



Analysis of Pre-Project Planning Effort and Success Variables For Capital Facility Projects

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

**Under the Guidance of the
Pre-Project Planning Research Team**

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EXECUTIVE SUMMARY

The CII Pre-Project Planning Research Team was chartered to determine the impact of pre-project planning on the success of projects. The research team conducted a detailed study of capital construction projects to determine how the level of effort expended on pre-project planning affected the success of the projects. This source document presents analysis of quantitative data from 62 projects that were part of that investigation.

The study hypothesis "*the successful completion of a capital construction project is positively correlated with the level of effort expended during the pre-project planning phase of the project*" was tested using regression analysis. Through index construction and bivariate regression modeling, the relationship between pre-project planning and project success was identified and graphically depicted. This relationship proved to be positive, with a regression equation for the prediction of project success having an R^2 of 0.4190.

Six statistically significant pre-project planning variables that lead to success were identified:

- Existence of a Written Project Charter
- Existence of a Pre-Project Planning Plan
- Percent Design Complete at Authorization
- Development of Control Guidelines
- Number of Corporate Groups Represented during Pre-Project Planning
- Defined Execution Approach

Four variables were identified as significant in measuring success:

- Budget Achievement
- Schedule Achievement
- Design Capacity
- Plant Utilization

The major conclusion that can be drawn from this study is that there does exist a positive, quantifiable relationship between effort expended during the pre-project planning phase and the ultimate success of a project. Given the lack of previous research in this area, these findings are significant to the construction industry. This positive relationship was based on analysis of pre-project planning functions identified in the model found in CII Source Document 94. Therefore, this analysis contributes to the verification of the published model.

The pre-project planning effort level **directly** affects the cost and schedule predictability of the project. By establishing lower third, middle third and upper third pre-project planning effort groups within the sample and evaluating each against success variables, some broad conclusions can be made. As the level of pre-project planning moves from the lower third to the upper third group, average project cost performance versus authorization estimate favorably decreases by as much as 20 percent. Similarly, variance between average schedule performance versus authorization estimate decreases by as much as 39 percent. In addition, plant design capacity attained and facility utilization improve by about 15 percent versus authorization estimate. Finally, project scope changes after authorization tend to decrease as the level of pre-project planning effort increases.

For this sample, the likelihood that a project met or exceeded its financial goals increased as the level of effort in pre-project planning increases. This finding is particularly important because business success is the major criteria used to approve most capital expenditures. Other findings are also outlined in this source document.

Many recommendations can be made from the findings of this study. They fall into two basic categories: 1) organizing for pre-project planning; and 2) having a well defined project scope (project definition plan). Recommendations include:

- The pre-project planning team should be working with a written charter.
- The pre-project planning effort should have a pre-project planning process and plan.
- Participation of more corporate groups with varied interests during the pre-project planning phase increases success.
- Control guidelines should be developed during the pre-project planning process.
- An execution approach for engineering, procurement, construction, and start-up should be developed during the pre-project planning process.
- Design work hours complete before project authorization should be from 10 to 25 percent of total design effort depending on the complexity of the project. Expenditure of less effort should be accompanied with an understanding of the implications.

In summary, facility owners should place emphasis on organizing pre-project planning efforts using a formal process incorporating the effort variables identified in this report. It is also important that they expend the resources necessary to insure a well-defined project scope before an authorization decision is made. Owners should understand that the implication of not providing this effort is decreasing probability of project success.

Contractors are currently providing pre-project planning services to many owners and are encouraged to adopt the findings of this research investigation as well. They should understand the implications of pre-project planning in terms of project execution and the contracting environment that currently exists in the industry.

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CHAPTER 1: INTRODUCTION

Pre-project planning of capital facilities is an extremely important function in determining the ultimate outcome of a project. How well it is performed will affect cost and schedule performance, plant operating characteristics, as well as the overall financial success of the project. When a high level of effort is put forth in this early phase, the project is likely to experience fewer scope changes after project execution. Overall, proficient pre-project planning is vital to the success of a project.

This study is part of an ongoing Construction Industry Institute (CII) sponsored research project studying pre-project planning and its relationship to the success of capital construction facilities. Pre-project planning was identified by CII as an area deserving study due to its place in the construction life cycle and its potential for increasing project cost effectiveness and productivity.

This chapter presents a brief discussion of the project life cycle phases: business planning, pre-project planning, project execution and operation. The mission of CII's Pre-Project Planning Research Team is presented with specifics of how this research helps fulfill that mission. The investigation hypothesis is outlined and the source document objectives are identified. Lastly, the format of the source document is presented and outlines the contents and objectives of each chapter.

1.1. Project Cost versus Influence

Many professionals within the construction industry believe that early stages in the project life cycle can have a much greater influence on a project's outcome than later stages. This relationship is shown in Figure 1.1 below. The curve labeled "influence" in Figure 1.1 reflects a company's ability to affect the outcome of a project during the various stages of a project.

