

Mohamed A. El-Reedy

CONSTRUCTION

Management

of Industrial Projects

 WILEY

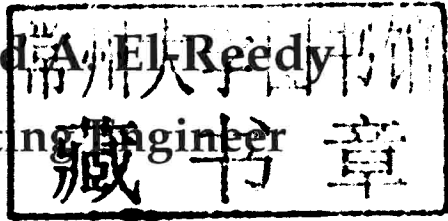

Scrivener

Construction Management for Industrial Projects

A Modular Guide for Project Managers

Mohamed A. El Reedy

Consulting Engineer



Scrivener

 WILEY

Copyright © 2011 by Scrivener Publishing LLC. All rights reserved.

Co-published by John Wiley & Sons, Inc. Hoboken, New Jersey, and Scrivener Publishing LLC, Salem, Massachusetts.

Published simultaneously in Canada.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, scanning, or otherwise, except as permitted under Section 107 or 108 of the 1976 United States Copyright Act, without either the prior written permission of the Publisher, or authorization through payment of the appropriate per-copy fee to the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923, (978) 750-8400, fax (978) 750-4470, or on the web at www.copyright.com. Requests to the Publisher for permission should be addressed to the Permissions Department, John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, (201) 748-6011, fax (201) 748-6008, or online at <http://www.wiley.com/go/permission>.

Limit of Liability/Disclaimer of Warranty: While the publisher and author have used their best efforts in preparing this book, they make no representations or warranties with respect to the accuracy or completeness of the contents of this book and specifically disclaim any implied warranties of merchantability or fitness for a particular purpose. No warranty may be created or extended by sales representatives or written sales materials. The advice and strategies contained herein may not be suitable for your situation. You should consult with a professional where appropriate. Neither the publisher nor author shall be liable for any loss of profit or any other commercial damages, including but not limited to special, incidental, consequential, or other damages.

For general information on our other products and services or for technical support, please contact our Customer Care Department within the United States at (800) 762-2974, outside the United States at (317) 572-3993 or fax (317) 572-4002.

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic formats. For more information about Wiley products, visit our web site at www.wiley.com.

For more information about Scrivener products please visit www.scrivenerpublishing.com.

Library of Congress Cataloging-in-Publication Data:

ISBN 978-0-470-87816-3

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

Construction Management for Industrial Projects

Scrivener Publishing
3 Winter Street, Suite 3
Salem, MA 01970

Scrivener Publishing Collections Editors

James E. R. Couper	Ken Dragoon
Richard Erdlac	Rafiq Islam
Pradip Khaladkar	Vitthal Kulkarni
Norman Lieberman	Peter Martin
W. Kent Muhlbauer	Andrew Y. C. Nee
S. A. Sherif	James G. Speight

Publishers at Scrivener

Martin Scrivener (martin@scrivenerpublishing.com)
Phillip Carmical (pcarmical@scrivenerpublishing.com)

This book is dedicated to the spirits of my mother and my father, my wife and my children Maey, Hisham and Mayar.

Preface

The development of any country depends on increasing investment in industrial projects. Although there are many types of industrial projects, such as food processing plants, automobile manufacturing plants, and wind farm construction, the author has chosen oil and gas projects as the main source from which to draw examples throughout this book. The principles herein are meant to be universal and can be applied to any industrial project, but oil and gas projects were chosen as the primary focus because of the author's experience in this area and because, even now, with climate change and other questions about energy, oil and gas are still the primary fuels which drive economies and worldwide development.

Project management is the main tool to achieving a successful project. This book focuses on using practical tools and methods that are widely and successfully used in project management for industrial projects. Most engineers study subjects that focus on project management in housing projects, administration projects and commercial buildings or other similar projects, but industrial projects have their own requirements and characteristics that set them apart from those other types of projects.

This book is not only addressed to graduating engineers who wish to improve their skills in project management, but it is also helpful to upper level management. This book covers all of the project management subjects from an industrial project point of view. The aim of this book is to be helpful to any engineering discipline or any staff in sharing or applying work of an industrial project.

Why do senior managers accept certain projects and refuse others? Why does a company have huge investments in a certain country but no investments on other countries, especially in oil and gas projects? Certainly, it isn't just because "that's where the oil is," because there are countries that are extremely rich in oil and gas reserves in which there is little investment. These questions are important for understanding project management as a discipline and why using the tools of project management correctly will lead to successful projects.

Knowledge is power. When you understand well, you will do well. So in this book we will illustrate exactly what the project manager is thinking when he is working on a project and what his objectives and goals are. On the other hand, we will discuss what team members may be thinking through the project stages and what their objectives and goals are.

