focused on an existing facility, which includes the act, process, or work of replacing, restoring, repairing, or improving this facility with capital funds or non-capital funds. It may include additional structures and systems to achieve a more functional, serviceable, or desirable condition, including improvement in:

- profitability
- reliability
- efficiency
- safety
- security
- environmental performance
- or compliance with regulatory requirements."

The definition was derived with several aliases so every organization would be able to identify with the subject. These aliases were presented in section 1.4.

4.3 The Sample

The survey was distributed at the CII Board of Advisors meeting in November 2006 with a cover letter explaining the reasoning behind the survey as well as the purpose

statement of the research team and the definition of R&R with alias terms. Additional follow up attempts were performed to gain the maximum amount of participation between December 2006 and February 2007. A list of the participating companies is in Appendix A.4. In all, a total of 41 organizations responded, representing a 40 percent response rate of the entire CII membership at that time.

4.4 Findings of the Study

After the data collection was complete, the analysis of the 41 responses, including 24 owner organizations and 17 contractor organizations began. The first step was to divide the responses into two categories: owner and contractor. Within the owner category the information was divided into 1) total project budget for both domestic and international for each year requested; 2) R&R project budget for both domestic and international for each year requested; 3) number of total projects and R&R projects for a 2006, and 4) different management strategies for R&R and what characteristics made the organization handle such projects differently. The contractor category was divided in a similar manner with 1) total project revenue for both domestic and international; 2) R&R project revenue for both domestic and international; 3) number of total projects and R&R projects for a 2006; and 4) different management strategies for R&R and what characteristics made the organization handle such projects differently.

4.4.1 Project Budget and Revenue

Once the information was categorized, sample means were calculated for the total budget/revenue and R&R project budget/revenue illustrated in Table 4.1.

Table 4.1: Mean Project Budget per year for Owners and Revenue per year for Contractors

Project Budget Type	Mean Budget Size (\$ Billion)
Owner's Total Project Volume	4.6
Owner's R&R Project Volume	1.5
Contractor's Total Project Revenue	5.2
Contractor's R&R Project Revenue	1.5

Since the CII member companies perform work with one another, it must be stated the dollars evaluated in the survey can represent the same project. It should be noted that some of the projects budgeted by CII owner respondents were probably performed by CII contractor respondents. Based on the sampling method chosen it was impossible to segregate these projects.

The survey generated data for three years: 2005, 2006, and predicted 2007. Each year was evaluated in terms of the percentage of R&R projects to total projects per contractor and owner. The percentages were calculated by adding all the R&R revenues and budgets for each year and dividing by the total project budget and revenues. Figure 4.1 illustrates that in 2005, owner organizations spent 26 percent of total budget on R&R projects, while contractors earned 29 percent of total revenues on R&R. Figure 4.2 illustrates that in 2006, owner organizations spent 24 percent of the total budget on R&R projects, while 30 percent of contractor revenues came from R&R projects.