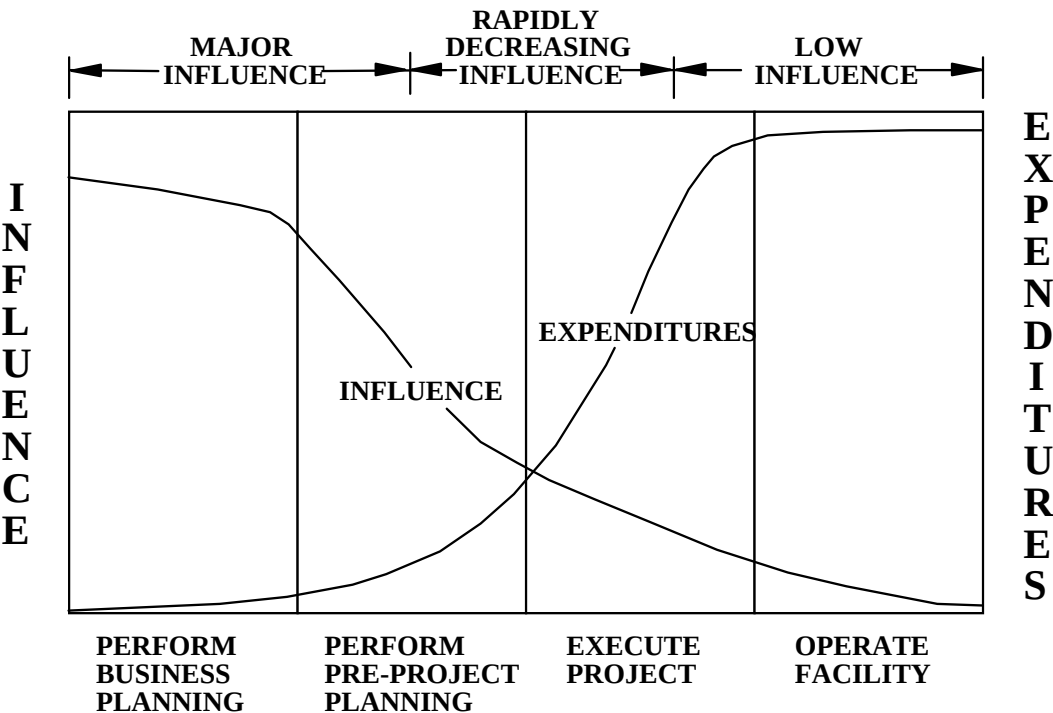


Figure 1.1 Influence and Expenditures Curve for the Project Life Cycle

As shown in the diagram, it is much easier to influence a project's outcome during the early stage of the project when expenditures are relatively minimal. Given the potential impact of this phase on the final outcome of the project, CII formed the Pre-Project Planning Research Team.

1.2. The Construction Industry Institute

The Construction Industry Institute, established in 1983, is located at The University of Texas at Austin. The focus of CII is to improve the total quality, cost effectiveness and international competitiveness of the U.S. construction industry. The 87 current member companies that select and direct the research are recognized leaders in the industry. Member companies staff CII Research Teams to provide guidance for specific research activities at more than 30 different universities. The title of each research team suggests, to some extent, its problem area focus.

Since its first formal publication in May 1986, CII has produced over 100 different publications. These publications summarize the findings of the detailed research which is contained in the CII source documents. The publications are offered to the construction industry as a contribution with the intent of disseminating the results of the research conducted.

1.2.1. CII Pre-Project Planning Research Team

In order to investigate the potential for increased project success through improved pre-project planning, CII commissioned Research Team 39. This team was dedicated to studying pre-project planning and consisted of 18 individuals, with two coming from academia and the balance evenly divided between owners and contractors. The Pre-Project Planning Research Team was given the following charter by CII:

To find the most effective methods of project definition and cost estimating for appropriation approval.

1.2.2. Research Team Objectives

In order to meet the charge set forth by CII, the research team set for itself the following objectives:

- 1) Define the pre-project planning process for the construction of capital facilities and develop a glossary of planning terms;
- 2) Evaluate the relationship between overall project success and the level of pre-project planning effort; and
- 3) Develop a handbook identifying the best pre-project planning practices.

1.3. Project Domain

The construction industry is diversified. Due to this diversification, a study on pre-project planning encompassing all industry sectors would be too broad and it is doubtful that meaningful research results would be revealed. Therefore, the research is limited to the following domain:

- Industrial construction projects in North America
- Projects that exceeded \$5,000,000 in final cost
- Projects that had been completed for at least two years

1.4. Research Hypothesis

With the domain defined, the hypothesis of this source document is the following:

The successful completion of a capital construction project is positively correlated with the level of effort expended during the pre-project planning phase of the project.

1.5. Source Document Objectives

The four primary objectives of this source document are:

1. To identify the relationship that exists between pre-project planning effort and project success,
2. To identify significant pre-project planning and success variables,
3. To identify measures for success and pre-project planning and,
4. To establish a baseline methodology and database for follow up research.

The objectives of this source document help to fulfill the research team objectives by targeting research team objective number two, to evaluate the relationship between overall project success and the level of pre-project planning effort.

Identifying the relationship between pre-project planning and success is paramount to the success of this research effort. The other three objectives will be met in order to establish this primary relationship. First, a database of information was instituted. Raw data were then transformed into measures that could be

analyzed. Through various statistical analysis procedures, significant variables for success and effort were identified, thus satisfying objectives number two and three. Distinguishing the relationship between these variables reveals the correlation between pre-project planning effort and success. These procedures combined encompass the baseline methodology of objective four.

1.6. Organization of Source Document

Following this introduction chapter, background information regarding pre-project planning, theories of research and data collection are presented in Chapter 2. Research methodology is presented in Chapter 3, including data collection methods employed, data conversion and statistical analysis procedures used. Variable conceptualization and measurement, and development of the survey instruments will be discussed in Chapter 4.

Chapter 5 displays descriptive characteristics of the survey sample such as project type, construction type and size characteristics. Additionally, contracting strategies for all project phases are presented as well as descriptives of the success attained by the sample. Chapter 6 focuses on the subject of success by analyzing all objective success measures obtained during data gathering to obtain a single, composite success measure or benchmark. In Chapter 7, pre-project planning effort is examined and a combined measure is proposed which consists of weighted values applied to six objective effort measures. Individual effort variables and their relationship to success are presented. Additionally, there is a display of how

different levels of pre-project planning affect success. Lastly, benchmarks of the pre-project planning process are given.

Chapter 8 defines the relationship between success and pre-project planning effort through bivariate regression analysis of the two composite measures derived. The regression prediction equation for success is then given. Lastly, Chapter 9 reviews the achievement of the research objectives and goals as well as conclusions, recommendations and suggestions for follow-up research.

