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Trade-Off between Cost and Schedule

Research Summary 214-1

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Trade-Off between Cost and Schedule

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Executive Summary

Projects must meet budget, schedule, safety, and quality goals to be regarded as a success. Many decisions are made that influence a project's outcome. Today, owners are often faced with deciding between a project execution strategy that emphasizes either cost or schedule. Such a decision may be made not once, but throughout the life cycle of the project.

CII established the Trade-off between Cost and Schedule Research Team to investigate this topic. Through a survey of CII member organizations, the research team identified 23 techniques that consistently influence project success. The team then developed a simple yet effective tool to assist in selecting the optimum group of techniques to achieve a specific cost-schedule trade-off. The Cost-Schedule Trade-Off Tool (CSTT) offers the following advantages:

- Applies to projects that are either schedule or cost-driven.
- Recommends techniques for success unique to each stage of the project.
- Provides references to selected CII Best Practices for further guidance to the user.
- Applies not only to trade-off projects, but virtually any project.

The techniques recommended by the tool are not unique, but are routinely used in successful project management. In fact, many of the techniques are CII Best Practices. The key, however, is that CSTT helps the user in knowing the specific techniques to employ at each stage of the project. Project teams can then use these techniques in a more timely fashion to increase the likelihood of project success, particularly in an era when trade-offs are continually being made to favor cost or schedule.

1

Introduction

The objective of this research was to identify techniques that can be used to optimize cost and schedule for capital projects and to prioritize these techniques to help achieve the appropriate cost/schedule trade-off for a project. The approach consisted of the following steps:

- Identification of the techniques that lead to reduction in cost and/or schedule.
- Estimation of the relative impact of these techniques on the cost and schedule of the various project phases.
- Identification of the drivers and barriers that govern the decision about the trade-off between cost and schedule.

The data used in this research were collected from four sources:

- Literature review
- Questionnaires
- Case studies
- Impact assessment surveys

A decision tool was developed to facilitate selection of techniques appropriate for the desired cost/schedule trade-off.

Literature Review

The first source to be consulted was existing literature that addressed cost reduction, schedule reduction, and the impacts of such reduction on each other and on project quality and safety. The CII Best Practices and other available literature provided a framework for organizing the questionnaires that were used to collect the detailed data.

Questionnaires

Two questionnaires were sent to the entire CII membership to collect data for this study. The questionnaires were used by the research team in identifying the techniques, barriers, and drivers governing a cost/schedule trade-off. A profile of the respondents to the questionnaires is illustrated in Figures 1 and 2. This profile shows a broad mix of job responsibilities and organization types.

Questionnaire 1 was primarily used to locate case studies that would help identify and verify techniques successfully used on capital projects to achieve a trade-off between cost and schedule. In addition, the questionnaire was used to survey respondents as to the trends in the industry toward trading cost over schedule and the availability of tools to achieve the trade-off. Responses revealed that there is indeed an industry trend toward trading cost over schedule. It also revealed a consensus that cost reduction is possible without sacrificing schedule, project quality, or safety. The respondents indicated that although the tools for such a trade-off are available, they are not being used to their full potential in the project industry.

As an added feature of Questionnaire 1, respondents were asked to provide a list of techniques that they felt were of value in achieving the cost over schedule trade-off. These techniques were added to the list developed through the literature search.

Questionnaire 2 was designed to identify the drivers, barriers, and techniques for achieving a cost/schedule trade-off. Through this survey, the drivers determined to have the most significant effect in deciding the degree of trade-off were:

- Executive sponsorship
- Owner's need
- Owner's commitment
- Cost/capital efficiency/return on investment (ROI)
- Cost competitiveness/market share
- Legislative/environmental compliance

