PRE-PROJECT PLANNING AND ITS PRACTICE IN INDUSTRY

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Abstract: Pre-project planning is the project phase encompassing all the tasks between project initiation to detailed design. The development of a project scope definition packages is one of the major tasks in the pre-project planning process. Project scope definition is the process by which projects are defined and prepared for execution. It is at this crucial stage where risks associated with the project are analyzed and the specific project execution approach is defined. Nevertheless, the pre-project planning practices vary significantly throughout the industry from one organization to another. Pre-project planning practice data from 62 industrial projects and 78 building projects, representing approximately $5 billion in total construction cost, were collected and pre-project planning practices (as measured by the level of scope definition) were analyzed. Poorly defined scope elements among the surveyed projects will be identified and compared between the two industry sectors. The pre-project planning practices among successful and less-than-successful projects will be compared.

Keywords: Scope Definition, Project Success, Pre-Project Planning, Project Processes, Industry Practice

1. INTRODUCTION

Significant decisions are made by the project team during the early planning phase of capital facility project developments. The process of pre-project planning constitutes a comprehensive framework for detailed project planning and includes scope definition. Project scope definition, the process by which projects are selected, defined and prepared for definition, is one key practice necessary for achieving excellent project performance [1] and is a key element in the pre-project planning process. How well pre-project planning is performed will affect cost and schedule performance, operating characteristics of the facility, as well as the overall financial success of the project. [2]

The construction industry has recognized the importance of scope definition during pre-project planning and inadequate or poor scope definition, which negatively correlates to the project performance, is among the most problems affecting a construction project. [3] Due to poor scope definition, final project costs can be expected to be higher because of the inevitable changes which interrupt project rhythm, cause rework, increase project time, and lower the productivity as well as the morale of the work force. [4] Nevertheless, the pre-project planning practices vary significantly throughout the industry from one organization to another. In order to investigate the pre-project planning practices in the construction industry, a scope definition tool, Project Definition Rating Index (PDRI) is incorporated in this research.

Researches conducted by the Construction Industry Institute (CII) have developed the PDRI to address scope definition in pre-project planning for both the industrial and building sectors. The PDRI is a comprehensive, weighted checklist of crucial scope definition elements that have to be addressed in pre-project planning process. It provides the project team a simple and easy-to-use tool to objectively evaluate the current status of a project during pre-project planning. Since its development, researchers at the University of Texas at Austin and CII have been collecting pre-project planning information using the PDRI.

The PDRI was used to collect information of the pre-project planning practices in the industrial and building industry. The similarities and differences of the PDRI scope elements as well as the scope definition levels will be compared between the two industry sectors. In addition, the pre-project planning practices (as measured by scope definition level in the PDRI) among successful and less-than-successful projects will be compared.

2. DATA COLLECTION

The data collection was accomplished through a series of retrospective case studies. A scope definition tool, Project Definition Rating Index (PDRI) is used as a survey instrument in these case studies to measure the pre-project planning practices in the industry. Data from 62 industrial projects and 78 building projects, representing approximately $5 billion in total construction cost, were collected and used to conduct an investigation of the early planning practices in the industrial and building industry.

2.1 Project Definition Rating Index

CII constituted a research team in 1994 to produce effective and easy-to-use pre-project planning tools that extended previous research efforts so that owner and contractor companies would be able to better achieve business, operational, and project objectives. [5] This research effort led to the development of the Project Definition Rating Index (PDRI). The PDRI for industrial projects is a weighted matrix with 70 scope definition elements (issues that need to be addressed in pre-project planning) grouped into 15 categories and further grouped into three main sections. In responding to the needs of the building industry, CII developed the PDRI for Building Projects in 1999. [6]

The PDRI provides a means for an individual or team to evaluate the status of a construction project during pre-project planning with a score corresponding to the project's overall level of definition. The PDRI helps the stakeholders of a project to quickly analyze the scope definition package and to predict factors that may impact project risk specifically with regard to industrial and building projects. [7] For illustration purposes, Section I – Category A of the PDRI for Building Projects (both elements and their weights) is shown in Figure 1. This is one category of 11 in the PDRI for buildings and encompasses eight of 64 scope definition elements. [8]