CHAPTER 2 BACKGROUND

This chapter is provided to give the reader a firm understanding of the total pre-project planning process modeled and defined by the research team. Definitions of the pre-project planning functions are provided for the purpose of facilitating understanding of future chapters on data presentation and analysis. A pertinent literature review on the subjects of this study, pre-project planning, project success, and benchmarking are examined. Material on data collection are reviewed to include data gathering strategies, sampling procedures and handling of missing data.

2.1. Project Life Cycle

As mentioned in Chapter 1, the project life cycle can be divided into distinct stages: business planning, pre-project planning, execute project, and operate facility. A detailed breakdown of the four phases is shown below in Figure 2.1, the project life cycle. This breakdown includes the sub-processes that occur during implementation of the phases. This diagram was developed by CII's Pre-Project Planning Research Team. The focus of this study, pre-project planning, is enclosed in the shaded box.

Note that pre-project planning encompasses those sub-processes that occur after the project concept has been developed in the business planning function and before the project is finally authorized for detailed design and construction. The

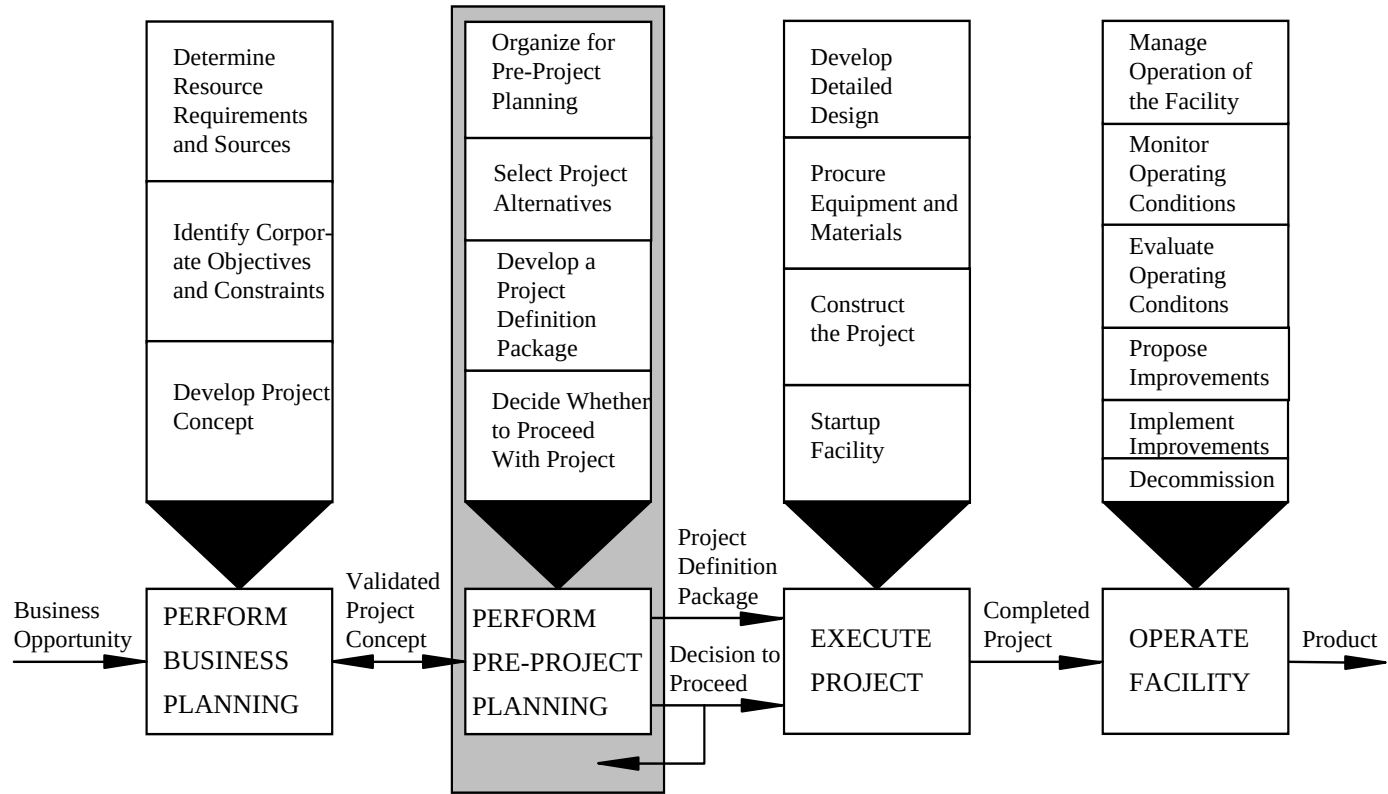


Figure 2.1 Project Life Cycle

four primary functions include: organize for pre-project planning, select project alternatives, develop a project definition package. The last function is to decide whether or not to proceed with the project.

2.2. Pre-Project Planning Defined

CII's Pre-Project Planning Research Team has defined pre-project planning for a capital facility as *the process of developing sufficient strategic information for owners to address risk and decide to commit resources to maximize the chance for a successful project*. This process constitutes a comprehensive framework for detailed project planning. Pre-project planning begins when a validated project concept has been identified during the business planning process and ends when a decision has been made whether or not to authorize funding for the execution of the project.

To mitigate efforts in further defining the pre-project planning process, the IDEF0, Structured Analysis and Design Technique, methodology was adopted for process modeling. The methodology provided a structured, graphical tool to organize thoughts in a group setting. Figure 2.2 is an example of one of the IDEF0 diagrams that was developed and relates to the major functions involved in pre-project planning. Underlying these diagrams is a structured review process, a detailed glossary of terminology, and a narrative describing the interactions within the diagram. The life cycle diagram, pre-project planning model and definitions are published in CII Source Document 94.