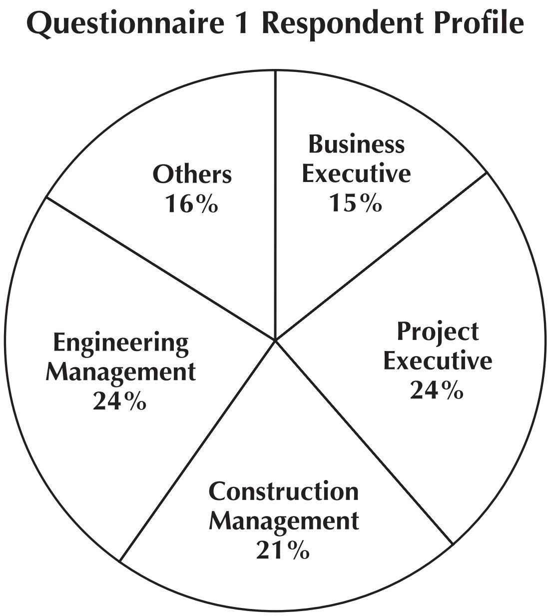

Figure 1. Respondent Job Profile

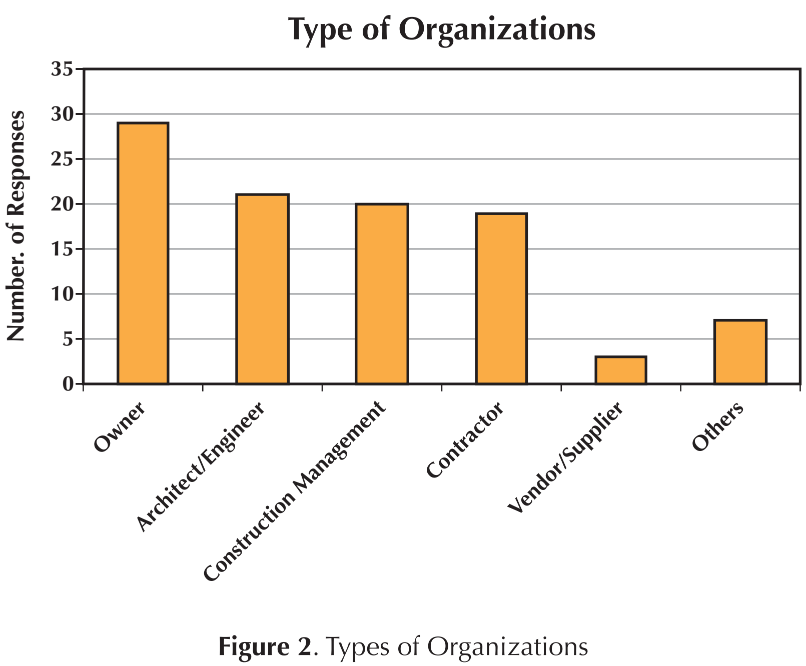

Figure 2. Types of Organizations

The most significant barriers to the trade-off were identified as:

- Unclear project objectives or business definition
- Lack of alignment with project objectives
- Poor planning
- Scope changes
- Poor decision making
- Turnaround/outage schedule
- Lack of project team alignment

The respondents were also requested to identify on the list of techniques already developed those that have been adopted in their organizations to reduce project costs.

Case Studies

The purpose of the research team's case studies was to verify the use of CII Best Practices and other practices and techniques on successful projects in the industry. The techniques, drivers, and barriers identified in the questionnaires and literature reviews were the primary basis for the case study interviews. The case studies were selected for analysis and determination of techniques used based on their successful project results.

Five case studies were conducted encompassing a variety of industries and project sizes (Table 1). A summary of the case studies is provided in the following paragraphs.

Owner 1 is a leading biotechnology company with operations in Asia, North America, and Europe. Its corporate headquarters are located in California and it has a worldwide work force of over 13,000. The same owner was involved in both case studies 1 and 2. The project studied for case study 1 was an administrative building project with a budgeted cost of $85 million. The main driver for the reduction in project cost was to achieve a benchmark set by an internal audit to reduce the cost per full-time employee.