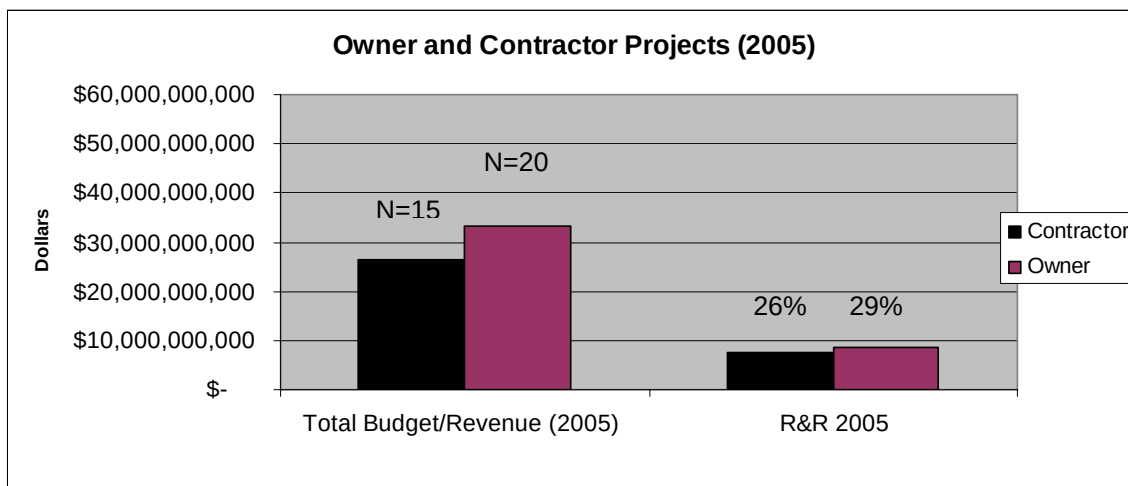


Figure 4.1: Total Projects v. R&R Projects for Owners and Contractors in 2005

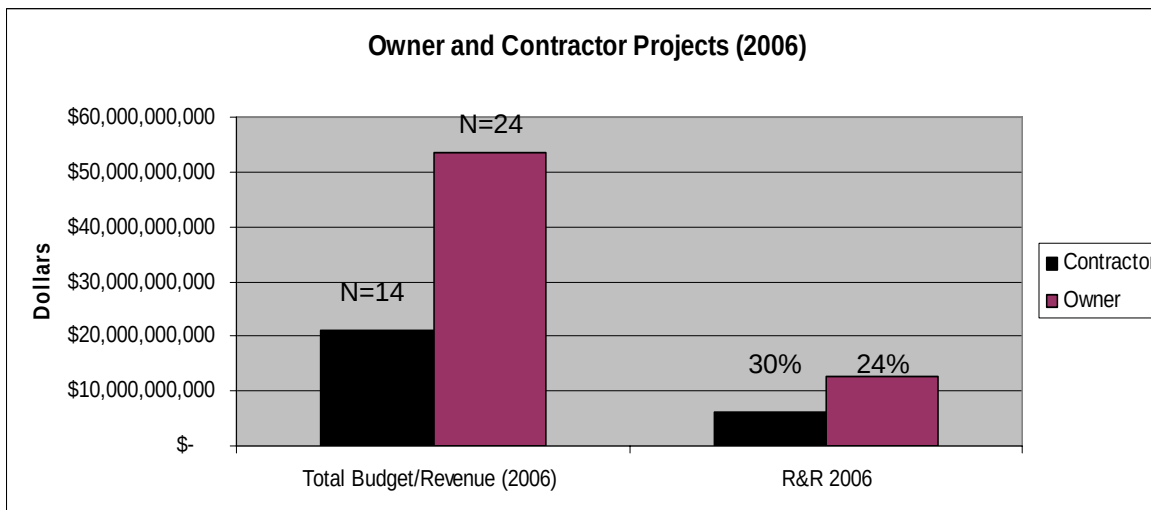


Figure 4.2: Total Projects v. R&R Projects for Owners and Contractors in 2006

Figure 4.3 illustrates that owner organizations projected to spend 43 percent of the total budget on R&R projects, while contractors predicted 29 percent of their revenue would come from R&R projects for the year 2007.