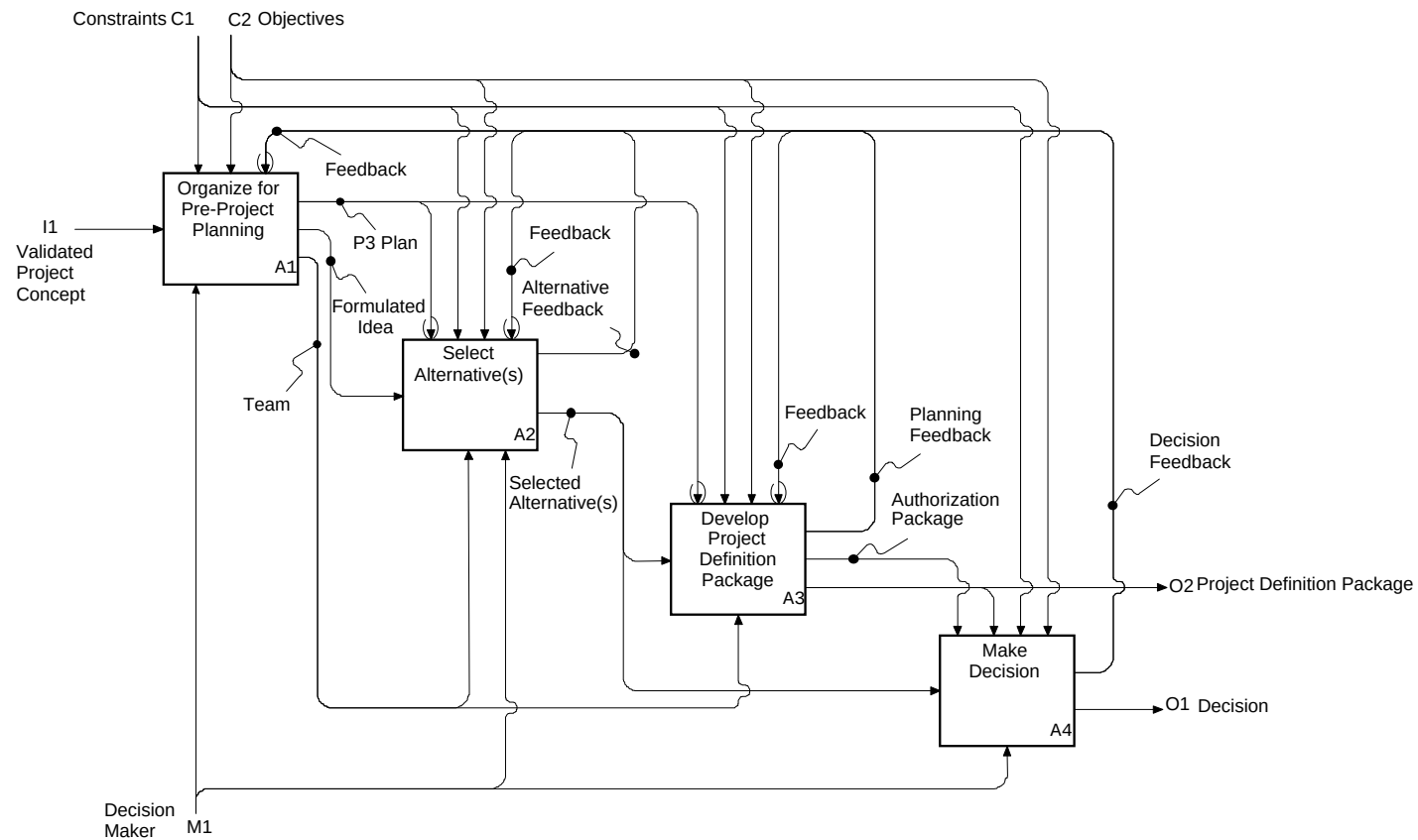


Figure 2.2 A0 Diagram: Perform Pre-Project Planning

2.3. Major Pre-Project Planning Sub-processes

This section discusses in detail the sub-processes that occur during pre-project planning and the functions within those sub-processes. The sub-processes are introduced at this time to provide a complete picture of the overall pre-project planning process and to help define the major functions (variables) that will be analyzed later in this source document. The IDEF0 model shown in Figure 2.2 shows the interrelationships among the defined sub-processes. Each box represents a sub-process and the arrows indicate actions occurring in regard to sub-processes based on entry or exit points. Arrows entering the left of the box are inputs to the process and are transformed by the process. Arrows entering the top of the box are controls on the process. Arrows leaving the right are outputs of the process, and arrows entering the bottom are mechanisms needed for the process to occur. The key points to note from this diagram are: 1) The process is not a linear and functions can be occurring concurrently; and 2) Interaction and iteration are inherent within this process. A brief discussion of the major sub-processes identified in Figure 2.2 is given below.

2.3.1. Organize for Pre-Project Planning

This first sub-process has three major functions. They are:

- *Select Team*: In this function, the team that is responsible for ensuring that pre-project planning is carried out properly is selected and developed.

The team should be comprised of multi-disciplinary corporate representatives who can respond to the business and project objectives.

- *Draft Charter:* The charter defines the pre-project planning team's mission and responsibilities, and further refines the original project concept into a workable, project-based concept. This charter must be based on corporate-sponsored guidance.
- *Prepare Pre-Project Planning Plan:* Based on the charter and available resources, a plan is prepared documenting the methods and time schedule for completing the pre-project planning activities to be performed by the team.

2.3.2. Select Alternatives

Select alternatives is the second major pre-project planning function and is comprised of the following four functions:

- *Analyze Technology:* Existing and emerging technologies are evaluated for feasibility and compatibility with corporate business and operations objectives in terms of inclusion and usage within the project.
- *Evaluate Site:* Alternate siting locations are evaluated to meet the client's needs in terms of relative strengths and weaknesses. Note that analyze

technology and evaluate site are typically performed in conjunction with one another.

- *Prepare Conceptual Scopes and Estimates:* The team develops and assembles the required information on the various combinations of alternatives in a format that permits valid comparisons based on corporate and project objectives and constraints.
- *Evaluate Alternatives:* The team and decision maker compare viable project options and choose the option(s) that is most advantageous to the business for further study.