Table 1. Case Studies

	Owner	General Contractor	Type	Project Description	Duration (months)	Actual Duration (months)	Budgeted Cost (US Mil. $)	Actual Cost (US Mil. $)
Case Study 1	Owner 1	Contractor 1	Bio-Tech Company	Administrative Building	21	18	85	75
Case Study 2	Owner 2	Contractor 2	Bio-Tech Company	Parking Facility	24	12	1.7	1.2
Case Study 3	Owner 3	Contractor 3	Oil and Energy	NGL Recovery Plant	34	33	Currently running under budget	
Case Study 4	Owner 4	Contractor 4	Food Manufacturing	Production Facility	24	22	115	84.9
Case Study 5	Owner 5	Contractor 5	Oil and Energy	Refinery	32	30	300	251

Factors that helped in reducing the cost of the project

- Prior similar project knowledge
- General contractor's initial involvement and information about previous project
- Redesigning and value engineering for some of components
- Early buy-out of subcontracts and materials

CII Best Practices Identified

- Alignment
- Design effectiveness
- Materials management

Case study 2 included the redevelopment of a 140,000 square-foot land area to create surface parking, the addition of two large retention basins, and demolition of an existing structure and asphalt pavement. The main driver for the reduction in project cost was to reduce the cost per parking space.

Factors that helped in reducing the cost of the project:

- Cost engineering personnel assigned to the project
- Online reverse auction for construction
- External and internal benchmarking
- Value engineering — component redesigning
- Use of information technology

Owner 3 is a leader in crude oil production that owns and operates an extensive network of refining and distribution facilities around the world. Case study 3 included the construction of a natural gas liquid extraction recovery plant and associated pipelines in the Middle East. The main driver for the reduction in project cost included cost reduction/lump sum strategy to limit owner risk.

Factors that helped in reducing the cost of the project

- Internalization of suppliers
- Prior experience with contractors

- Upper management commitment: CEOs of all companies met twice over the duration of the project
- Better contracting strategy
- Lean construction

CII Best Practices Identified

- Alignment
- Team building
- Materials management

Owner 4 is a century-old producer of canned food products. The company required a new facility for a new line of products that had to meet or exceed U.S. Department of Agriculture and industry regulations. The main driver for the reduction in project cost was to get the best production capacity/cost ratio for the new product line. The project schedule was not a driver for this case study.

Factors that helped in reducing the cost of the project

- Reengineering and value engineering employed for design of project
- Use of electronic media
- Contractor's commitment to cost
- Early site work
- Clean scope of work
- Value engineering

CII Best Practices Identified

- Design effectiveness
- Pre-project planning

Contractor 5 is an engineer-procure-construct (EPC) contractor recognized worldwide for delivering high quality, cost-effective solutions for the oil and gas, liquefied natural gas, gas-to-liquids, refining, chemical, pharmaceutical, and power industries. The project studied for case study 5 included construction of a delayed coke unit for processing crude and piping (a tie-in with an existing facility) and modifications to an existing refinery, crude handling system, coke handling system, and sour water stripper unit. The main driver for the reduction in project cost came from a trade-off for finishing the project sooner and cashing in on the market revenues.

Factors that helped in reducing the cost of the project

- Familiarity (similar project accomplished by contractor in 32 months)
- Use of standard design
- Project timing
- Efficient communication — six-person owner team at Contractor 5
- Freezing scope

CII Best Practices Identified

- Constructability
- Team building
- Pre-project planning
- Materials management
- Planning for startup
- Change management

The case studies provided a close look at the use of the various techniques during actual project execution. Table 2 summarizes the significant findings from the case studies.

Impact Assessment Surveys

The data gathered through literature review, questionnaires, and case studies were used to identify a preliminary list of 48 techniques for achieving cost over schedule trade-off. In an effort to create a more manageable tool and surveys, the research team consolidated this list to the 23 most effective techniques listed below. The definition for each technique is provided in the appendix.