SECTION I - BASIS OF PROJECT DECISION							
	Definition Level						
CATEGORY Element	0	1	2	3	4	5	Score
A. BUSINESS STRATEGY (Maximum = 214)							
A1. Building Use	0	1	12	23	33	44	
A2. Business Justification	0	1	8	14	21	27	
A3. Business Plan	0	2	8	14	20	26	
A4. Economic Analysis	0	2	6	11	16	21	
A5. Facility Requirements	0	2	9	16	23	31	
A6. Future Expansion/Alteration Considerations	0	1	7	12	17	22	
A7. Site Selection Considerations	0	1	8	15	21	28	
A8. Project Objectives Statement	0	1	4	8	11	15	

0 = Not Applicable 2 = Minor Deficiencies 4 = Major Deficiencies
1 = Complete Definition 3 = Some Deficiencies 5 = Incomplete or Poor Definition

Figure 1: PDRI for Building Projects, Category A

Each element has a corresponding detailed description. Figure 2 gives an example of an element description. Please refer to CII 1996 and 1999 [5] [6] for detailed information on development of the tool, all the element descriptions and application of the PDRI.

A1. Building Use

Identify and list building uses or functions. These may include uses such as:

- ❑ Retail
- ❑ Institutional
- ❑ Instructional
- ❑ Medical
- ❑ Research
- ❑ Multimedia
- ❑ Office
- ❑ Light manufacturing
- ❑ Storage
- ❑ Food service
- ❑ Recreational
- ❑ Other

A description of other options which could also meet the facility need should be defined. (As an example, did we consider renovating existing space rather than building new space?) A listing of current facilities that will be vacated due to the new project should be produced.

Figure 2: Example Description of Element A1:Building Use

2.2 Data Collection

The sample projects used in this study were obtained from three different sources: previous PDRI research, CII Benchmarking and Metrics research, and institutional organizational (which prefers remaining anonymous) PDRI benchmarking research.

In summary, information for a total of 62 industrial projects representing a total budget cost of approximately $3.9 billion dollars was obtained for the research. 78 building projects representing approximately $1.1 billion dollars in total budget cost provided information for the research analysis. Both domestic and international projects are contained in the sample. It is important to note that the sample selection of the study is based on organizations volunteering projects for the study and not on a random sample of a known population. A detailed breakdown of the projects is presented in Table 1.

Table 1: Industrial and Building PDRI Data Sample

Sector (1)	Resource (2)	No. of Projects (3)	Represented Cost (Billion) (4)
Industrial	PDRI-Industrial Research (1996)	23	$1.6
	Alignment Research (1998)	18	$1.9
	CII BM&M Database (2001)	21	$0.4
	Industrial Projects Total	**62**	**$3.9**
Building	PDRI-Buildings Research (1999)	33	$0.8
	Institutional Organization Benchmarking (2001)	45	$0.3
	Building Projects Total	**78**	**$1.1**

In the PDRI survey questionnaires, specific questions were intended to obtain historical and "after the fact" project information. The questionnaires included questions regarding project basics (location, type, budget and schedule), operating information, and evaluation using an unweighted PDRI score sheet. Survey participants were asked to think back at a point just prior to construction document (detailed design) development when they filled out the PDRI evaluation score sheet. The total scores were then calculated based on pre-assigned element weights after the questionnaires were returned. Due to the unique nature of these two different sectors, industrial and building projects were examined separately throughout this research investigation.

3. DATA ANALYSIS AND FINDINGS

In the PDRI survey questionnaires, specific questions were intended to obtain historical and "after the fact" project information. The questionnaires included questions regarding project basics (location, type, budget and schedule), operating information, and scope definition evaluation using a PDRI score sheet. In the survey, participants were asked to fill out unweighted PDRI score sheet for their pre-project planning evaluation and they were asked to think back to a point prior to Construction Document development. Based on the evaluator's perception of how well one scope element has been decided, only one definition level (0, 1, 2, 3, 4, or 5) for that element was chosen. Definition level 1 stands for complete definition, 2 for minor deficiencies, 3 for some deficiencies, 4 for major deficiencies and 5 for incomplete or poor definition. If the scope element is not applicable to the project decision making process, the respondent was asked to check definition level 0.