2.3.3. Develop Project Definition Package

Development of the project definition package is the third major sub-process of the pre-project planning process and its five functions are given below:

- *Analyze Project Risks:* The team identifies and analyzes risks associated with the selected project alternative. These analyses should include financial/business, project, and operational risk categories in order to proactively seek to minimize the risk's impact on project success.
- *Document Project Scope and Design:* The team clearly identifies the commercial and technical intent of the project and brings the percent design

complete before authorization to that stage which is necessary to reasonably minimize the risks associated with execution and operation of the facility.

- *Define Project Execution Approach:* This function involves addressing and documenting the methods to be used to perform the detailed design, procurement, construction, and startup of the project.
- *Establish Project Control Guidelines:* The team develops detailed procedures to manage execution of the project, including control guidelines such as milestone CPM schedules, procurement schedules, safety guidelines, etc., and a control plan that addresses such issues as planning, scheduling, change management, and management information systems.
- *Compile Project Definition Package:* The team compiles the information developed in the four functions listed above into an authorization package that allows the decision maker to determine the viability of the overall project. A more detailed project definition package is also compiled and provides the basis for project execution if the project is authorized.

2.3.4. Make Decision

Make decision is the final major sub-process of pre-project planning. In this sub-process, the decision maker must weigh the business objectives of the project and determine through evaluation of the authorization package if the project

will meet the company's needs. The decision must be made with a thorough understanding of the project's risks and objectives in mind. At this point, the decision maker can either approve the project for further execution, kill the project, or send it back for further pre-project planning study.

In summary, the IDEF0 models define the process of pre-project planning in functional terms and provide the basis for pursuing the objectives of this study further.

2.4. Literature Review

This section will report on the literature available in the public domain on the major subjects of this study. First, the scholarly research related to pre-project planning will be presented. Second, previous research on the subject of success to include definitions of success and factors that influence the success of capital construction are presented. Last, literature related to benchmarking, specifically that pertaining to measurement and benchmarking of the pre-authorization phase, will be presented.

2.4.1. Pre-Project Planning

While substantial effort has been expended on understanding and improving the execution phase of capital projects, phases involving pre-project planning have received considerably less examination. This fact is upheld by the few articles appearing in both academic and general journals. While industry professionals have recognized the importance of the pre-project planning phase (Hill et al.,

Jolivet and Batignolles 1986), little conceptual modeling of the planning, designing, and building of large capital projects has been performed, and little emphasis has been given to the pre-authorization phase of projects. While Murphy (Murphy et al. 1974), Pinto (Pinto and Slevin 1988), and Merrow (Merrow 1990) have used regression techniques to attempt to explain factors associated with project success, their explanations are not founded on a published conceptual model. Sanvido (Sanvido 1990) does provide a conceptual model, but it is primarily directed toward commercial projects and has had fairly limited validation. Fergusson (Fergusson 1993) analyzes the final product quality and the level of integration used in developing projects from inception through operation. This research attempts to model the impact of process performance on the ultimate quality of a facility.

Hackney (1992) studied capital costs estimating and controls that included research on the planning of industrial process plant projects. Hackney proposed a detailed checklist for project planning from which a definition rating used to improve areas of uncertainty and predict project performance for a project could be calculated.

A study by the Rand Corporation investigated the reasons for inaccurate estimates of plant capital costs and performance difficulties on pioneer plants. The study, a first-of-a-kind and limited to process plants, provided factors responsible for inaccurate cost estimates and poor plant performance. The study also found that both performance problems and cost estimation error were associated with the technical and site characteristics of the project. These were characteristics that were known and that developed early in the project (Merrow et al. 1981).

2.4.2. Project Success

A comprehensive review of the current relevant literature has revealed that project success has been the focus of many recent studies. Several studies have focused on identifying the critical factors that contribute to project success. These studies suggest factors, preconditions, procedures, and determinants for achieving project success (Jolivet and Batignolles 1986; Kothari 1986; Tuman 1986; Ashley, Jaselskis, and Lurie 1987; Pinto and Slevin 1988; Freeman and Beale 1992; Sanvido et al. 1992 and Fergusson 1993).

Jaselskis (Jaselskis 1988) gives an excellent review of contemporary work in this area. Throughout all the research effort, there is general agreement that whether a project is deemed a success depends on whom is making that decision and when it is made. Thus, not surprisingly, a second key point is that few studies have attempted to measure success using objective factors. In fact, only one study (Ashley et al. 1987) was found that used any objective measures for project success. While two of the factors used were objective, the remaining four were subjective.

In addition to the issue of success factors, many studies have concentrated on the challenge of measuring and defining project success. Several researchers have concluded that measuring project success in solely objective terms is an impossible task (de Wit 1986; Morris 1986; Stuckenbruck 1986). Many reasons can be found for the complexity of measurement of results. These include: project objectives that change over time, the multitude of project participants and

stakeholders and their different objectives, and the subjective nature of many desirable project outcomes (de Wit 1986).

Some research has been conducted in the area of project success using regression analysis methods. Success models have been developed primarily subjective data to identify relationships between project success and the inputs to success. Researchers have identified several relationships between certain factors and project performance (Ashley et al. 1987; Pinto and Slevin 1988b; Merrow 1990; Ashley 1991; and Fergusson 1993). A common ingredient is that all of these studies have identified the pre-authorization phase as a key factor that contributed to achieving project success.

2.4.3. Benchmarking

Benchmarking can be defined as "a process in which companies target key improvement areas within their firms, identify and study best practices by others in these areas, and implement new processes and systems to enhance their own productivity and quality" (Mittelstaedt 1993). Benchmarking is an integral part of a comprehensive total quality management effort.