Table 2. Significant Findings from the Case Studies

		Case Study 1	Case Study 2	Case Study 3	Case Study 4	Case Study 5
Factors Helping to Achieve Cost/Time Reduction	1	Prior similar project knowledge	Cost engineering personnel dedicated to the project	Good relations with vendors/ suppliers — internalization	Value engineering and reengineering the process	Prior knowledge of similar project
	2	General Contractor's initial involvement and information about previous project	Online reverse auction for GC selection	Prior similar work experience with contractor	Contractor's commitment to cost	Inhouse software innovation allowing faster estimation
	3	Redesigning and value engineering for some of the components of the project.	Internal and external benchmarking	Vendor participation	Front-end planning	Suppliers were given electronic design data
	4	Early buy-out of subs and material	Value engineering — components redesign	Lean construction	Early site work	Preferred vendor/supplier relationship getting better pricing
	5				Clean scope of work	All material at site before construction of work
	6					Work packaging
CII Best Practices and Other Techniques Identified	1	Alignment	Use of information technology	Alignment	Fixed scope of work	Effective communication
	2	Design effectiveness	Value engineering	Team building	Use of electronic media	Use of electronic media
	3	Materials management			Front-end planning	Work packaging
	4				Value engineering	Materials management
	5					Team building
	6					Constructability
Insights Identified	1	Proactive buying of raw materials saved on cost		Novation (substituted one party in a contract for another party)		Use of standard design
	2			Value engineering		Modular/prefab construction
	3			Interim design (30%) before contractor		
	4			No liquidated damages (LDs) leading to lower insurance cost for contractors		
	5			Upper management commitment		

The techniques identified through the research are not unique: they are routinely used in successful project management. In fact, many of the techniques are CII Best Practices, as should be expected. The aim of the research was to determine the techniques that are most successful and applicable according to project phase.

Two steps were used to narrow the list from 48 to 23 techniques: first, the techniques were rank-ordered as identified by the questionnaire respondents to be the most effective under cost-schedule trade-off situations (techniques with low response rates were eliminated) and second, techniques relatively close in description were consolidated. The resulting 23 techniques are:

1. Alignment (CII Best Practice)
2. Effective communication
3. Empowerment
4. Team building (CII Best Practice)
5. Change management system (CII Best Practice)
6. Constructability (CII Best Practice)
7. Measuring design effectiveness versus project objectives (CII Best Practice)
8. Risk management system
9. Value engineering
10. Cost control systems
11. Materials management plan (CII Best Practice)
12. Freezing project scope
13. Planning for startup (CII Best Practice)
14. Pre-project planning (CII Best Practice)
15. Work packaging
16. Design personnel at site during construction
17. Engineering concurrent with construction
18. Financial incentives for project participants

19. Implement reverse auction contracting technique
20. Include design in subcontractor's/supplier's scope
21. Offshoring to low-cost design centers
22. Use of modular construction/prefabrication/pre-assembly
23. Use of pre-existing/standard design

An impact assessment survey was developed to allow respondents to score the perceived effect of each of the techniques on both cost and schedule within each of the five phases of a project: pre-project planning, design, materials management, construction, and startup. These surveys were sent to a broad range of engineers, owners, contractors, and suppliers in the CII membership. The team also sponsored focus group sessions. A total of 83 impact assessment surveys were completed for this study. Scores for the effect of the techniques obtained from the surveys were the root source of data used in developing the decision support tool.

2

Cost/Schedule Trade-Off Tool (CSTT) Development and Application

To assist the decision maker in identifying opportunities for trade-off between cost and schedule, the research team developed an Excel® based tool. This user-friendly tool (CII Implementation Resource 214-2), the Cost/Schedule Trade-Off Tool or CSTT, evaluates the degree of trade-off and assists in identifying techniques to optimize cost and schedule. The CSTT is designed to accomplish the following:

- Analysis of project drivers to rank importance of the drivers in the trade-off decision.
- Quantify the trade-off between cost and schedule based on the drivers and set a scale to measure it.
- Using this scale and the input from the impact assessment surveys, techniques are ranked by their relative effectiveness to achieve the trade-off.
- Based on analysis, lists of applicable techniques are provided for each project phase individually as well as for the whole project.

A flowchart of the operation of the CSTT is shown in Figure 3.