The main tools in managing the project, which are time, resources, cost, and quality management, shall be illustrated by using practical examples from petroleum projects. In addition to that, this book presents all the types of contracts and methods of technical and commercial evaluation for the tenders, with highlights on the FIDIC contract and its advantages.

I have worked on major rehabilitation projects for offshore structures with the best international companies from the owner, working with the engineering offices, the contractors, and the suppliers. Often, the project management staff and all the team members have ideal skills and competence as described in many textbooks, but unfortunately, the end users are not fully satisfied, which is a situation that usually faces us in industrial projects. The solution to this problem is proposed by using a whole building commissioning system that is used successfully in administration building, and this management system is clearly illustrated in this book.

This book tries to be practical and, at the same time, match with the Project Management Professional (PMP) guide, so we selected one hundred questions from the PMP exam to help you obtain the certificate. But we chose questions that present actual cases we face in managing industrial projects.

Mohamed Abdallah El-Reedy, Ph.D
elreedy@yahoo.com
Cairo, Egypt

Contents

Preface	xvii
1. Introduction	1
2. Project Management	5
2.1 The Principle of Project Management	5
2.2 Project Characteristics	6
2.3 Project Life Cycle	9
2.3.1 Initiation of the Project	12
2.3.1.1 Getting to the Scope Baseline	14
2.3.2 Feasibility Study	15
2.3.3 Feed (Preliminary) Engineering	16
2.3.4 Detail Engineering	20
2.3.5 Decision Support Package	22
2.3.5.1 What Is the DSP?	22
2.3.5.2 Executive Summary	23
2.3.5.3 DSP Notification Document	23
2.3.5.4 DSP Reference Document	23
2.3.5.5 Why Is It Important?	23
2.3.5.6 How Can We Implement this Document?	24
2.3.5.7 When Is the Reasonable Time?	24
2.3.5.8 Who Is Responsible for this Document?	24
2.3.6 Design Management	25
2.3.7 Execution Phase	26
2.3.8 Commissioning and Startup	27
2.4 Is this Project Successful?	27
2.4.1 Project Management Goals	28

vi CONTENTS

2.4.1.1	Project Integration Management	29
2.4.1.2	Project Scope Management	29
2.4.1.3	Project Time Management	29
2.4.1.4	Project Cost Management	30
2.4.1.5	Project Quality Management	30
2.4.1.6	Project Human Resource Management	30
2.4.1.7	Project Communications Management	31
2.4.1.8	Project Risk Management	31
2.4.1.9	Project Procurement Management	31
2.5	Project Management Tasks	32
2.5.1	Define the Project Target	32
2.5.2	Define the Scope of Work	32
2.5.3	Define the Time Frame	33
2.5.4	Define the Available Resources	33
2.5.5	Define the Cost	34
2.5.6	Evaluate the Master Plan	34
2.5.7	Accept the Master Plan	34
2.5.8	Schedule Follow Up	35
2.5.9	Cost Follow up	35
2.5.10	Comparing Between Actual Work and Master Plan Cost	35
2.5.11	Performance Evaluation	36
2.6	Project Manager Skill	36
3.	Economic Risk Analysis	39
3.1	Introduction	39
3.2	Project Cash Flow	40
3.2.1	Depreciation Methods	43
3.2.1.1	Straight-Line Method	45
3.2.1.2	Declining-Balance Method	45
3.2.1.3	Sum-of-the-Year-Digits	46
3.2.1.4	Sinking-Fund Method	46
3.2.1.5	Service-Out Method	47
3.2.2	Method of Net Present Value (NPV)	47
3.2.2.1	Inflation Rate	48
3.2.3	Minimum Internal Rate of Return (MIRR)	49
3.2.4	Payout Method	50
3.3	Economic Risk Assessment	51
3.3.1	Probability Theory	51

3.3.2	Probability Distribution of Variables	57
3.3.2.1	Normal Distribution	57
3.3.2.2	Log Normal Distribution	62
3.3.2.3	Binominal Distribution	63
3.3.2.4	Poisson Distribution	66
3.3.2.5	Weibull Distribution (Rayleigh Distribution)	68
3.3.2.6	Gamma Distribution	69
3.3.2.7	Logistic Distribution	70
3.3.2.8	Extreme Value (Gumbel Distribution)	70
3.3.2.9	Pareto Distribution	71
3.3.3	Distribution for Uncertainty Parameters	72
3.3.3.1	Triangular Distribution	72
3.3.3.2	Uniform Distribution	73
3.3.4	Choosing the Appropriate Probability Distribution	74
3.3.4.1	Chi-Square Test	74
3.4	Decision Tree	75
3.5	Monte-Carlo Simulation Technique	80
3.6	Risk Adjusted Value (RAV)	83
4.	Time Planning	87
4.1	Introduction	87
4.1.1	Plan Single Point of Accountability (SPA)	90
4.1.2	Starting the Plan	91
4.1.3	Work Breakdown Structure (WBS)	95
4.2	Responsibilities of the Team	97
4.3	Expected Activity Time Period	99
4.4	Calculating the Activity Time Period	100
4.5	Time Schedule Preparation	101
4.5.1	Gantt Chart	103
4.5.2	Arrow Diagram Method (ADM)	103
4.5.3	Precedence Diagram Method (PDM)	104
4.5.4	Critical Path Method (CPM)	104
4.5.5	Program Evaluation and Review Technique (PERT)	105
4.5.6	Example	106
4.5.7	Application of the PERT Method	112