Several benchmarking models were found in the literature review. All are similar in the respect that their steps can be collapsed into four main phases of performance: Planning, Analysis, Integration, and Action (Spendolini 1992; Xerox 1988; Singleton-Green 1992). The planning phase includes identifying target areas to benchmark, selecting benchmarking partners and collecting data. Analysis of the data is the second phase in the process. Finally, integration and action include

implementing the plans and monitoring progress and recalibration of the benchmarking effort.

While one article was found regarding benchmarking of project management systems (Thamhain 1991), no literature was found that specifically targets benchmarking of pre-project planning or the pre-authorization phase of the construction life-cycle. To date, no research has been published in the public domain that quantifiably establishes benchmarks for the level of effort expended in the pre-project planning phase or that correlates this level of effort with the success of the project.

Some private owners and consultants have compiled databases, or enlisted consultants to do so, in attempts to benchmark the capital project management process. For instance, because of poor project performance, Chevron utilized the services of two consultants: A.T. Kearney, a Chicago-based management consultant, and Independent Project Analysis (IPA), a consulting company from Reston, Virginia, that specializes in capital project analysis for the petro-chemical industries, to help companies benchmark themselves against the best in the area of capital project management (Blessed 1991). Chevron discovered that the primary reason for a worse-than-industry-average record in meeting cost and schedule projections was poor project definition prior to making an appropriation request. Through this effort, Chevron identified seven priority areas for improvement that include planning and project definition. Since these efforts come from the private sector and no literature has been published on the benchmarking methodology employed, an analysis or study comparison cannot be made. Consequently, this

study is unique in the public domain in that it attempts to benchmark the pre-project process for capital construction projects.

2.5. Data Collection

Exploratory survey research best describes the type of research employed to accomplish this study. Field research was used to a lesser degree by the CII research team in the modeling process previously described. Data collection theories are discussed below, with the specific data collection methodology used for this source document discussed at length in the next chapter.

There are different methods of classifying the collection of social data are available. Of all those reviewed, Babbie's taxonomy (Babbie 1992) is the simplest. Babbie lists five modes of observation, each of which is described.

1. Experimental research involves taking action and observing the consequences of that action, and is usually associated with the physical sciences.
2. Survey research involves collecting data through asking people questions and is perhaps the most frequently used mode of observation in the social sciences.
3. Field research involves the direct observation of social phenomena in natural settings.
4. Unobtrusive research involves investigation without the researcher intruding into whatever is being studied. It can consist of content analysis, analysis of existing statistics, or historical/comparative analysis.

5. Evaluation research seeks to evaluate the impact of social intervention by using experimental and quasi-experimental methods.

Sedlack and Stanley discuss another topic, exploratory research, under the general heading of data gathering procedures. Exploratory research is that "in which the investigator is exploring the possibilities of an idea or where little has been previously recorded" (Sedlack and Stanley 1992). They suggest that there are three basic questions under which exploratory research is conducted:

1. Are there any variable relationships that appear to exist?
2. What more detailed and systematic investigation is warranted?
3. What methods are most likely to generate profitable data?

If the hypothesis undergoing research has a lack of previous studies, as indicated in the case of pre-project planning, they recommend using the data collection strategy of triangulation, which is "the process of comparing the measurement of the same variable from a variety of measuring instruments" (Sedlack and Stanley 1992). Triangulation is "the combination of methodologies in the study of the same phenomena or programs" and states "Where possible, triangulation is to be highly recommended. Indeed, the capability to implement a strategy of triangulation means that evaluators must include in their repertoire of skills the ability to use qualitative methods" (Patton 1989). Patton's support of the use of multiple, proven, research methods in the exploration of new areas of research has the apparent aim of minimizing the chance of researchers falling prey to the common mistakes of over-simplification and over-generalization.

Since this was a pilot study with little previous research, it can be considered exploratory in the field of pre-project planning. The data gathering method of triangulation was employed by using multiple data gathering tools and data sources.

2.5.1. Sampling

Because it is usually not feasible to obtain data from the entire population of interest in a research study due to cost, time, or other constraints, data are normally collected from a sample of that population. Two general methods of selecting a sample are probability sampling and non-probability sampling. As described by Sedlack and Stanley, "a *probability sample* is one in which the likelihood of selecting any one element from the sampling frame is known," while "a *non-probability* sample is one in which the likelihood of selecting any element from the sampling frame is *not* known" (Sedlack and Stanley 1992). They further categorize probability samples into simple random samples, systematic samples, proportional and disproportional stratified samples, and single-stage and multiple-stage cluster samples; non-probability samples are categorized into accidental samples, judgmental or purposive samples, and referral or snowball samples.

For the purposes of this research, the primary distinction between probability and non-probability samples is that when probability samples are used, a statistically valid estimate of the sampling error can be made, while this estimate cannot be made for non-probability samples (Sedlack and Stanley 1992). In interpreting collected data, a researcher would prefer to be able to estimate the error

inherent in the projections due simply to sampling error; thus the preference to use probability sampling in collecting the data. The use of probability sampling is sometimes not a viable alternative, however, and non-probability sampling is the only option available. When this is the case, care must be used in interpreting the data. A separate but equally important issue in sampling is confidentiality of the responses. If sensitive data are being collected, the respondent will often not be truthful, fearing disclosure to other people who might stand to benefit from the information being provided. To obtain accurate data, therefore, the data collection method must assure a level of confidentiality commensurate with the information sought. The specific sampling techniques used in this study are discussed.

2.5.2. Survey Methods

The types of survey instruments, their development process and data format are of paramount importance in survey research. The type of data to be gathered, analysis methods, proximity of respondents and research resources all must be considered when determining the procedures that are best for a study. In this case, questionnaires and telephone interviews were the methods employed to gather the data for the study. While chapters three and four give the particulars of each, this section discusses the subject of survey methods in general.