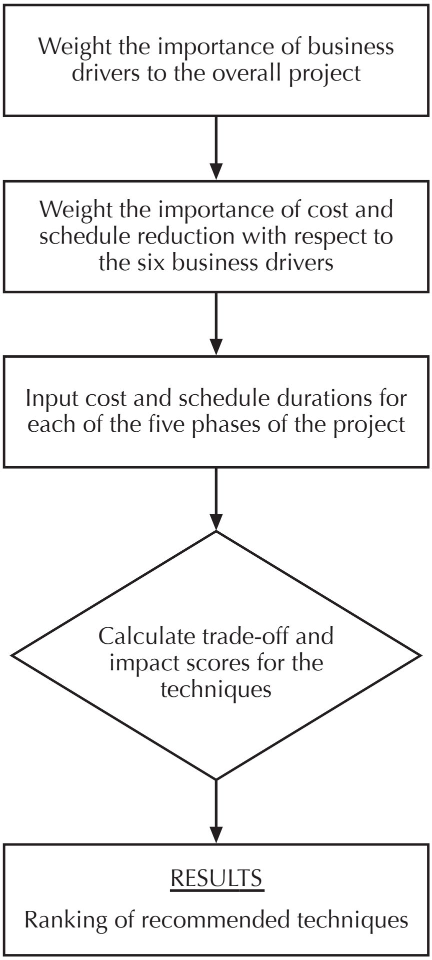

Figure 3. CSTT Operation Flowchart

Using the Tool

The opening screen of the Cost/Schedule Trade-Off Tool (CSST) is shown in Figure 4. This screen gives a general procedure for use of the tool and an area to enter basic project information.

CSTT

COST/SCHEDULE TRADE-OFF TOOL

Procedure

1 Driver Analysis: Six drivers are evaluated based on their importance to the cost and schedule of the project (user input)
2 Project Cost and Schedule Distribution: Project cost and schedule distribution among the project phases (user input)
3 Optimization Output: List of techniques identified to achieve the required trade-off (Output)

General Information

1	Analysis Conducted by	Project Manager
2	Date of Analysis	1/26/2006
3	Project Name	Manufacturing Retrofit
4	Overall Project Cost Considered for Analysis	$19.2M
5	Overall Project Schedule Considered for Analysis	10 Months
6	Current Phase of the Project	Complete

Proceed

Figure 4. Opening Screen Example

Driver Analysis

The first input screen for the analysis tool is shown in Figure 5. On this screen, users are asked to weigh the top six project drivers on a scale of 1-10 with respect to their importance in the overall project. In the second section, the drivers are rated again, also on a 1-10 scale, with respect to the importance of cost or schedule reduction from the standpoint of each of the drivers.

On the second input screen (see Figure 6), the user is asked to distribute project cost and schedule duration among the five phases:

- Pre-project planning
- Design
- Materials
- Construction
- Startup

DRIVER INPUT

The trade-off point between cost and schedule is evaluated in two steps.

1. Evaluating the importance of each driver to the overall project.
2. Evaluating the importance of Cost and Schedule reduction for each driver.

CII research has identified six drivers that affect cost/schedule trade-off.
Please enter the importance of the business drivers on a scale of 0 to 10:
(10 = most important, 0 = not important)

DRIVER	IMPORTANCE
Executive sponsorship	10
Owner need	10
Owner commitment	10
Cost/capital efficiency/ROI	5
Cost competitiveness/market share	10
Legislative/environmental compliance	2

Proceed

Driver Defin.