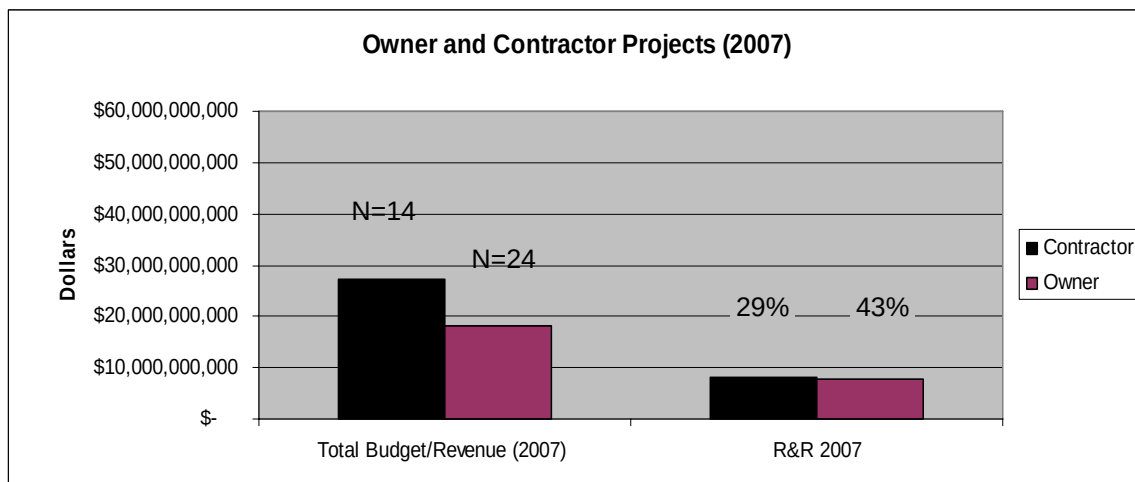


Figure 4.3: Total Projects v. R&R Projects for Owners and Contractors in 2007

The combined information provided additional insight; an overall sample percentage shows the importance of researching R&R projects since a significant percentage of capital spending in this sample was on R&R projects. Figure 4.4 illustrates the overall R&R project budget/revenue to total project budget revenue for each year.

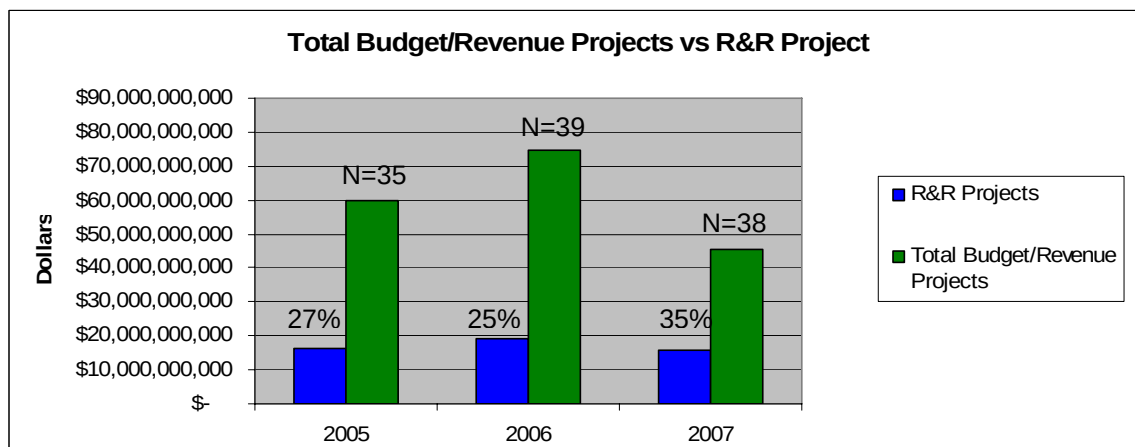


Figure 4.4: Total Projects v. R&R Projects for Owners and Contractors per 2005, 2006, 2007

Figure 4.5 shows the complete rollup of quantities for all three years, with 28.5 percent total sample projects consisting of R&R projects for both contractors and owners. Note that the entire sample consisted of approximately \$180 billion dollars. As discussed

earlier, some of these projects may be “double counted” because some of the CII owner’s projects were probably performed by CII contractors and the 2007 data are projected.