The three basic procedures used to conduct a survey are: questionnaires, face-to-face interviews, and telephone interviews, each with its particular strengths and weaknesses. The questionnaire is a self-administered measuring instrument consisting of questions to be answered by a respondent. It can consist of either

open-ended (fill-in-the-blank) or closed-ended (predetermined response) questions. It has the advantages of being cost-efficient and allowing the respondent to answer at his or her convenience. Its chief disadvantages are a lower response rate than other survey methods and inflexibility.

In the face-to-face interview, the researcher collects data by questioning the respondent in person. The interview can be conducted using a structured schedule, similar to a questionnaire, or an interview guide, which provides general statements and question areas for the interviewer to present to the respondent. Its main advantages are the flexibility gained from personal contact and a high response rate, while it has the disadvantages of higher cost, the requirement to train and supervise interviewers, and the need to coordinate the schedules of the interviewer and the respondent.

The third method, the telephone interview is similar to the face-to-face interview except that it is conducted by telephone and is, therefore, less costly to perform. Its main disadvantage is the loss of face-to-face contact with the respondent.

2.5.3. Pre-testing

Pre-testing is basically a trial run for the data collection strategy using a small sample of the population. It is used to identify unclear or confusing questions and instructions, as well as to provide a preliminary test of the validity and reliability of the data collection method. Babbie (Babbie 1973), who gives some guidelines for pre-testing survey instruments, suggests that it is best to pre-test the

entire survey instrument rather than just portions of it. Additionally, the instrument should be pre-tested in the manner intended for the final study. As discussed in the next chapter, both these suggestions were adhered to in the pre-test of the survey instruments for this study.

2.5.4. Handling Missing Data

In virtually every case of data gathering by surveys, some respondents fail to answer some questions. While this presents a problem at all stages of analysis, it is especially troublesome in index construction, which is part of the methodology of this study. If some respondents fail to provide answers to items being included in a composite index, the researcher faces a particular problem in assigning scores to those respondents in constructing the index. However, Babbie (Babbie 1973) presents several methods for dealing with this problem.

One method is to exclude the respondents with missing data from the index. The primary concern in this instance is whether the numbers available for analysis will still be sufficient and whether those excluded will result in a biased sample whenever the index is used in the analysis.

A second method is to assign an intermediate score for missing data. For example, if a given item is assigned scores of 0, 1, and 2 for its three possible responses, the researcher may assign the intermediate (1) to those respondents who gave no answer. Another method offered by Babbie is that of treating the missing data as one of the available responses. This is done through careful analysis of the data available. Other methods include assigning index scores proportionately on the

basis of the answers that a respondent does give and assigning values for missing data on a random basis (Babbie 1973).

When missing data were encountered in this study, one of two methods mentioned above was used. The cases with missing data were either excluded from the study or missing data were assigned as one of the other available responses. The second method was used in the case of one variable and only when the missing variable was highly correlated with the available response.

2.6. Summary

This concludes the background information presentation on pre-project planning, the literature search, and discussion of data collection methodology. As modeled, the pre-project planning process is formal in its procedures and functions. These functions provide the basis for the remaining portions of the study.

The literature review revealed that the pre-project planning phase of a capital construction project has received little scholarly attention. No studies were uncovered that quantified its affect on the success of a project or that provided specific benchmarks or a benchmarking methodology for the process. Lastly, three procedures for conducting a survey were presented along with recommendations for pretesting survey instruments and handling missing data. The next chapter will provide the methodology, specific to this study, that was employed.

CHAPTER 3: METHODOLOGY

The specific methodology of this study is examined now. First, data gathering methods and strategies including data collection procedures and the creation of the database are discussed. The method used to transform the raw data into useful measures, recode them and develop indices with these measures for both success and pre-project planning effort is presented. Also, the specific data analysis procedures used in this study are examined. The primary statistical test used was bivariate regression analysis; others, however, were used to a lesser extent or to support the index construction or regression analysis.

3.1. Data Collection

Of the five modes of observation described in the previous chapter, survey research, which involves collecting data through asking people questions, was the most feasible for this study. Experimental and evaluation research were not viable because of their intrusive nature. Because there was little existing data about pre-project planning, unobtrusive research, which relies on the availability of existing data, was not applicable here. Field research was employed to some extent during the modeling phase of the study by having task force members observe and report on pre-project planning activities in their firms.

Data collection is critical phase in survey research. This effort determines the size and characteristics of the database to be analyzed. The data collection process attempts to obtain the estimated sample sizes and population characteristics

required to confirm the study hypotheses. The success of this effort determines whether the conclusions can be generalized to all participating groups.

This particular survey required owner participation. They were a difficult group to sample on this subject because constructing facilities is not their primary business. Since this research was directly sponsored by the CII, its owner organizations were the main source for data. All CII owner companies were given the opportunity to participate. Initially, a letter was sent to the contact person for each company soliciting for participation in the study. All responding in the positive were then sent forms to nominate projects. Copies of the solicitation letter and nomination form are found in Appendix A.

3.1.1. Sample Selection

Due to data source constraints, probability sampling was not a viable alternative for this study. Consequently, this survey used non-probability sampling. In specific, judgmental sampling was deemed to be appropriate because the researchers had knowledge of the population, its elements, and the nature of the research aim. The specific procedure to select the sample followed the following procedure.

Nominated projects were reviewed for adherence to the project domain. If projects were outside of the domain, they were deleted from the sample. A maximum of five projects were selected from any one company in order to keep that company from dominating the database or bearing undue burden regarding data collection time and effort. Consequently, if any company nominated more than five

projects, a sample of five were randomly selected. For companies nominating exactly five projects, four were randomly selected. For companies nominating three or less, all nominated projects were selected if they met the study domain. The result was a sample of 81 projects selected from the 107 nominated. Table 3.1 summarizes the survey sampling effort of the study.

Table 3.1 Summary of Sampling Efforts

	Nominated	Selected	Returned	Percent Responding
Companies	26	26	24	92%
Surveys	107	81	65	80%

In recognition of the sensitive nature of some of the data collected, and in accordance with established CII procedures, this research was conducted with strict confidentiality. All responses are known only to the researchers and will not be divulged.