Clear Values

Please enter the importance of cost and schedule reduction with respect to the various business drivers:
(10 = most important, 0 = not important)

DRIVER	COST	SCHEDULE
Executive sponsorship	5	10
Owner need	5	10
Owner commitment	5	10
Cost/capital efficiency/ROI	5	7
Cost competitiveness/market share	7	10
Legislative/environmental compliance	2	2

Figure 5. Driver Input Screen Example

COST AND SCHEDULE DISTRIBUTION AMONG PROJECT PHASES

In this step of the tool, input is provided with respect to the distribution of project cost and schedule among the various project phases

Please enter the project cost ($) and duration (months) for each project phase

PROJECT PHASE	COST FOR THE PHASE	COST PERCENTAGE	DURATION FOR THE PHASE	SCHEDULE PERCENTAGE
Pre Project Planning	200000	1.35 %	1	7.14 %
Design	1200000	8.11 %	2	14.29 %
Materials	6300000	42.57 %	5	35.71 %
Construction	6800000	45.95 %	5	35.71 %
Start Up	300000	2.03 %	1	7.14 %

Activities in Phases

Clear Values

Proceed

Figure 6. Cost and Schedule Input Screen Example

Further definitions of the project phases are provided by the generic model of the EPC process developed by CII (see Research Report 125-11) and shown in Figure 7. The start of the project is defined as when the owner signs off on the Product Technical Plan (PPP.TP). The project is said to be complete when the Start-up Plan has been implemented (SU.SP).

PPP	**Pre-Project Planning**
PPP.BP	Business
PPP.TP	Product Technical Plan
PPP.SD	Facility Scope Plan
PPP.PP	Project Execution Plan
PPP.CS	Contract Strategy

D	**Design**
D.FS	Finalize Scope
D.DCE	Detailed Cost Estimate
D.DS	Detailed Schedule
D.DD	Detailed Design
D.PWP	Prepare Work Package

MM	**Materials Management**
MM.BC	Bulk Commodities
MM.FI	Fabricated Items
MM.STE	Standard Engineered Equipment
MM.SPE	Specialized Engineered Equipment
MM.FD	Field Management
MM.S	Services
MM.DO	Documentation
MM.FEM	Field Equipment Management

C	**Construction**
C.PW	Prework
C.EX	Execution
C.DM	Demobilize

SU	**Start-Up**
SU.SP	Start-Up Plan
SU.CO	Commissioning
SU.PCO	Project Close-Out

Figure 7. EPC Macro Model

Decision Tool Output

The tool develops a prioritized list of techniques for the overall project as well as for each individual phase by using the relative weights of the drivers, their importance with respect to the project cost and schedule, and data that identify the relative effect of the techniques during each phase. (The tool output screen for an example project is shown in Figure 8.)