4.5.7.1	Statistics Calculation for Activity Time	113
4.5.7.2	Example	113
4.6	Planning Overview	116
5.	Resource Management	119
5.1	Introduction	119
5.2	Project Organization	119
5.2.1	Types of Organization	120
5.2.1.1	Project Organization as Part of the Company	120
5.2.1.2	Independent Project Organization	122
5.2.1.3	Matrix Organization	123
5.2.2	Selecting the Best Organization	125
5.3	Roles and Responsibilities of the Project Manager	127
5.3.1	Project Manager as a Leader	129
5.4	Administrative Organization for Total Quality Management	130
5.5	Team Member Selection	132
5.6	Managing the Team	134
5.7	Allocate Resources to Project Plan	135
5.7.1	Example	135
5.8	Relation Between Project Parties	141
5.9	Document and Information Transfer	141
5.10	Information Transfer	141
5.11	Quality Control in the Design Phase	143
5.11.1	Inputs and Outputs of the Design Phase	148
5.11.2	Design Verification	148
5.11.3	Change in the Design	148
5.11.4	Approval of the Design	153
6.	Cost Management	157
6.1	Introduction	157
6.2	Cost Types	160
6.2.1	Cost Estimate	161
6.2.1.1	Top-Down Estimates	162
6.2.1.2	Bottom-Up Estimates	162

6.2.1.3	Analogous Estimates	163
6.2.1.4	Parametric Estimates	163
6.2.2	Steel Structure Cost Estimate	168
6.2.3	Detailed Cost	168
6.2.4	Cost Estimate to Project Control	170
6.3	Economic Analysis of Project Cost	170
6.3.1	Work Breakdown Structure (WBS)	171
6.3.2	Organization Breakdown Structure (OBS)	171
6.3.3	OBS/WBS Matrix	172
6.3.4	Work Packages	172
6.3.5	Cost Control	174
6.3.6	"S" Curve	177
6.4	Cash Flow Calculation	181
6.4.1	Project Cash Flow	182
6.4.2	Impact on Increasing Cost	183
6.4.3	Project Lateness Impact	184
6.4.4	Impact of Operational Efficiency	184
7.	Bidding, Tenders, and Contracts	187
7.1	Introduction	187
7.2	Contracts	189
7.2.1	The Measured Contract	191
7.2.2	The Lump-Sum Contract	191
7.2.3	The Cost-Plus Contract	192
7.3	Contracts Between an Owner and an Engineering Consultancy Office	193
7.4	The Importance of Contracts for Project Quality Assurance (QA)	194
7.5	Contracts in ISO	195
7.6	FIDIC Contracts	196
7.7	General Conditions in Contracts	203
7.8	Arbitration and the Arbitrator	205
7.9	Bids and Tenders	206
7.9.1	Public (Open) Tender	207
7.9.2	Limited Tender	208
7.9.3	Negotiated Tender	209
7.9.4	The Direct-Order Tender	210

7.9.5.1	Tender Technical Evaluation	211
7.9.6	Commercial Evaluation	214
7.9.6.1	Commercial Evaluation Methods	215
7.10	Closeout Report	216
8.	Quality — From Theory to Reality	219
8.1	Introduction	219
8.2	Quality Management Systems	219
8.3	The ISO 9000 Standard	221
8.4	Quality Management Requirements	222
8.4.1	Quality Manual	222
8.4.2	Quality Plan	222
8.4.3	Quality Control	223
8.4.3.1	Why Is Quality Control Important?	224
8.4.3.2	Submittal Data	225
8.4.3.3	How to Check Incoming Materials	226
8.4.3.4	Methods of Laying Out and Checking Work	226
8.4.3.5	Material/Equipment Compliance Tests	228
8.4.3.5.1	Soils Testing	228
8.4.3.5.2	Concrete Tests	228
8.4.3.5.3	Mortar Testing	229
8.4.3.5.4	Heating, Ventilation, and Air-Conditioning Testing	229
8.4.3.5.5	Plumbing Tests	229
8.4.3.5.6	Performance Tests	230
8.4.3.6	When to Inspect Work	230
8.4.3.6.1	Inspection before the Commencement of Work	230
8.4.3.6.2	Inspection During Work-in-Progress	230
8.4.3.6.3	Inspection of Work after Completion	231
8.4.3.7	Paperwork/Documentation	231
8.4.3.7.1	Recording Logs	231
8.4.3.7.2	Pre-installation Inspection Reports	232