The data collected from the actual projects represented project scope definition levels and were used for analyzing the characteristics of past early decision making practices. This investigation was focused on the identification of poorly defined PDRI scope elements for both industrial and building projects.

After receiving the survey responses, definition levels were averaged and total number of projects was counted for each of the 70 scope elements in the industrial PDRI or 64 elements in the building PDRI. The mean definition levels were calculated for the 70 scope elements and then compared with each other to determine which elements were not well-defined for the industrial projects. Table 2 presents a list of 15 scope definition elements with mean definition levels greater than 2.5 (which corresponds to some deficiencies).

Table 2: Poorly Defined Industrial Scope Elements

Industrial Project Scope Definition Element (1)	Definition Level Average (2)
K2. Logic Diagrams	3.1
G13. Instrument Index	2.9
P5. Start Up Requirements	2.8
G11. Tie-in List	2.8
G12. Piping Special Item List	2.8
G10. Line List	2.8
P4. Pre-Commissioning Turnover Sequence Requirements	2.7
K6. Instrument & Electrical Specifications	2.6
N3. Risk Analysis	2.6
I1. Civil/Structural Requirements	2.6
E3. Design for Constructability Analysis	2.6
P6. Training Requirements	2.5
G3. Piping & Instrumentation Diagrams	2.5
G7. Piping System Requirements	2.5

The poorly defined industrial scope elements identified in Table 2 indicate poor scope definition practices when considering these aspects of the project scope in the pre-project planning phase.

The list above identified the poor scope definition practice from the surveyed industrial projects. The worst-defined scope element is element K2: Logic Diagrams. Logic diagrams provide a method of depicting interlock and sequencing systems for the startup, operation, alarm, and shutdown of equipment and processes. [5] In the sample, 27 projects indicated scope definition for element K2: Logic Diagrams was either incomplete or poorly defined (definition level 5). Also, in a category level, it is found that Category G, Process/Mechanical, and Category P, Project Execution Plan, were not well defined. Half of the scope elements in these two categories are in this list.

After receiving the survey responses, definition levels for the 64 scope elements were averaged and then sorted to examine the level of pre-project planning for the surveyed 78 building projects. Table 3 illustrates a list of poorly-defined scope definition elements with average definition levels greater than 2.5 for the building projects.

Table 3: Poorly Defined Building Scope Elements

Building Project Scope Definition Element (1)	Definition Level Average (2)
E1. Program Statement	3.4
A8. Project Objective Statement	3.0
C4. Scope of Work Overview	3.0
C6. Project Cost Estimate	2.8
C1. Value-Analysis Process	2.7
F7. Constructability Analysis	2.7
C5. Project Schedule	2.7
F4. Mechanical Design	2.6
E11. Room Data Sheets	2.5

Similarly, the list above identified the poor scope definition practice from the surveyed building projects. From the list, the most poorly-defined scope element for the 78 surveyed building projects is element E1: Program Statement. The Program Statement identifies the levels of the performance of the facility in terms of space planning and functional relationships. It should address the human, physical, and external aspects to be considered in the design. [6] Category C deals with Project Requirements, and four out of the six elements in Category C are on the list (poorly-defined). Surprisingly, project cost estimate and project schedule were among the poorly-defined elements as well. Normally, these two scope elements are assumed to be the basic requirements for project management. However, the survey results showed that the sample project participants did not focus as much on these two scope elements as perceived. The fact that limited time and resource availability might contribute to poorly-defined cost estimate and project schedule.

Although industrial and building projects are two different sectors, it is interesting to find that the survey results showed that decision making process for Project Objective Statement and Value Analysis are poorly executed for both building and industrial sample projects. Overall, for the survey results showed that the industrial projects should focus more on Process/Mechanical, Instrument & Electrical, and Project Execution Plan in their decision making process. In the mean time, the building project should improve on issues such as project program and objective statement, project cost and schedule, constructability and value analysis.

Table 4 lists industrial scope elements with average definition levels lower than 2.0. Definition level 2 means that the scope definition only has minor deficiencies for this particular scope element. Generally, these surveyed industrial projects did well in defining scope elements relating to site information, technology, business objectives, and project scope in their pre-project planning process.