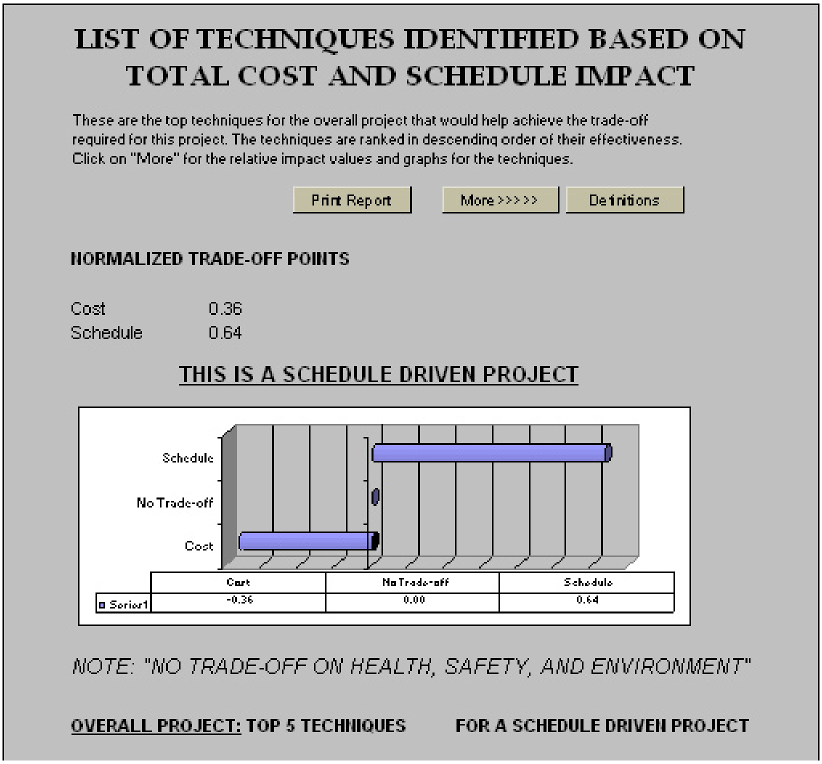

Figure 8. CSTT Output Screen

The initial output screen (see Figure 9) provides a graphical representation of the cost/schedule trade-off, identifying whether the project should be handled as "cost-driven" or "schedule-driven," as well as a listing of the top five techniques identified for the overall project. The "More" button on the screen provides a breakdown of the top techniques identified by the tool for each phase of the project.

Selection of the "More" buttons from this screen will provide additional numerical and graphical information on the relative weightings of each of the identified techniques. With the information provided by the tool, the project team can then select the techniques it wishes to incorporate during the execution of the project based on:

- Current phase of the project
- Relative scores of the recommended techniques
- Applicability of techniques in light of the organizational structure
- Resource availability

Cost/Schedule Trade-Off Tool Validation

The complexity of today's engineering, procurement, and construction processes required that a significant protocol for the testing and validation of the CSTT be undertaken. The basic principle for validation is in ensuring that the tool is robust and meets the goals and expectations of the end users. Establishing confidence through appropriate testing that the finished product meets requirements for functionality and accuracy is key to its widespread use and adoption.

Figure 9. Initial Output Screen

The research team applied the CSTT on six case studies as listed in Table 3. The tool was successfully tested on a variety of project attributes, e.g., project duration, cost, location, project phase, and both as a post-mortem and as a planning tool for projects.

The effectiveness of the tool was successfully demonstrated, documented, and validated by various parties involved in the case study analyses.

Table 3. Validation Case Studies

Organization	Project Type	Actual Duration (Months)	Actual Cost ($)	Trade-off	Percent of Identified Techniques Used on Project
Owner A	Building Renovation	8	$16.5 MM	Schedule over Cost	92%
EPC 1	Blast Furnace Renovation	12	$14 MM	Schedule over Cost	60%
EPC 1	Expansion - Power Plant	28	$72 MM	Schedule over Cost	60%
Owner B	Plant Renovation	8	$2.1 MM	Schedule over Cost	84%
EPC 3	Power Plant	18	$420 MM	Schedule over Cost	96%
Owner C	Research Building	27	$82.5 MM	Cost over Schedule	80%

3

Conclusions and Recommendations

A renewed focus by owners for a leaner cost structure has caused an increasing emphasis on project cost, rather than schedule, and often a willingness to compromise the schedule in favor of cost. However, many projects still have first-to-market product and other schedule constraints. Therefore, trade-off conditions may present themselves on almost any project. This research aimed to develop a method to identify that trade-off and provide tools to a project team to help achieve the trade-off goal.

This research identified the following six major drivers governing cost/schedule trade-offs and 23 techniques of most value to project teams:

The Six Major Drivers

1. Executive sponsorship
2. Owner's need
3. Owner's commitment
4. Cost/capital efficiency/return on investment
5. Cost competitiveness/market share
6. Legislative/environmental

The 23 Techniques

1. Alignment
2. Effective communication
3. Empowerment
4. Team building
5. Change management system
6. Constructability

7. Measuring design effectiveness versus project objectives
8. Risk management system
9. Value engineering
10. Cost control systems
11. Materials management plan
12. Freezing project scope
13. Planning for startup
14. Pre-project planning
15. Work packaging
16. Design personnel at site during construction
17. Engineering concurrent with construction
18. Financial incentives for project participants
19. Implement reverse auction contracting technique
20. Include design in subcontractor's/supplier's scope
21. Offshoring to low-cost design centers
22. Use of modular construction/prefabrication/pre-assembly
23. Use of pre-existing/standard design

The Cost/Schedule Trade-Off Tool developed by the research team will help to identify and quantify the cost/schedule trade-off and to prioritize the identified techniques based on their effectiveness during various project phases. The intent is to select appropriate execution techniques that may be incorporated in projects to achieve the desired balance between cost and schedule.