	8.4.3.7.3	Punch List Log	233
	8.4.3.8	Quality Control Plans	233
8.4.4		Quality Assurance	234
	8.4.4.1	Quality Assurance in the ISO	236
	8.4.4.2	The Responsibility of the Manufacturer	236
	8.4.4.3	Responsibility of the Owner	237
8.5		Project Quality Control in Various Stages	238
	8.5.1	Feasibility Study Stage	239
	8.5.2	Quality Considerations During FEED (Front-End Engineering and Design) Preliminaries	240
	8.5.3	Quality Considerations of Detailed Study	243
	8.5.3.1	Design Quality Control	245
	8.5.4	Execution Phase	246
	8.5.4.1	ISO and Control Work	247
	8.5.4.2	Inspection Procedures	247
	8.5.4.3	Importance of Well-Prepared Contracts in Assuring Project Quality	248
	8.5.4.4	Checklists	249
	8.5.4.4.1	Checklists for Reviewers	249
	8.5.4.4.2	External Auditing	251
8.6		Operational Phase of the Project	255
8.7		The "Total Building Commissioning System"	256
	8.7.1	Planning Stage	258
	8.7.1.1	Identifying the Commissioning Team	258
	8.7.1.2	Defining the Owner's Project Requirements with the Customer Agency	260
	8.7.1.3	Developing Preliminary Commissioning Plan	260
	8.7.1.4	Commissioning for Certifications (LEED, Energy Star, etc.)	268
	8.7.1.4.1	Establishing Initial Budget for Commissioning	271
	8.7.1.5	Commissioning Agent Costs	271
	8.7.1.6	Cost-Benefit Analysis for Commissioning	272

xii CONTENTS

8.7.2	Design Stage	272
8.7.2.1	Incorporation of Commissioning into A/E and CM Scope of Services	273
8.7.2.1.1	Project Lifecycle of the Design Professional	273
8.7.2.1.2	Project Lifecycle of the Construction Manager	274
8.7.2.1.3	Retain Commissioning Agent Services	275
8.7.2.1.4	Commissioning Agent Qualifications	275
8.7.2.1.5	Request for Qualifications (RFQ) for Commissioning Agent	276
8.7.2.1.6	Commissioning Agent Selection	277
8.7.2.1.7	Review Owner's Project Requirements and Basis of Design	277
8.7.2.1.8	CxA Roles in BOD	278
8.7.2.1.9	Concept, DD, and CD Design Reviews	278
8.7.2.1.10	Issues Log	280
8.7.2.1.11	Design Review Meetings	281
8.7.2.1.12	Update/Refine Commissioning Plan	281
8.7.2.1.13	Develop Commissioning Specifications	282
8.7.2.1.14	Written Test Procedures	282
8.7.3	Construction Stage	283
8.7.3.1	Review Submittals for Performance Parameters	283
8.7.3.2	Develop and Utilize Construction Checklists	284
8.7.3.3	Oversee and Document Functional Performance Testing	285

8.7.3.4	Test Data Records	285
8.7.3.4.1	Test Issues and Follow-up	286
8.7.3.5	Hold Commissioning Team Meetings and Report Progress	286
8.7.3.6	Conduct Owner Training	287
8.7.3.7	Turnover Commissioning Record	289
8.7.4	Building Commissioning Process in the Post-Construction Stage	291
8.7.4.1	Post-Construction Stage	291
8.7.4.2	Perform Deferred and Seasonal Testing	291
8.7.4.3	Re-inspect/Review Performance Before End of Warranty Period	292
8.7.4.4	Complete Final Commissioning Report	292
8.7.4.4.1	Final Satisfaction Review with Customer Agency	293
8.7.4.5	Recommission Facility Every 3–5 Years	294
8.7.4.6	Recommissioning	294
8.7.5	Advantages for Total Building Commissioning System	295
9.	Project Risk Management	297
9.1	Introduction	297
9.1.1	The Risk Management Process	299
9.2	Project Risks	299
9.3	Risk Assessment	303
9.4	Risk Identification	304
9.4.1	Methods of Defining Risk	306
9.4.1.1	Brainstorming	306
9.4.1.2	Delphi Technique	307
9.4.1.3	Nominal Group Technique	308
9.4.1.4	Crawford's Slip	309
9.4.1.5	Expert Interviews	309
9.4.1.6	Root Cause Identification	310
9.4.1.7	Checklists	310