Table 4: Well-Defined Industrial Scope Elements

Industrial Project Scope Definition Element (1)	Definition Level Average (2)
G9. Mechanical Equipment List	1.9
B3. Project Strategy	1.9
K3. Electrical Area Classifications	1.9
F4. Permit Requirements	1.9
D1. Project Objective Statements	1.9
E1. Process Simplification	1.9
F2. Surveys & Soil Tests	1.9
E2. Design & Material Alterations Considered/Rejected	1.8
M1. CADD/Model Requirements	1.8
K4. Substation Requirements Power Source Identification	1.8
J3. Transportation Requirements	1.8
B2. Market Strategy	1.7
G8. Plot Plan	1.7
G2. Heat & Material Balances	1.7
F3. Environmental Assessment	1.7
C2. Processes	1.7
G1. Process Flow Sheets	1.6
C1. Technology	1.6
L1. Identify Long Lead/Critical Equipments & Materials	1.6
B5. Capacities	1.5
D6. Project Schedule	1.5
D3. Site Characteristics Available and Required	1.5
B1. Products	1.4
F1. Site Location	1.0

Table 5 listed building scope elements with average definition levels lower than 2.0, meaning that the scope definition only has minor deficiencies for this particular scope element. Generally, these building projects did well in defining scope elements relating to business strategy, site information, building programming, and project execution planning.

Table 5: Well-Defined Building Scope Elements

Building Project Scope Definition Element (1)	Definition Level Average (2)
E5. Growth and Phased Development	1.9
E4. Stacking Diagrams	1.9
L5. Substantial Completion Requirements	1.9
B4. Design Philosophy	1.9
D8. Special Water and Waste Treatment Requirements	1.9
D1. Site Layout	1.8
E3. Overall Adjacency Diagrams	1.8
K1. Project Quality Assurance and Control	1.7
A4. Economic Analysis	1.7
A5. Facility Requirements	1.7
F6. Building Life Safety Requirements	1.7
J1. CADD/Model Requirements	1.7
B1. Reliability Philosophy	1.7
E6. Circulation and Open Space Requirements	1.7
E7. Functional Relationship Diagrams / Room by Room	1.6
E9. Transportation Requirements	1.6
D3. Civil/Geotechnical Information	1.6
L2. Owner Approval Requirements	1.6
L1. Project Organization	1.6
D7. Site Life Safety Considerations	1.6
A7. Site Selection Considerations	1.6
E8. Loading/Unloading/Storage Facilities Requirements	1.6
C3. Evaluation of Existing Facilities	1.6
D5. Environmental Assessment	1.6
A3. Business Plan	1.5
D4. Governing Regulatory Requirements	1.5
K5. Safety Procedures	1.5
D2. Site Surveys	1.4
A1. Building Use	1.3
A2. Business Justification	1.3

Relationship between project performance and scope definition levels is also investigated in this research. In order to accomplish this, previous projects were first divided into two groups, successful and less-than-successful projects, based on their performance (cost and schedule growth). Projects with less than zero percent cost/schedule growth were grouped as successful cost/schedule projects where as other projects were grouped as less-than-successful cost/schedule projects. The element scope definition level means for these two groups of projects were calculated and compared with each other to see if there is any significant relationship between the scope definition level and project performance. Statistical significance tests (i.e., *t*-test) were first conducted to identify if there is statistical difference between the means for these two groups. In addition, Effect Size was measured to compare the difference between the mean definition levels for the two groups.

For any scope element, if the value of the Effect Size obtained from the sample project data is greater than 0.8, the difference of definition level averages between the two performance groups is determined significant for that element. [9] This implies that, historically, sample projects with better performance did better in defining that particular scope element than projects with poor performance. Therefore, this element identified as a performance indicator based on information collected from data sample.

Tables 6 and 7 summarize these scope elements based on their cost performance for industrial and building projects, respectively. Tables 8 summarize these scope elements based on their schedule performance for industrial projects. Note that no indicators were determined for schedule performance in the building project sample.