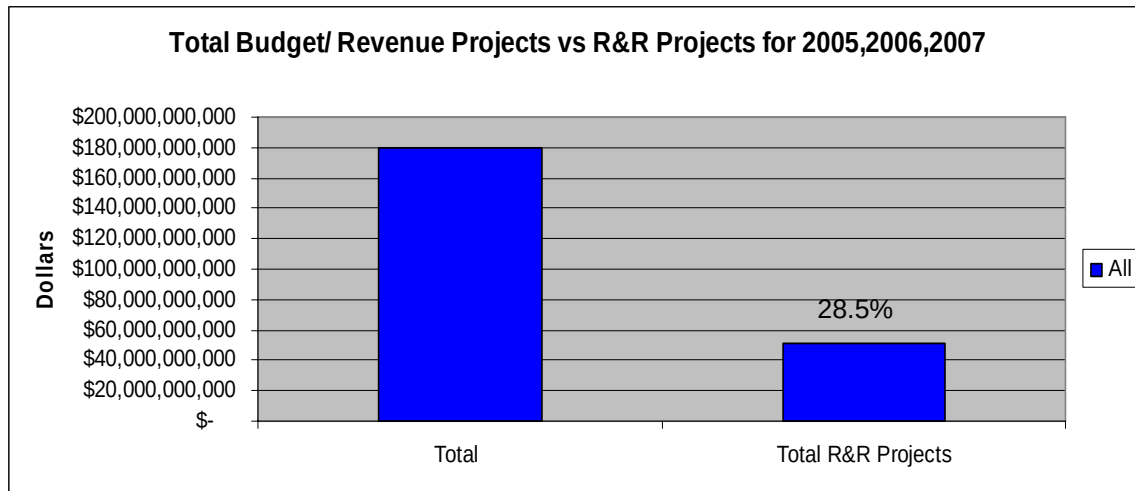


Figure 4.5: Total Projects v. R&R Projects for Owners and Contractors

The Phase I survey also asked for the number of R&R projects executed in 2006. Due to limited information provided by the respondents on this question, the data could not be effectively analyzed.

4.4.2 Comparison of Domestic and International Project Budget and Revenue

For projects included in the survey, domestic projects were defined as projects within the country of the organization’s primary operations and international projects are outside the country of the organization’s primary operations. Not all survey participants indicated a breakdown between domestic and international projects and thus were excluded from this analysis (four each respondents from both the owner and contractor sub-samples gave a combined response and thus could not be used in this part of the assessment).

Once the information was categorized, sample means were calculated for the total domestic budget/revenue and R&R domestic project budget/revenue illustrated in Table 4.2. This table shows that owner organizations spent 47 percent of the total domestic budget on R&R projects, while 39 percent of contractor revenues came from domestic R&R projects. It should be noted that these values are averages for the three years asked for in the assessment. In some cases, the respondents did not give data for some of the years that were requested (most notably 2005 and 2007), hence the variation in sub-sample sizes.

Table 4.2: Mean Domestic Project Budget per year for Owners and Revenue per year for Contractors

Project Budget Type	Mean Budget Size (\$ Billion)
Owner's Total Project Volume (N=20)	1.7
Owner's R&R Project Volume (N=20)	0.8
Contractor's Total Project Revenue (N=13)	3.8
Contractor's R&R Project Revenue (N=11)	1.5

Sample means were calculated for the total international budget/revenue and R&R international project budget/revenue as illustrated in Table 4.3. This table shows that owner organizations spent 29 percent of the total international budget on R&R projects, while 22 percent of contractor revenues came from international R&R projects.

Table 4.3: Mean International Project Budget per year for Owners and Revenue per year for Contractors

Project Budget Type	Mean Budget Size (\$ Billion)
Owner's Total Project Volume (N=12)	2.4
Owner's R&R Project Volume (N=10)	0.7
Contractor's Total Project Revenue (N=9)	3.6
Contractor's R&R Project Revenue (N=8)	0.8

These data show that the volume of domestic R&R projects is higher than international projects for this subsample. This seems to confirm one of the “rumors” that is widely discussed in the industry. Namely, that more R&R work is done domestically (in this case mostly North America) than internationally. This is a small sample and cannot be extended to the industry as a whole, but gives a snapshot of this phenomenon.

4.4.3 Management of R&R Projects

In addition to the budget and revenue data it is also important to discuss different management strategies for R&R projects, including project characteristics that influence the organization to handle them differently. In the survey, participants were asked to answer the question “Do you manage R&R projects differently in your business processes than new construction?” Table 4.2 shows the response to this question, including a breakdown by owners and contractors. With 40 organizations answering this question, 26 responded yes to handling R&R projects differently. It appears that based on this sample that owners typically handle R&R projects differently while contractors are split. In some cases the owner or contractor indicated that almost all their projects were R&R, hence they were not handled differently.

Table 4.4: Management of R&R Projects

Participants	Yes	No
All	26	14
Owner	18	5
Contractor	8	9

Additional information concerning managing R&R projects was captured by asking the organizations to elaborate on this question. Selected quotes are given below explaining why they handle R&R projects differently.