3.1.2. Data Gathering Instruments

Associating available methodologies for data collection with study objectives and available resources revealed that questionnaires and telephone interviews were the most suitable for execution of this research. Because of the time constraints involved and distances between the locations of respondents, personal interviews were not feasible for use in this study.

In the initial phase of data collection, a questionnaire was used to collect quantitative, historical project data. These data included historical information such as project type, cost and schedule performance, plant operating characteristics, duration and cost expended on pre-project planning, etc. Once the questionnaires were received, telephone interviews were scheduled to obtain the subjective data about the project. Since variable conceptualization and measurement were integral to the development of the survey instruments, Chapter Four will discuss each in detail.

3.2. Data Conversion

Raw data from the questionnaire were initially entered into the relational database management system Microsoft Access™. Subsequently, the data were transferred into data files within the Statistical Package for Social Science (SPSS™), a statistical analysis program. Raw project information seldom provides data ready for analysis, particularly in exploratory studies such as this one. Consequently, the raw data were then examined and, when necessary, converted into measures that allow for meaningful interpretation and analysis. For instance, historical data provided information on the authorized capital cost of the project and the actual capital cost. These items, in themselves, do not provide a measure of performance, but they can be converted into the performance measure of *percent cost deviation from authorization*. As another example, by using the raw data on pre-project planning cost and the project authorization budget, the pre-project

planning effort measure of *percent of authorization budget* was established. Specific measures used in all areas are detailed further in Chapter Four.

3.3. Reclassifying Data

When several categories are in the data, or the data are continuous in nature, it can become difficult to detect patterns and discover significant relationships. In this case, it may be necessary to combine categories or regroup the data into fewer and larger categories (Abdul-Raheem 1994). The methodology used in this study to contend with the large ranges of continuous variables was to group them by percentiles and recode into nominal values ranging from one to five.

The process used to recode the variables was as follows. The example used, which was one of the variables, is for the "number of groups represented on the pre-project planning team." First, descriptives of the variable were examined. Descriptive data included a frequency table, mean and median values, and 20 percentile values. Percentiles compute values above and below where a specified percentage of cases fall. The tables were then examined and the 20 percentile ranges were used to establish value ranges. Whenever possible, recoding was established in such a manner that the mean and/or median value was included in the middle range and therefore had a recoded value of three.

Tables 3.2 presents an example of the frequency table. Each row describes a specific number or value as described in column one. The frequency of occurrence of that value appears in column two. The percent, valid percent and cumulative percent appear in columns three, four and five respectively. Valid

percent is the percent with missing values disregarded, or the percent of valid responses. Mean and median values are shown below the table. Table 3.3 provides the 20 percentile ranges in column 2 and the recoded nominal value in column 3. As an example, if a project had 10 groups represented during the pre-project planning phase, the recoded value would be four. Data reclassification tables for effort and success index variables are shown in Appendix B.

Table 3.2. Frequency Distribution; Groups Represented on the Pre-Project Planning Team

Value (1)	Freq (2)	Percent (3)	Valid Percent (4)	Cumulative Percent (5)
2.00	2	3.2	3.2	3.2
3.00	4	6.5	6.5	9.7
4.00	3	4.8	4.8	14.5
5.00	1	1.6	1.6	16.1
6.00	12	19.4	19.4	35.5
7.00	6	9.7	9.7	45.2
8.00	7	11.3	11.3	56.6
9.00	4	6.5	6.5	62.9
10.00	2	3.2	3.2	66.1
11.00	6	9.7	9.7	75.8
12.00	4	6.5	6.5	82.3
13.00	3	4.8	4.8	87.1
14.00	1	1.6	1.6	88.7
15.00	2	3.2	3.2	91.9
16.00	2	3.2	3.2	95.2
17.00	1	1.6	1.6	96.8
19.00	1	1.6	1.6	98.4
26.00	1	1.6	1.6	100.0

Median: 8.00 Mean: 9.00

Table 3.3. Reclassification of Data

Percentile (1)	Value Range (2)	Recoded Value (3)
80 - 100	12 - 26	5
60 - 80	9 - 11	4
40 - 60	7 - 8	3
20 - 40	6	2
0 - 20	2 - 5	1

3.4. Index Development

For this study, indices were used to create a single measure for both pre-project planning and success. This produced one summary measure for the dependent variable and the independent variable. Bivariate regression was then performed to determine any correlation between the two. The following paragraphs give a brief explanation of the important aspects of index construction.

A composite index can provide powerful and reliable summaries of measured data. Also, additive indices are often used to improve the reliability of data (Babbie 1973). Specifically, all measured data are composed of two parts: variation due to the concept being measured, and random variation. Random variation is often called noise or random error. An advantage of using an additive index is that it reduces noise in data because the random variation associated with each term tends to average to zero when summed across all terms (Fergusson 1993).

3.4.1. Criterion for Item Selection

When selecting variables to be included in an index, the first criterion to be considered is face validity, or logical validity. Each variable must appear, on its face, to measure the variable that the index is being constructed for. To clarify the issue of logical validity, Babbie (Babbie 1973) gives the example of a researcher wishing to measure political conservatism. In this instance, political party affiliation would satisfy the criterion of logical validity. Additionally, unidimensionality is stressed in index construction: a composite measure should represent only one dimension. The composite measure developed for pre-project planning represents the dimension of effort whereas the one constructed for success represents the dimension of project performance.

Variables are often selected for inclusion in an index based on some rating of importance. Variables of importance tend to yield more accurate responses. If variables are ambiguous or unimportant to respondents, they are more likely to be careless or uncertain in their responses, thus introducing error into the measurement. All variables considered for inclusion in the index constructed for pre-project planning effort were previously identified in the pre-project planning model and therefore, are considered important by professionals within the industry to the process. In the case of the success index, the variables considered for inclusion were identified by respondents during the interview portion of the study as important to the success of a project.