Table 6: Cost Performance Indicator for Industrial Projects

Industrial Projects (N1=25, N2=29)* Scope Element (1)	Mean Difference** (2)	Effect Size** (3)
A1. Reliability Philosophy	0.8	0.8
A2. Maintenance Philosophy	1.2	1.3
A3. Operating Philosophy	0.8	0.8
B6. Future Expansion Considerations	0.9	0.9
B7. Expected Project Life Cycle	1.4	1.2
B8. Social Issues	1.1	0.9
D2. Project Design Criteria	0.9	1.1
D4. Dismantling and Demolition Requirements	0.9	0.8
F2. Surveys and Soil Tests	0.7	1.0
G4. Process Safety Management (PSM)	1.2	1.2
G5. Utility Flow Diagrams	0.9	0.9
G7. Piping System Requirements	1.2	1.1
G10. Line List	1.2	0.9
G11. Tie-In List	1.2	0.9
G12. Piping Specialty Items List	1.2	0.8
H2. Equipment Location Drawings	0.8	0.9
J2. Location/Uploading/Storage Facilities Requirements	0.8	0.8
P4. Pre-Commission Turnover Sequence Requirements	1.2	0.8

* N1: number of successful cost project; N2: number of less-than-successful cost projects

** Mean Difference and Effect Size were obtained by comparing two cost groups

Table 7: Cost Performance Indicator for Building Projects

Building Projects (N1=11, N2=67)* Scope Element (1)	Mean Difference** (2)	Effect Size** (3)
A8. Project Objectives Statement	1.5	1.0
B2. Maintenance Philosophy	0.9	0.8
B4. Design Philosophy	0.7	0.8
E1. Program Statement	2.0	1.4
E2. Building Summary Space List	1.1	1.0
E11. Room Data Sheets	1.0	0.8
E13. Window Treatment	1.3	1.0
F2. Architectural Design	1.0	0.9
F4. Mechanical Design	1.2	1.0
F5. Electric Design	1.1	0.9
F7. Constructability Analysis	1.6	1.3
H1. Identify Long-Lead/Critical Equipment and Materials	1.1	0.9
H2. Procurement Procedures and Plans	1.0	0.8
J2. Documentation/Deliverables	1.3	0.9
L3. Project Delivery Method	1.0	0.8

* N1: number of successful cost project; N2: number of less-than-successful cost projects

** Mean Difference and Effect Size were obtained by comparing two cost groups

Table 8: Schedule Performance Indicator for Industrial Projects

Industrial Projects (N1=30, N2=24)* Scope Element (1)	Mean Difference** (2)	Effect Size** (3)
A3. Operating Philosophy	0.9	0.9
G4. Process Safety Management (PSM)	1.1	1.0
G5. Utility Flow Diagrams	0.9	0.9
G7. Piping System Requirements	1.2	1.1
G13. Instrument Index	1.1	0.8
K1. Control Philosophy	0.7	0.8
K6. Instrument & Electrical Specifications	0.9	0.8

* N1: number of successful schedule project; N2: number of less-than-successful schedule projects

** Mean Difference and Effect Size were obtained by comparing two schedule groups

If the identified scope elements were not well defined, the project is more likely to have a less-than-successful project performance (cost/schedule growth). That is, according to the sample projects, poor pre-project planning practice in these aspects is more likely to have a negative impact (cost or schedule performance) on the project.

4. CONCLUSIONS AND RECOMMENDATIONS

Using the Project Definition Rating Index (PDRI) in the survey, the researchers were able to collect specific information regarding the completeness of project scope definition. A total of 140 construction projects were surveyed to investigate the pre-project planning practice in the industry. By evaluating the project scope definition, as an integral part of pre-project planning process, pre-project planning practices for these surveyed projects were analyzed and industry practices were identified from the sample.

From data sample, it is shown that some aspects of the pre-project planning process were typically well defined and some were poorly defined for the surveyed projects. Further analysis shows significant difference between successful and less-than-successful projects. By improving these poorly defined aspects in the pre-project planning stage, it is more likely for the project team to expect future project success. That is, cautions should be taken if these aspects are poorly decided in the pre-project planning process.

It is recommended that the industry practitioners to use PDRI to evaluate their pre-project planning practices. Poor pre-project planning practices can be identified after the PDRI evaluation and the project team should improve the process to enhance the probability of project success. Survey results have shown that some aspects are typically poorly decided and these aspects should be treated with cautions. Furthermore, the analysis results presented in the paper identified several aspects that are more related to project performance. With this information, the industry practitioners are able to allocate limited resources efficiently to improve the overall pre-project planning practices.

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