Appendix

Driver Definitions

Executive Sponsorship: The management decision to go for cost/schedule trade-off.

Owner Need: The owner's need for the project.

Owner Commitment: Management's pledge to commit resources to implement cost/schedule trade-offs.

Cost/Capital Efficiency/ROI: The capital invested in the project is compared against the projected returns on investment.

Cost Competitiveness/Market Share: Gaining cost/market advantage over competition.

Legislative/Environmental Compliance: Laws requiring adherence to certain standards may govern the decision to consider cost/schedule trade-offs.

Definitions of Identified Techniques

GROUP A:

Alignment *(CII Best Practice)*

Objectives of all the project stakeholders are aligned towards project objectives and goals (CII RS 113-1).

Effective Communication

Communication protocol formalized between project participants. Includes identifying the channels, frequency, and type of communication.

Empowerment

Focusing or pushing down the decision making authority to the lowest possible level in all stakeholder organizations.

Team Building and Partnering *(CII Best Practice)*

A project-focused process that brings together team members from the owner, designer, and/or contractor to resolve differences, remove roadblocks, as well as build and develop trust and commitment, a common mission statement, and accountability (CII RS 37-1, CII RS 102-1, CII RS 102-2).

GROUP B:

Change Management *(CII Best Practice)*

A formal process of recognizing, evaluating, and implementing changes; includes approval and implementation schedule (CII RS 43-2).

Constructability *(CII Best Practice)*

Optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives (CII RS 34-2).

Measuring Design Effectiveness versus Project Objectives *(CII Best Practice)*

An all encompassing term to measure the results of the design effort, including input variables and design execution, against the specified expectations of the owner; the owner's expectations include such criteria as cost and schedule (CII RS 8-2).

Risk Management System

A plan for identification, qualification, quantification, allocation, and mitigation of risk.

Value Engineering

An evaluation of a project and its systems and components for the purpose of reducing cost (first and/or life cycle costs) and/or schedule.

GROUP C:

Cost Control Systems

Various methods of capturing progress of project in relation to the established baselines.

Materials Management Plan *(CII Best Practice)*

The planning and controlling of all necessary efforts to insure that the correct quality and quantity of materials and equipment are appropriately specified, procured, received, warehoused, and retrieved in a controlled manner.

GROUP D:

Freezing Project Scope

Milestone date on the overall project control schedule; forces activity planning to target this date.

Planning for Startup *(CII Best Practice)*

Systems, procedure, and requirements identified early on in the project to facilitate startup; includes planning the design procurement and construction to support the startup activities (CII IR 121-2).

Pre-Project Planning *(CII Best Practice)*

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 IR 155-2, CII IR 113-2).

Work Packaging (Work Breakdown Structure, WBS)

A well-defined scope of work that terminates in a deliverable product(s) or completion of a service; packaging the project in such a way that there is effective management of cost, schedule and risk.

GROUP E:

Design Personnel at Site during Construction

Design personnel are located on site to avoid any interruptions to the project work flow.

Engineering Concurrent with Construction

Design is not 100 percent complete before starting construction (fast track).

Financial Incentives for Project Participants

Project participants are offered incentives for meeting project objectives or milestones.

Implement Reverse Auction Contracting Technique

A real-time bidding exercise carried out between a group of pre-qualified contractors where contractors have the opportunity of underbidding the lowest bid.

Include Design in Subcontractor's/Supplier's Scope

Design of a system or a subsystem furnished by the supplier.

Offshoring to Low-cost Design Centers

Portioning off the design to design centers that are less expensive than traditional designers, often overseas.

GROUP F:

Use of Modular Construction/Prefabrication/Preassembly

The components of the facility are fabricated at manufacturing facilities and are arranged and integrated on site.

Use of Preexisting/Standard Design

Designs used for earlier projects are used in new facilities with little or no modification.

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